Handouts of Information Technology in Education (Topic 1 to Topic 227)

Chapter 1

My Story-My School

Topic 1

Formative Years

Since antiquity knowledge has passed from generation to generation through stories. We all have stories to tell. To commence with I, felt my story might have some utility. Maybe it can provide some insights into the role of technology in education? What do we mean by pedagogy and the science of learning? How the two configure in relation to technology and integration into education? How has the classroom evolved and technology incorporated?

I remember my aunt who was a professor, author of numerous articles and few books, sitting beside her typewrite and researching her work. The click clack of the keys remains with me today. These were the times of romantic early and mid-sixties - The US invasion of Vietnam and the daily carpet bombing on Hanoi used to be the first news on the BBC. My aunt was extremely active in writing articles against the super power who invaded a small country for no reason - there was no Osama Bin Laden hiding in the North Vietnam. Now she writes her articles against the invasion of Iraq and Libya using a word processor. These days the computer has been incorporated in most classrooms but does it act a little more than a word processor with some research component? The answer sadly is no – the classroom may appear different yet for the most part remains the same.

Topic 2

The Story of My Education

This is then the story of my education. I was an only child and father (who was a senior officer in the Pakistan Army) passed away, only a year after birth. The responsibility of my upbringing fell solely on my mother. We resided in Multan with my maternal family. The question of education was a critical one, since we had no personal resources it was imperative that I acquire a good education and look after my family. Being the sole child and much loved my schooling started a little later than usual and initially I was educated at home.

When I started my home education; I had great difficulty with English. A solution was proposed by my aunts and my mother: my grandfather would teach me. He was a professor of English and it was said about him that he had no peers in his field. I was repeatedly told how lucky I was that my grandfather would teach me English. While my grandfather taught me English, a local preacher was employed to teach me recitation on my mother's insistence.

The combined learning experience was tremendously traumatic. My grandfather would sit in our veranda overlooking our back garden and I started avoiding going in the veranda. If I needed to go to the back garden I hide behind my mother's legs. If this was being lucky I shuddered to think what unlucky would be!

Why was this experience so painful for me? My maiden encounter with English commenced through the Radiant Reading books. These books, as far as English teaching went were very good and I believe remained the books of choice for many years to come in so many schools. The problem was that they were designed for people with an English background, i.e. their mother tongue was English. Despite the fact that I had mastered the English alphabet and knew the words; when it came to reading and stories I could not understand. I had tremendous difficulty in learning since I was unable to comprehend - for me making meaning of what I was studying was essential - Now I see several experts of pedagogy insisting that deep learning takes place only when you relate it to your experiences - you make sense out of it?

Memorization and understanding are both components of the learning process. While memorization is a critical part of learning, it is only a small part. Without comprehension, and only memorization, there is no understanding. Comprehension is derived from how particular information is related or understood by a person in a personal context – it is experiential in nature. Having learnt a little about Pedagogy now, I realized that our brain is wired to learn in a particular manner. We learn through association to an experience or context which we have gone through. If you try to teach and there is no association this leads to an inability to learn. This, I now understand, was why my early learning experience was so painful. Was Radiant Reading the right methodology for learning English? Later we will discuss in detail what pedagogy should be applied for learner like me and how can technology assist in the process.

Topic 3

School and Early Challenges

Having completed home schooling my story turns to my first school. I was enrolled in Muslim High School in Multan. A private school, supported through charitable donations. The school’s business model was such that in the English medium primary classes the fees were higher and tapered off as you progressed to high school. While in the Urdu medium counterpart of the primary school the fees were negligible. Here we discuss the school’s business model since these days with the aid of technology we can alter these models. Allowing us to creating educational opportunities for the underprivileged, which did not exist earlier?

It was in the third grade that I faced my next educational challenge, involving Urdu penmanship. In comparison to English where writing meant the current phonetic placement of alphabets, Urdu was a much more complex proposition. Apart from the correct conjoining of alphabet, the placement of accents, indicating the proper pronunciation, proved hard for me to grasp. Added to this was the fact that some knowledge of Arabic and other source language was also needed. For instance when writing a prophets name, it is followed peace be upon him is used. This is written in Arabic and in Arabic style. Things came to head in the third standard, when my teacher called my mother and told her that things could not continue in this manner. Seeing my difficulty my mother told me to that I had to correctly learn the words and then joining them would not be such a problem. Similarly, for the Arabic honorific, she told me to use an abbreviation, instead of the entire phrase. It was with great difficulty that I progressed.

In those we had assessments on a daily basis. Teachers had sufficient time to pay individual attention to each student and to be able to check these assessments on a daily basis. The teachers were motivated and the student body small enough to allow individual attention. If this is not the case then we will look at alternate pedagogy and technology which can engage students and provide them with the required attention.

Finally, it was time for Urdu penmanship assessment. Having finished my paper, I glanced at a class fellow's paper and noticed that apart from his beautiful handwriting he had used to the entire phrase (peace be upon him) in Arabic with all the appropriate accents. That was the probable last straw and I just tore my exam sheet and left. I never forgot the incident. It happened that I was traveling by bus and met the same person; whom I recognized instantly and even remembered his name after a forty year interlude. He was quite shocked and had no recollection of me.

Two lessons derive from this story, the power of association and the requirement of a particular subject and how its learning can be improved. Memorization is integral to the learning process. Marvin Minsky in the Society of Brains, a very interesting book on the science of a brain, states that the critical thing is association. We only remember things by which we are directly affected, and tend to forget the rest. If we started to retain all our past experience we would be solely lost in them. We will then look at how we can engage the student and create learning which will be retained. Similarly, we have to consider how technology can assist us in learning subjects like penmanship.

Topic 4

The Power of Association

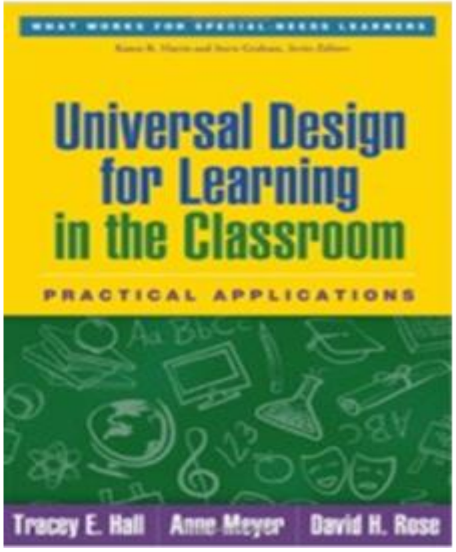
My tussle with education had not ended. In the fourth standards mathematics proved to be another subject with which I had difficulty. Concepts such as Zouazaf-e-Aqal & AdayAzam (???) translated into Urdu had no meaning for me. The learning process entails understanding something and remembering it, i.e. *Memorization;* the second step is to *DO* and *the third Act is to Connect*. The *Do involves solving a problem through certain procedure* and *its application*. But most crucially pedagogists maintain that long term learning involves connecting this to real life in a personal context. If there is no comprehension of the term or the applicable procedure employed how is a concept be understood? These Urdu terms are not used in everyday language and even those extremely proficient in it never utilize these terms. What sense does it make to a fourth standard student? While Urdu should be utilized a means to of teaching it, in fact it is my medium of choice, but terms used should be ones that make sense to student and real life connectivity to the concept being explained.

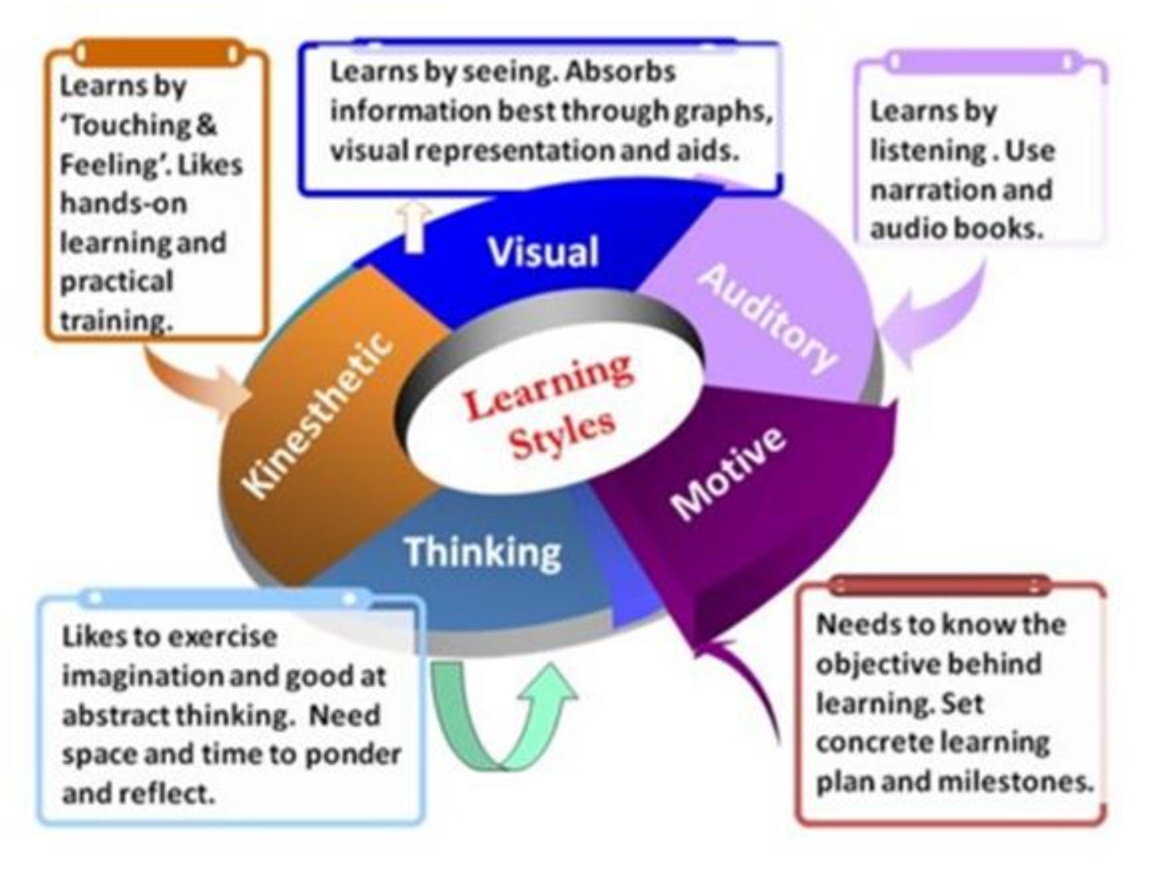
Topic 5

Different Pedagogy for Different Students

Due to these two concepts I had tremendous problems with mathematics. Things came to head when my mother was called to school and told that things could not proceed in this fashion. What was surprising about my school, and here we are talking about the sixties, was the fact that they understood that an alternate teaching methodology was required for weaker students. With this in mind they split the class in two sections; those with more understanding of mathematics, and those with lesser ability. There thinking was correct that a different pedagogy was required for the weaker students, even though they were not aware of the word. This was for that time a truly modern concept. The concept was later developed by Gardner in the1990's, whose work was based on 'multiple intelligences.' His basic premise was that different people think differently and understand differently.

Conversely, our education system is designed to teach everyone in the same manner – one size fits all. The real need is create technology based pedagogies, with customized content, to cater to each learning style and ability. The task is not as complex as it seems. Currently, about ten or so different intelligences have been identified. With the support of technology the appropriate tools can be designed to cater to these.





Let the students feel that they are being discriminated against or allow them to feel a sense of inferiority. An experience I underwent when I was classified as a weak student. We have to remember that no one particular learning style or intelligence is superior to another – it is just that we all learn differently. A fact that is reflected through the other extreme end of technology: using interactive games to teach. The most popular games are those that allow you to win occasionally but also incorporate the element of loss. Games which only allow you to win or lose, do not work. Similarly, it is the job of a teacher, pedagogy and technology to create learning methodologies which teach and do not discriminate. If a student answers wrongly, the objective should be to understand why that is so. What is his learning style and how can we teach.

Anyway back to my story, where my school tried this modern innovation. The result was that I topped the lesser student group. Another modern incentive which our school provided was that the sections were named after the top position holders – the intelligent group. This created strong extrinsic motivation for students to perform well.

Topic 6

Classroom Technology

Now my story turns towards high school. In the seventh standard I used to study Arabic and was taught by my Aunt. By that time I had also mastered mathematics. But before we proceed I would like to turn back to my primary school and discuss a topic which is strongly related to technology. In those days we used to use a tablet. This was used for developing penmanship. Great fanfare, which was quite exciting, went into preparing the appropriate tablet, washing it and using clay to coat the surface. A reed pen was sharpened for use. This was the technology of our times. It was a fun technology and environmentally friendly, no wastage took place apart from the ink, very unlike today. Anyway, the current counterpart to our technology is the modern tablet (apple’s IPad or android).

We can also be used on writing and for penmanship. It is an intelligent tablet; if you deviate from the prescribed penmanship format the tablet lets you know. In our times we were taught by teachers who by told us how to hold the reed pen and then by holding our hands guided how we wrote. A latter innovation used writing books where the appropriate letters were printed in a broken (dashed) form and we had to complete the letters. Our tablets were based on static technology. It did not provide instant feedback; it was the job of the teacher. Tablets these days can be designed to teach you this art and also provide instant feedback, if you start to make a mistake - a quicker way to learn. These tablets can also be used for storing all your textbooks. In comparison to actual text books which not only cost enormously, waste environmental resources and need to be lugged around. Today’s technology allows you to create a tablet which not only allows you to do your work but contain all your learning resources.

Topic 7

What we are taught?

From the last example we can clearly see the need for alternate methods of teaching. Yet, unfortunately for the greater part we are still utilizing the methodology employed in the past. What we need instead is to understand our objectives clearly. Should the focus be on form or should we make students learn real problem solving skill and critical thinking skills. Here I do not refer to college or high school level but primary school. What are more important, dictation skills or thinking capabilities? A fourth, fifth grade student is very creative and has his opinions. Unfortunately, our educational system gradually diminishes, if not outright eliminates, this natural enquiry ability. Now in terms of technology it is up to us how we utilize it. If we only use tablets as was done for the older tablets, we would be misusing and wasting technology. In Horten's, E-learning by Design, he states that three elements are required for teaching; memorization, do and connect activities. All three elements need to be present when considering appropriate design of technological pedagogy.

Topic 8

Proving Theorems

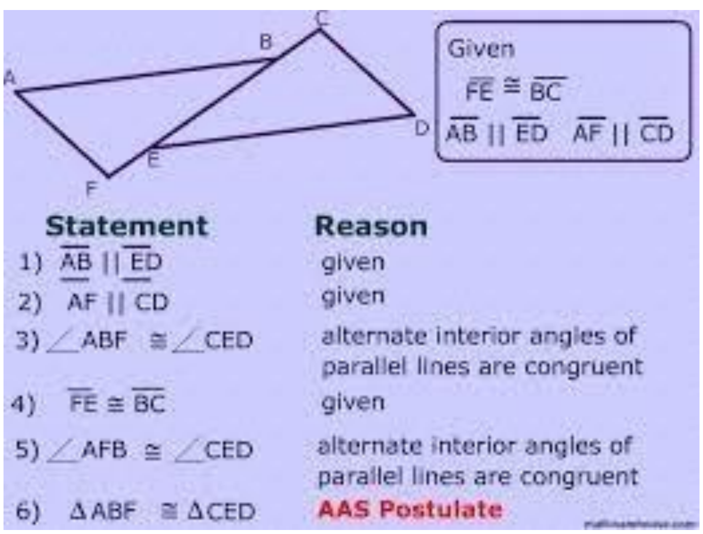
Moving onto the night standard and geometry; in our days we had theorems in geometry, which we needed to prove. It is unfortunate that these days we have none, since these encouraged a certain way of thinking and required creativity. Again, we had quizzes every day to monitor our performance. Unlike earlier classes, the class sizes were very large in our High School. Each class had close to a hundred children, there were four sections and one or two teachers were available to teach the entire batch. As mentioned earlier the quizzes were done on a daily basis. It was necessary that they were marked on a daily basis and handed in the next day. A task that was physically impossible for the teachers. With the current technology available this would not be an issue. An innovative solution was developed in the form of Teaching Assistants in those times. Later when I was teaching at various universities I truly discovered the utility of teaching assistants. It was the job of the teaching assistant to grade the quizzes and address any particular problems the students faced. Now a computer program can help you as a teaching assistant in marking quizzes instantly and efficiently?

Here I would like to point out that; pedagogy the science of learning states that there is a tremendous difference between a student and a teacher in terms of understanding. A teacher can take a lot of things as given which is not applicable for the student. The mental learning process entailing; memorization, doing and connecting may vary considerably from what the teacher is trying to put across. Instead if a student was to teach the same thing it might imply a similar thinking process and perhaps better understanding from a student perspective. By the time I was in high school I had started to excel in academics and usually topped my class. It was because of this that I was chosen as a class monitor and teaching assistant. Apart from my other duties, it was also my responsibility to check all the quizzes and hand them back the next day. My own quizzes were checked by the teacher himself, which was quite equitable and ensured transparency. It is important to remember that without the help of technology, in those days, we could still provide instant feedback to the student, which greatly assisted in the learning process.

Topic 9

Test Challenge

The next story is about how I was, one day, challenged by a student that my grading was incorrect. The student sat next to me class in the ninth standard and had previously come second in the entire Punjab Board. He was main competition. While he was brilliant but a little lax about his studies, I made up with hard work and effort and was able to usually beat him. Now how do you deal with students who are extremely intelligent but less focused? How do you motivate them and keep their interested? This is truly critical since these people are integral to development of society. They are usually difficult and do not fit in the typical mold, but are creative and bring about major innovations. These are the people who change the game.



Now Ali, my competition was one such student. On a particular quiz day he came to class without studying; while I on the other hand, had put in great effort and knew the theorem and its proof by heart. While actually doing the quiz it seemed to me that the book was open in front of me. Here it needs to be understood that it is critical, from a perspective of pedagogy and teaching, to be able to distinguish between true understanding and mere memorization. More importantly how this difference should be assessed? Here technology can play a vital role? Back to the story, while I solved the theorem line by line as given in the book, he tried to solve it on his own. This was truly remarkable and impacted me greatly. Whenever I am teaching if a student commits an intelligent mistake I give him more marks than a student who just reproduces whatever is given in the text book. Anyway, at that time, while checking his quiz, I gave him a zero, since instead of proving the theorem he actually disproved it. The mistake was very subtle and one which I could not identify at that time.

For my quiz the teacher gave me full marks. Next day when the teacher came to class and all the quizzes were distributed the teacher showed my quiz to the class and said that I had gotten full marks. Accountability in those days was crucial and students were shown that their papers were marked correctly.

Topic 10

Memorization VS Understanding

Ali stood up in the class and told the teacher that it is not fair that I was given full marks while he was given a zero. He said all I had done was to reproduce exactly what was in the textbook. While I tried to use my intelligence to solve the problem, even if it was disproved

It was not fair. The teacher looked at me and I told him that instead of proving the theorem he has disproven it. The solution proposed by the teacher was that I should sit with him, go through it line by line and sort out where Ali went wrong. This would also show if I had only memorized the theorem or also understood it. As mentioned earlier it is critical for a pedagogist to understand this difference and surprisingly the teachers in those day did, which was a very modern concept. When I actually sat with him and went through his quiz in detail I had a very surprising feeling.

From a view of pedagogy and technology it is critical that we understand this difference. When I go through a textbook I presume that what is given is correct. But this only engages my memorization faculty and to some extent understanding. While going through his quiz my faculty of doing and connecting were also engaged and it was a very unique learning experience and an enlightening one. It was through this exercise that I really understood the theorem and its proof. Finally, we were able to locate his mistake and we went back to teacher and told him this is where he went wrong and he realizes his mistake. I told the teacher even though wrong it was a very intelligent mistake. On hearing this, the teachers asked me what should be his actual marks. I told him he should decide. If I remember correctly he was given half the marks or slightly more. The teacher also asked him to study a bit more in the future. God has given you a good brain please, use it slightly more! The important lesson is that, while memorization is an essential part of learning, the doing and connecting elements are more critical. This is how the story of my school unfolds.

Chapter 2

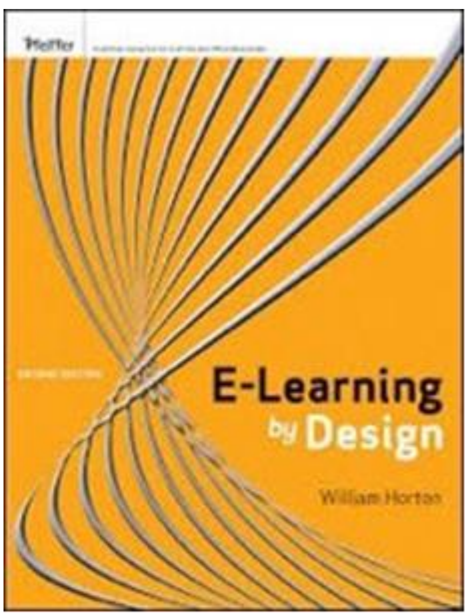
Connecting New Knowledge with Prior Knowledge

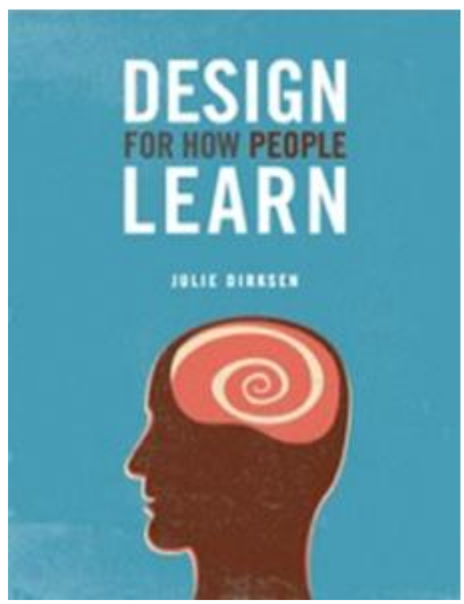
Topic 11

Objectives, Content and Deliverables

Previously, we had discussed stories, particularly that of my education. The purpose was to provide an overview of what we are attempting in this course. If we had discussed these issues in isolation, purely definitions, they would not provide you with a particular context. By association with my educational experiences and perhaps with your own, it may provide a better understanding.

We now turn to what are the courses objectives, content and deliverables. Here, we will also discuss the expertise that you would acquire from this course.





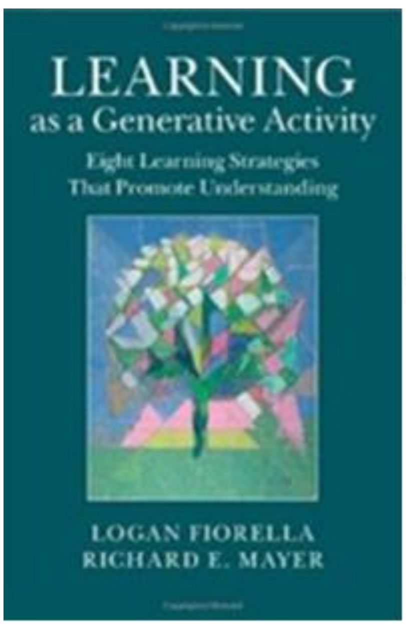
We begin by a quotation from a famous pedagogist/psychologist in education: “The single most important factor in influencing learning is prior knowledge and then the next step is relating the prior knowledge to the new knowledge.” This in our case implies that when coming across new information, observing, listening, or in case of a book reading and understanding alone are not sufficient. True learning will only arise when you can link this new information which is being processed through your brain, perhaps in form of questions or new concepts, when you can relate them to your prior experience. In terms of cognitive setup your brain is designed to learn and retain when particular information is grounded in your personal experience. This was discussed earlier in terms of William Horton's book E Learning by Design (***Absorb – Do – Connect***). This may seem like hard going but we will try to simplify and illustrate this through the use of another story. Before proceeding, a small side note: we will be referring to quite a few books, which utilize different terminologies. We should not be worried by this fact since they are referring to the same things. Our focus will be on what they are trying to say and we will try to minimize the definitions as far as possible.

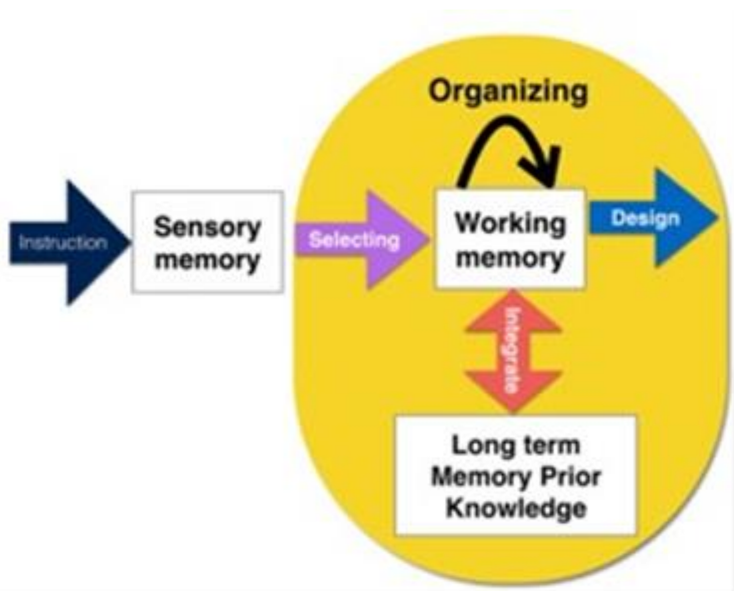
Topic 12

Learning as a Generative Activity

Another interesting book, Design for How People Learn by Julie Derkson, is a fun learning tool which is full of cartoons and illustration, which allows you to learn about Learning, Pedagogy and Technology required. A colorful book which is also available in an e-format deals with the question of learning in this form. The process of connecting with prior knowledge (Absorb – Do – Connect) is described a cognitive process which create friction in your mind due to the new data. The key is to transpose this data on prior concepts available to you or rather create linkage between the two. For example an old relative visits for the first time. The first order of things is to establish the exact relationship without which you are not quite comfortable and there is friction in your mind. Once the relationship is established your feel more comfortable, since you now know how the person fits into the scheme of things (family tree) and you can proceed further. The same process happens with any new information (word, picture, concept) there is friction in your mind until that thing is placed within the cognitive schematics of your brain. Friction or active involvement is crucial. In context of learning process the active involvement can be in the form of curiosity, disappointment, initial failure which ultimately lead to that aha moment, when true learning transpires. Once the puzzle pieces fall into place the concept is clearly understood and retained. We continually reiterate on this theme since this is key consideration when designing any learning technology.

A third book which we need to consider here is; Learning as a Generative Activity – Eight learning strategies that promote understanding by Richard Meyer and??? This is a very recent book, published in 2015 and one we believe will be valuable and informative addition to this course. The book deals with the same things which we covered earlier from previously mentioned books. In this book the learning process is referred to as a Generative Activity. By this the author implies that people wishing to learn with understanding should engage in appropriate Cognitive Processing. This process simply is as follows: selecting key information, mentally organizing it, and integration with relevant prior knowledge. This explanation differs in two ways from the earlier definitions. The process is selecting information refers to the particular information which we are trying to absorb, since it would be impossible to absorb everything, i.e. there is a filter mechanism to the input process, whether perceptual or sensory. Additionally, integration is with relevant prior knowledge; it has to be contextual to make sense. All three books, which we will use throughout the course, will allow us to breakdown the learning process into smaller segments for greater understanding and analysis. This will allow the appropriate use of pedagogy and technology in understanding an intelligent and relevant learning process.





Topic 13

Social, Teaching and Cognitive Presence

We now go back to Muslim High School and I am still studying in primary school. As I told you earlier, students at that time were segregated in different sections based on ability. Those having difficulties with learning were placed in a different section from those who had no issues. I had problems with quite a few subjects and was in the lesser group. A situation, which was very disturbing, for my mother, who was a Philosophy Professor. In those days there was no distinction between Psychology and Philosophy which were treated as one subject. The conjoined subject fell under the purview of arts, unlike today where Psychology is a separate science. My mother understood that I was having problem not because of my lack of intelligence but due to my social integration which is needed for social presence in the class room (apart from this presence - we need teaching presence and cognitive presence for meaningful learning to take place - we shall talk about these presences in detail later). I was an only child and singularly brought up by my mother. She told me to start socially interacting with other children in my class and that I could invite my friends over to the house and that she could help me and friends with their homework. Now what was the logic behind her offer? In her wisdom she realized when studying in a group, it would be the right atmosphere and she could be strict on the other student which would also keep me in line. Another thing which she did, and for which I remain grateful, was that she made an effort to ensure that I complete my homework earlier with her assistance and then help other complete theirs. She never told me why she was doing this. Now going through these books, especially Generative Learning, I observe that one of the learning strategies out of eight is - learning by teaching. It has proven experimentally that by teaching peers you learn rapidly. For her time it was truly incisive. Another reason she wanted us to study together was that it would be simpler to discuss ideas and ask each other for help, if unable to understand something in class. Again she was way ahead of her time. These days the phenomena these days is referred to as Social Presence. This refers to the fact that any student either in class or groups, physically or on-line or need to have awareness that they are connected and not alone. It is critical in the sense of social presence that each student has an equitable access to voice their opinions; they can express themselves and approach someone for their problems and queries.

When she initially told me to bring them over, I told her I would be hungry. She told me it was not a problem and they too can have lunch. Our school was located between the cantonment and old city. In those days there were only two classes in Multan, the landed and mostly lower middle to lower classes. The very well off were not really inclined towards education. Similarly, the poor did not really realize the real utility of education and were mostly accidental students. The first time my friends came over to our place they felt terribly out of place.

Topic 14

My House and Associations

Before turning to this story let me briefly describe my house. It was located next to small canal in Pul Moaj Darya. The canal no longer exists. The house itself was a huge pre- partition mansion belonging to a Hindu lawyer. We were allocated half of the mansion. It was surrounded by fields and trees and was isolated from the city. There was no boundary wall except a fence of cane? There was little movement around and when my friends were invited they told me that was a strange house. When they came over, crossing the canal and seeing the huge house, with its looming corridors they were quite bewildered. They were equally curious and were trying to take in their surroundings. The first thing they saw was a wooden shelf full of books and magazine. This was ignored. Instead there was a lot of female laundry which was hung out to dry and this was observed; reinforcing their belief that there was no male presence in the house. Next they turned towards my grandmother who was sitting in the porch on a divan against a bolster and greeted her. As she left for the house to inform someone to get drinks for them, they noticed she was wearing a loose pajama. Now in Multan, in those days this was not normally worn and one could only see this in the movies. Now all this was being selected by friends for interpretation. One of these friends was from the inner city from dubious area. Naturally, he was trying to absorb this information and relate this to his prior knowledge.

Topic 15

Mental Pictures

The mental picture he created was truly astounding. Since he could not ask me directly, he was rather embarrassed; he instead asked me indirect questions. Asking relevant questions is also an important part of learning and is an art. It is also an important pedagogical learning strategy. The question he asked me was truly relevant and I remember it to this day. He was amazingly brilliant and it is sad that we cannot provide the appropriate educational opportunities to such brilliant students. The question he asked me was that, is there pandan in your house? On the surface this seems as rather silly question. Yet, his mental picture was hinged on this question. I told him yes but was used occasionally. His picture was now complete. His next question was that is there a musical instrument in the house. When I replied no, my mother and aunts were teachers and there was never a musical instrument in our house. The entire picture created by him fell apart; I could see the disappointment in his face. I believe this example illustrates the learning process and how an individual tires to solve a particular problem. The same process which a doctor, detective and physicist employ. Some observations, few clues, and some information which needs to be connected to form a hypothesis and a theory arrived at. Another important point to remember is that none of the other friends were following his logic and were as perplexed as I was. Based on his prior experience only he could link this new information in a certain light and create his particular mental picture.

The story does not end here. Since the first premise had failed my friend was still trying to place the house in a context which was relevant to his own experience. We moved to the main room, which was stacked with numerous books, few desks and beds. This was the area where my mother and aunts studied and slept. Incidentally, I remember my aunt listening to the BBC on the radio about American bombing in Vietnam. The terrible memories of carpet bombing and other atrocities remain vividly with me, to this day. Anyway, on seeing all the books and desks my friend enquired if this was a library? He was still trying to categorize the house and contextually integrate it to his previous knowledge.

The basic purpose of the story was to illustrate how we learn. To arrive at understanding we have to transverse through a defined process. With advances in pedagogy and science of learning we are in a position to chart this process in its smaller constituent components. This helps us in diagnosing or mapping the process where an individual might falter. It is no longer sufficient to say that a student is not able to grasp a particular concept. We are now in a position to exactly pinpoint the area where he is facing a problem. Is the student facing problems in the absorbing or selection of knowledge, is it the DO part and finally is having problem connecting? Are his past experiences and references valid for successful integration of new knowledge?

Topic 16

Diagnosing and Mapping the Process

Suppose a student is facing difficulty in grasping the Periodic Table in Chemistry. Previously, when help was asked for all we would do is repeat what we had already taught or possibly alter it slightly. This is no longer valid; we are now in a position, through technology, to provide help in determining the particular student probably knows this or that. In most cases this proved to be false and caused great distress to student in the learning process. We can now successfully identify where corrective action is required.

If you remember another past story, a really intelligent class fellow had disproved a geometry theorem instead of proving it? We could also utilize technology in this case to see where he went wrong? Was it an issue with absorption, doing or connecting the knowledge?

Despite our sincere efforts at sidelining a lot of definition we still require some working knowledge, especially in context of the books we would be utilizing.

Topic 17

Selecting, Organizing and Integrating

Apart from the learning process; selecting of information, organization of information and its integration we also need to understand the monitoring and controlling of these cognitive processes. This is especially critical in the context of students being able to do it on their own during a complex understanding task. The ability to do this is known as meta-learning and is much in vogue these days: the ability of students to learn and control their own learning process. Naturally, this has much wider application since learning and de-learning is a continuous process and not confined solely to acquiring education. Coupled with the enormous amount of information which we are bombarded these days, we will all have to learn to select, organize, connect and integrate information at a rapid pace.

A person may be able to select appropriate information, organize it and integrate it yet they still may not learn – the person just does not want to learn. We can say that this particular person does not seem motivated. What is then the technical definition of motivation for our purposes? "Motivation is defined as a special cognitive state that starts, energizes and maintains a specific goal directed behavior." Now when does this state occur? There are two ways through which this occurs: extrinsic mechanism, where reward and punishment determine a person's level of motivation; and an intrinsic mechanism where the individual is self-motivated.

Even though the carrot and stick approach is a time honored and recognized methodology for motivation; yet if we look at history for the past fifty years we see that all major innovations and inventions which have redefined the way we live, we see that there was no coercive element behind the individuals and firms, who brought them to us. These people or groups of people were intrinsically motivated. For firms like Apple profit was not the sole objective.

When I was at LUMS our department (of Computer Science) used to stay in office till ten at night. We aimed to create a Doctorate program which would not only be compatible globally but would exceed most. We were offered no rewards. When an artist is creating his work, he is lost in it. The process of creation is reward enough – passion paves the way.

Topic 18

Intrinsic Motivation

Now let us turn to a story of intrinsic motivation. Ten years ago, while I was a professor at LUMS, we went to my mother's house to meet with her. At that time I usually drove my own car. Being in a hurry I parked my car in a manner which was inconvenient for other drivers. I realized my mistake but did not rectify it. After having visited my mother and walking back to the car with her and my wife; while my mother was talking to my wife I thought I would go move the car. As I approached the car I saw another car trying to pass and it seems to be having difficulty doing so. The other cars window rolled down and an extremely beautiful lady smiled and told me there was no need to move my car. I truly felt embarrassed but unfortunately my wife, at a little distance, also saw the smile and saw that she was saying something to me. Naturally, my wife was rather miffed and asked me why that lady was being so bold with me? Even though there was no truth to the picture my wife was painting in her head. She only chose to see the beautiful lady smiling at me. She did not see the parked car which was obstructing her way – selecting the wrong information.

Topic 19

Car Trouble

My mother asked me what was going on: I told her about the parked car but my wife told me to tell her the real reason. Then she asked my mother where this lady lived. My mother told her she had not seen the car before. You could tell by her (my wife) expression the turmoil that was taking place in her mind. She was intrinsically motivated to find out about the lady. Fearing future repercussion I told her that we should leave. As we sat in the car and closing my door, to distract her, I told her that there seems to be some problem with door closing. She turned towards me smiling and said she had figured out why the lady was smiling at me? She asked me to step down, which I did immediately. Next she told me to see the blue paint on our car. Despite the fact that she was strongly, extrinsically motivated by jealousy, she was able to figure out what had actually transpired. The lady had hit our car, as reflected by the problematic door and residual paint from her car. The smile I figured out was to distract me from seeing what had actually occurred.

My wife figured this out quite easily, which another person could not, because of some prior knowledge – my parking was causing difficulty for other cars and her intrinsic motivation through jealousy to disprove the fact that another young and attractive lady was drawn to me. This story clearly reflects the importance of accidental prior knowledge and intrinsic motivation.

Chapter 3

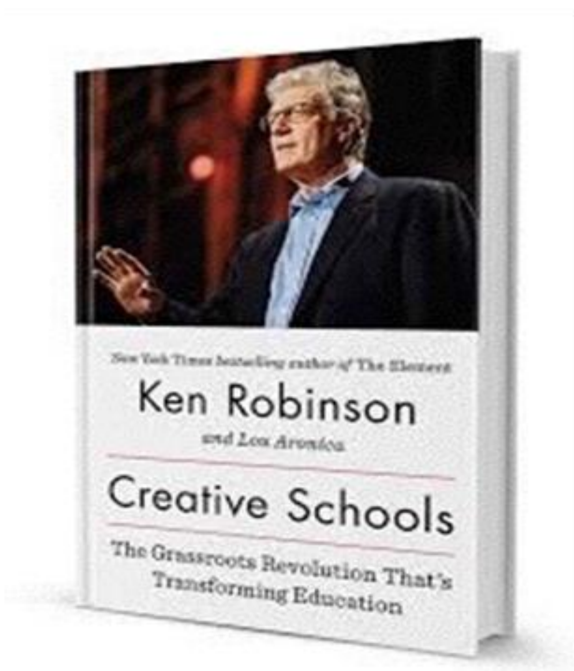
One Size Fits All

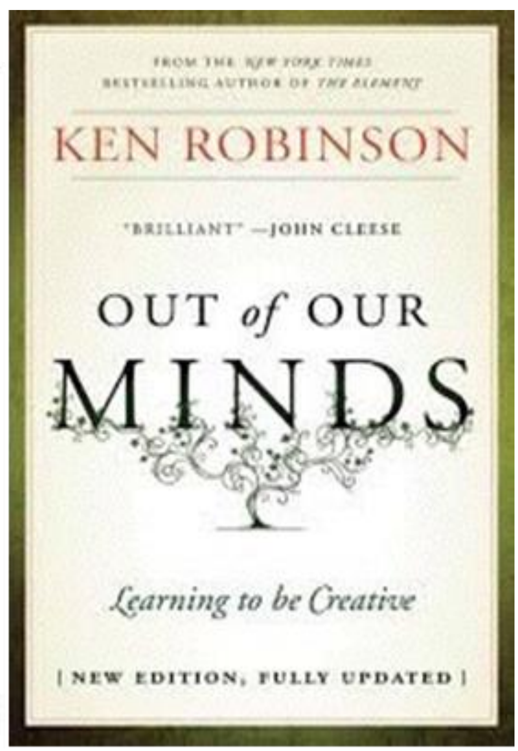
Topic 20

Rapidly Changing Technologies

Education is a vast field in which technology can be utilized in innumerable ways. The tremendous amount of changes in technology, in the past decade, has been astounding. If we go back twenty years it is even more amazing. For instance; when we used to go to university, we did not even possess a calculator. Our technology consisted of a slide rule.

Just in my lifetime the advances in technology have been mind boggling. Unfortunately, despite these changes none have been utilized in education – an area where it can assist greatly.





We all have to now face the existing situation and see where technology can play a role in overcoming the existing deficiencies in the education system. Turning to Ken Robinson's book, 'Out of our Minds, we begin with this quotation: "current systems of education were not designed to meet the challenges we now face; they were developed to meet the needs of a former age. Reform is not enough they need to be transformed." The reference from the quote about educational system design, i.e. what were they were designed for will constitute an interesting separate module. To transform any system we have the following option: by delving into the system and attempting to correct its inherent issues, which in our case consists of teachers training, student involvement, change in pedagogy, assessment and so on. Yet we have to understand that certain systems are quite static and do not retain the capacity to be flexible. These can only be transformed radically, through the use of appropriate technology.

Sadly this is the case with the current educational system, which is cannot be rectified by cosmetic and patchwork measures. A major overhaul is required and the current state of technology allows us to do this in a much more efficient, less time intensive and cheaper manner more importantly in a more exciting way.

Topic 21

A Model School

We, now, went back to our stories and the Muslim High School, Multan. Here we are talking about the sixties and despite the fact that this school was located in the small town, then, of Multan, yet the school was academically outstanding- not only in Pakistan but I would say Asia. It was run by a visionary headmaster, Chaudhry Abdul Rehman, with the help of a small management committee. He was stickler for all things educational and could not bear to compromise on quality. Despite the fact that the school was a model one, there were shortcomings. These in this day and age with help of technology can be addressed.

In those days one of the major criteria which academically distinguished a particular school was the number of scholarships for matriculation which were granted, by the Punjab Board. There were numerous schools which excelled academically, including Central Model School in Lahore; closer to home was the Millat School in Multan. But thanks to our principal our school was also renowned for its extracurricular activities including its sports programs. This was renowned not only locally, but at the national level. A lot of our students were qualified to take part in any national team in their particular sport. An interesting sidelight, a lot of these students who excelled at sports lacked in their academics - a critical question, not only in our context but globally, and one which we will come back to later. Apart from sports, at our school, there were literary and debating teams, again competing at the national level. Drama and theatre was encouraged, with the teachers acting as amateur Directors. The theatrical presentations were open to students from other institutions, along with the general public. Music was another area which was emphasized. Our school band was considered the second best band after the army's in the entire country. There were literary gathering every week, organized by the students themselves. Cold water was available in all classrooms during summer. The procurement of ice, its management and distribution was the responsibility of the students and constituted their social participation.

Topic 22

Maintaining a Diary

Each student was required to maintain a diary and classroom cleanliness was also the responsibility of students. I will discuss these in details later. These extracurricular activities were essential to the formation of a rounded personality of student and for instilling a sense of self belief and awareness, which are critical.

Here I would like you to remember that all these activities were taking place in a school which was run on charitable donations. Most students were not paying fees and the school was entirely driven through fund raising, without any support from the government.

Topic 23

Cleaning the Class

We now turn to story of school cleanliness. At the school there were only two sweepers which maintained the enormous facility. Each classroom was spotless, how was this done? Two students were assigned each day to sweep and mop the floor and ensure that it was spotless. It was the job of a committee to ensure that each classroom was immaculate and decided upon who would be awarded the prize for the cleanest classroom. One of the students, a scion of wealthy Khwaja family, whose business was in leather and his father a large and important fund donor to school, was assigned the particular task. On that particular day, after returning from assembly to the classroom we saw that the classroom was shining. Our class teacher came in and saw the classroom and was impressed by Khwaja’s work. But a student stood up and complained that the work was not done by Khwaja. On enquiry Khwaja appeared to be evasive. Yet the student insisted that Khwaja had not done the work.

Another student stood up and said that he had volunteered to clean on behalf of Khwaja. It was opportune moment to actually demonstrate the principle of right and wrong and the lack of distinction between rich and poor -unlike these days where a VIP culture is rampant. The professor took him to principal, who despite the fact that his father was one of the largest donors, assigned Khwaja to clean the class next day, with the entire class not attending assembly and watching Khwaja accomplish this task -a true example of adhering to ones principles.

Topic 24

Inequalities in Education

As I had mentioned earlier at that time there was no middle class, per se, in Multan. The school was either attended by the very poor, whose fees were exempted, or the very rich usually sons of wealthy donors. Why did the rich, unlike today, allow their children to mingle with the lowly? The school reputation was such that most of these people choose to overlook the fact that their children would be mixing with the lower classes. For the upper classes there was no intrinsic motivation for studying, since they had their businesses setup and their landholdings. Similarly, in the lower classes the choice is between allowing children to study or engaging them in work from which a revenue stream can be established. In either case the intrinsic motivation is low.

In terms of numbers our school was operating at capacity. In the sixth standard there were six sections and the total number of students was around three hundred and sixty. The dropout rate was also rather high. Those children who were unable to keep up academically were asked to leave. That is not to say that they were not otherwise talented, some were amazingly gifted. There was student, Azeem, who was a brilliant singer; he used to perform in any all school events. If he had given further musical training along with necessary educational skills, he would have been a phenomenon. Similarly, Usman, was an amazing artist. His paintings were even commissioned by the school for an event. Despite their talents both proved to be unsuccessful in a standardized educational format and dropped out of the system – an immense shame.

Masood was a gifted actor. He starred in a drama on Tippu Sultan, which was widely acclaimed and even held a special show for the armed forces stationed in Multan Cant. Bakhtawar Shah was impromptu speaker. You could give him any subject and with minimal preparation time he would deliver an authoritative lecture. Ali Shmas ul Qamar was a poet; Mirza Ghalib could always be found in his pocket. Shahid, was a story write. Conversely, I was not a great participant in extracurricular activities. Most practice took place after school hours and I was not allowed to attend. Compared to me they were all immensely talented and if their talent was allowed to be nurtured they would prove to be the innovators and game changers, which a society desperately searches for. Their worth could not be measured in the usual criterion of success; what house they possessed, what car they drive, yet their contribution to society would have immense.

Why did they all fail? They just could not fit into the standardized educational system, while I could. I adapted to the system, called distortion and not a desirable thing. With the technology available today we would have been able to retain these stars.

Topic 25

Technological Innovation and Difference in Learning

This story leads us to the definitive question which underlines the entire course: how can we, with the appropriate use of technological innovation, cater to people are who are different in education? By different we refer to people who cannot adapt to a standardized educational system, despite possessing innate talent. By answering this question gradually we will be able to achieve the objectives of this school.

There are two type of individual in this world. One who can adapt themselves to societal norms and as such are rewarded with material success. Then there are those who are unreasonable and unable to fit in. According to George Bernard Shaw all the progress in society is based on these people. Based on a set of limited resources and ever growing users, only with innovation will we be able to distribute these goods more evenly rather than letting their accumulation confined to the few.

Our current schooling system too is standardized and has hardly evolved for ages. Instead of the person having to adapt to the system, the system should be flexible enough to adapt to the individual user. As mentioned earlier, at that time, the number of matriculation scholarships was a criterion of academic distinction. In our school there were about three hundred students who would appear for this examination. Of these who had adapted themselves well to the system would, distortion, a numbering about fifty or so, would be sponsored by the school in terms of fees? Another advantage would be that this group would be groomed by the best faculty. This may seem a little harsh but what choice did the school have with three hindered students and limited resources? If the limited faculty members were distributed for the entire student body the marks of all would have improved marginally, but there would be no scholarship students.

This no longer hold true! Technology allows us to address this and other educational issues. Of this elite group of students fifteen to twenty student were identified as sure in getting a scholarship and were further segregated. These students, of which I was one, had become versed in meta-cognition: they were able to learn on their own. Consequently, they were treated differently and enjoyed a great deal of independence, i.e. if they wanted to study on their own. Of the remaining two hundred and fifty they had to pay and make their own way. The talented students I had mentioned earlier were nowhere on the scene. It was surprising that a mediocre student like me could through hard work reach a position where these more talented students could not? In the sixth standard, those who could not pass would not be detained. A standard practice in private schools at that time, i.e. they would still be promoted to class seven. There was no feedback and parents would often wonder why despite failing a grade the child was still promoted? From the perspective of school they could not be detained since there were three hundred students coming from lower classes and there was not enough space to retain these failed students.

Apart from our school there was government pilot school in the same vicinity; a good school with young qualified faculty. It was a practice in that school that any failed students would not be retained. Still there was no feedback mechanism, in both type of institutions there was no feedback as to how a student was performing and what help he required. In one you would be promoted despite failing while in the other you would be dropped from the school for failing. Things have not changed much; there is still no feedback apart from annual exams and various tests in between. With technology the equation has changed, we can now instantaneously gauge a child's academic level and requirements: we can see clearly where, how and why a student went wrong in a particular subject.

Topic 26

The Educational Challenge

This was and remains our greatest challenge and one which will only be further exacerbated by the growing population. How do we than handle students who dropout and those that do not have the time to attend school, i.e. most engaged in some menial employment? If we do not think about this, a time will come when this will becomes an issue with dire consequences for our nation. The problem is not as complex as it seems if we rely on technology.

Topic 27

Theoretical Learning and Actual Experimentation

We head back to our school and the ninth and tenth standards. At this level a lab environment is required, especially for Physics and Chemistry. When the time came to apply our theoretical learning to actual experimentation the excitement was palpable. Even those students who were bored with class lectures were really looking forward to the experiments. This entailed the Do part of learning which we had mentioned earlier. From this another point which is quite discernible is the unnaturalness of the lecture format.

Our instructor asked us to arrive on Sunday to the laboratory. We were told that each student would complete the experiment in varying times but we would not be allowed home until the experiment was complete. *The experiment required varying student times but a bare minimum understanding*. One wishes this insight could also be applied to theoretical classes but sadly that was not the case - it was just not possible at that time.

On the prescribed Sunday each students was there before time; in state of high intrinsic motivation, never the case with the regular lectures. Prior to the experiment we were told to study the background and theory of the experiment, which all students in their excitement failed to do so. Imagine their disappointment when the lab instructor told everyone that we would be doing a soft experiment focusing on the theoretical part. What we are trying to figure out, what equipment would be used, what might be expected results, etc.? This also proved to be exciting; most of the students were busy with thought experiments and were really immersed in the activity. Again the chain of Absorb, Do and Connect or Select, Organize and Integrate were all taking place in the virtual activity. What we can learn from this is the importance of making the absorbing part of education much more interesting through generating a Do component or making it activity based.

We were told by our Principal, that the Chemistry equipment was very expensive. Most of the equipment which was glassware was donated to the school. Come next Sunday and we all experimented. It was the highlight for us and all the children had tremendous fun. Unfortunately, there was significant breakage too. Some of us were so excited that we tried to create small labs at home. I saved up my entire year’s pocket money and bought a small experiment set. It was really enjoyable to repeat the experiments at home and other students would come over. The sad part was that the lab facilities our class enjoyed were not repeated the next year, due to the excessive breakage. Some of the equipment was truly expensive and the school was unable to generate the required funds. This was not only the case with our school but almost all with a few exceptions. It is also equally valid today for a majority of the schools.

Topic 28

Demonstrate or Experiment

Some schools tried an alternate. They felt that the students should not be directly involved in carrying out the experiment. This would be carried out by a qualified instructor who would demonstrate the actual experiment to a class. Even our school this methodology was later followed. Despite the impersonal nature of a demonstration it is still enjoyable for students. The Absorb and Connect activities are still taking place and there is still significant involvement. For most schools even this methodology is still financially prohibitive. For

example while gathering data from various schools in Pakistan to collate individual student intelligence and their critical thinking skills. What is their understanding or is it rote learning. Granted that the Earth is orbiting around the sun and spinning on its own axis. The sun rises in the East and sets in the West. Do we just know this knowledge or do we understand this? How do we prove it through an experiment? This was the question which was asked in various universities, colleges and schools in Pakistan. The question was followed by a rational debate. No actual demonstration was identifiable. The question was also framed on Facebook and no answers were forthcoming apart from a professor at University of Engineering and Technology (UET), who said there was a demonstration at the National Science & Technology Museum - adjacent to the UET, Lahore. The very expensive demonstration consisted of a pendulum being hung on a building. How does that demonstrate the Earth motion?

Topic 29

Why is the Earth Orbiting the Sun

I remember in our Physics class at UET, first year, a very intelligent and naughty student once addressing the Physics professor and enquiring if he could demonstrate a lab experiment which would rationally demonstrate the fact that Earth spins on its axis and that the sun is not moving? The professor said we should go next door to the National Science and

Technology Museum and see for ourselves; since there is an experiment which demonstrates this. We were all very excited and a time was set for next week. At the museum we were very warmly received and shown a huge pendulum which was hung with a very long length of wire. The pendulum was driven by a motor and remained in perpetual motion. Naturally, a motor was required since otherwise it would stop due to friction. On the sides of the pendulum there were sticks, which upon collision would fall down. It would do so one side and then the other with a slight shift, this shift demonstrates the circular motion of the earth. This was stated with such authority that no student with the exception of one questioned the museum representative's assertion. He was told that he was at the back and how he could understand. Now the dilemma for most students was connecting the shift in the to and fro motion of the pendulum to the spin of earth. The expensive demonstration was quite futile. A better option would have been to carry out a thought experiment, which would also entail some absorption activity, much like Galileo did several hundred years back.

Topic 30

Thought Experiments

Let us take a look at some common Physics experiments. Newton's Law cannot be proven in a lab environment. With the exception of maybe NASA and some other laboratories the creation of a perfect vacuum or a frictionless environment is impossible. All of Newton's laws were based on thought experiments. With the aid of technology we can create computer simulations; transforming thought experiments into actual experiments. Galileo, when asserted that if you take a heavy object and a light one and drop them from a height simultaneously; if there is no air resistance, they will fall at the same speed and acceleration and will fall down simultaneously. Now this is completely counterintuitive; a feather would be accepted to fall lazily in waving in the air stream, while a lead ball would fall directly. Imagine his imagination and the thought experiment carried out. This is what he assumed; suppose the heavy object will fall faster, then let us tie the heavy object to light object with a thread. The combined object is heavier and will fall faster.

Now the two things are not tied jointly, i.e. there is some space between them. This would imply that despite being tied together the heavier object will fall first and lighter follow with the thread in between will come down slowly. He then concluded that the lighter object would exert an upward force since following behind the heavy object. Imagine his thought processes. Similarly, Einstein, through his thought experiment imagined Black Holes through the relevant mathematics. The concept was so strange that initially he assumed he had made a mistake. Since he could not physically observe them he imagined their existence with extreme doubt and hesitation as the concept was so mind boggling, all he had to rely on his workings. Now we have the requisite telescopes /equipment which can prove his discovery.

The point of these examples is that a lot of exiting and interesting experiments cannot be done through physical lab experimentation. These have to be addressed through thought experiments and computer simulations. Most educational institutions cannot offer the required science labs, this gap can now be addressed and the excitement of discovery reintroduced.

Chapter 4

Instant Feedback

Topic 31

Future Experimentations

In the last module we had dealt with science experiments and how working with one's hands, created great excitement in the students. Now we will try to classify these experiments; how they were at our times and how they will be in the future. The experiments we were conducting were not open ended. A certain prescribed output was required. I remember we were required to make oxygen and to do this were provided with a certain procedure. You needed to mix potassium chloride with manganese dioxide in a certain ratio. The mixture was placed in a hard test tube, heated, from which a pipe was attached passing through water to a cylinder. All the steps were well defined; if the desired outcome was not as prescribed, it meant you had not followed the procedure correctly. Despite being a lot of fun, the procedure was laid out and formulaic. There are no surprises and there was no room for creative thinking outside the procedure. Why is that only these two particular chemicals are used, is it same in large scale manufacturers? Can we not extract oxygen from the air, water, if so how? These experiments have utility, but do address the elements of surprise, wonderment, discovery, expectations, and frustration – a process which has led to all the great and innovations and discoveries.

Conversely, open ended experiments incorporate all these elements and no fixed procedure is prescribed. You are provide some guidelines the rest is up to you. Why is it that these types of experiments did not exist in our times? The answer lies in the nature of experimental labs available to us. It is impossible and probably very dangerous to allow students of ninth and tenth grade complete freedom in the typical physics or chemistry labs. So what has changed? We now have the technology to simulate experiments. In simulated experiment you have the freedom to mix whatever you want, even if the outcome is dangerous. You might cause a virtual explosion but that is the limit of it. The availability of technology has allowed us to create open ended experiments, which has opened an entirely new dimension of learning at relatively little cost (one time). This type of experimentation allow us to incorporate the elements of assessment, discovery, theory – all the three elements of absorb, do and connect are present in the learning process. Also real time assessment and results can be provided. These days a lot of sites are available on the internet where you can find these experiments (Google open ended experiments). The technical definition provided is "an open ended lab is where the students are given the freedom to develop their own experiments instead of merely, following prescribed guidelines from a labor elsewhere: making a lab open ended pushes students to think for themselves and think harder. The students here have to devise their own strategies and back them with explanations, theory and logical justifications. This not only encourages students to come up with their experiments, but requires them to defend themselves as their experiment if question???" Here unlike, close ended experiments, you are not solely indulging in the Do part of the learning process; the faculty of thinking is also incorporated. The two elements combined develop scientists.

Topic 32

Open Ended Experiments

"In order to make this stage (experiment) open ended; the teacher may give a student a project with a purpose and not the procedure." In a closed ended experiment, within a lab environment, a strict regimen has to be followed. This is required since all precautions have to be in place to ensure student safety. An open ended experiment has a purpose, a goal in a project form. Apart from freedom granted to students they need to consult various sources including friends to successfully handle an open ended experiment. "Once the experiment concept is in placed whether developed by the students or teachers, it is time to design the experiment in accordance with the concept." I emphasize this point since the experimental design entails all the learning elements; do/select, absorb and connect associated with the learning process. The sad part is that this never implemented in our school systems, even the so called 'modern schools'. Experimental design never followed in accord with concept. All three elements do, absorb and connect were missing. "The teacher may choose to let the students study different experiment jotted down on a list and chose one: the teacher may drop hints and guide the students without choosing one for them." This allows for an element of choice for the students.

There can also be a blend of open and close ended experiments - you proceed thus far and then decide what needs to be done. Again technology allows us the option of customizing an experiment based upon the student's ability to learn and their progress. For a particularly gifted student the open ended element would be present in greater proportion in comparison to specified tasks and vice versa. Here we are not talking in the air. A book which I had shared earlier Disrupting Class, Johnson and, and from which the earlier descriptive text was taken contains what is actually transpiring in the United States, schools, today. The school of the future might be somewhat like this: the students upon entering the classroom (here we are not specifying a particular room a lab or otherwise) would go their chemistry benches, where there would be all the usual apparatus, test tubes, regents, etc. Here they will perform open ended experiments; seeing what changes occurs in pressure, volume and temperature of gases. The results may be completely counter intuitive. Earlier, we had specified the room where this would all take place. It turns out to be your bedroom. The experiment can be conducted at any time, any number of times and with anyone. The entire chemical laboratory is at your home and disposal.

To the earlier concept of absorb, do and connect or select, organize and integrate we add another element, on our own, for science subjects – observe. If we take away perquisite part of absorb, i.e. no information is provided, there is no lecture by the teacher, we can take the process one step further. Let us observe the sky, why is blue? Look at the lake, where do the waves come from? Why day and night alternate? Why seasons change? Why the rivers seek the sea? So from an initial observation we move to the select part. We try to find associated data which could be helpful in answering our query. Organize this data in terms of relevancy and finally integrate through find the right answer. Another aspect which needs to be noted is that we have built in the assessment part into the learning process (absorb, do and connect). This is not only relevant to science subjects but equally applicable to others. In our current system the learning and assessment parts are segregated.

Topic 33

Incorporating the Observe Element

Ask a child, these days, what is happening at your school and the answer will probably be exams and solely exams. These are then checked and the results handed back after a month. Similarly, the answer might be studying; the two aspects learning and assessment are devoid of any connectivity. Perhaps when this school system akin to a factory pipeline was incepted, it was requirement of that time, but it is unnatural. Assessment should be built in absorbing, doing and connecting; you should be unable to distinguish between the differing activities. What are the advantages of this approach?

In the traditional mode of learning the time for learning allocated to each student is equal. The assessment is variable with each student getting different marks; since each at a different learning stage. Their actual status is only known at end of period when assessment takes place. What we want, instead, is to make time variable and learning constant. A student will not be able to advance to the next module until they have mastered a particular module.

Technology provides us with the tools to do so now. In terms of science subjects you have a lab available to you continuously – time is variable. You can experiment anywhere and as many times as you want. Also, you are allowed to mistakes and discover new things. A side note; that mistakes, in learning, usually carry a lot of negative connotations. If you make a mistake your marks are deducted. This is in actuality incorrect, mistakes are essential in the process of learning and discovery. In fact, intelligent mistakes are essential for deep learning. This methodology of mistake is inaccurate; from a perspective of the person making the mistake he is completely right. The inaccuracy arises out of the mode of person thinking, which we need to understand.

Brigham Young University's virtual chemistry lab is currently serving one hundred and fifty thousand students. This is in a country where there is no resource deficiency and universities have access to large funding. They took two thousand and five hundred photographs, made two hundred and twenty videos and created simulated lab design through video game designing. The interface, critically, was not boring. By game design we shift from pure learning to student engagement which is fun and stimulating. The learning cycle of observe, absorb, do and connect part become an adventure in discovery. Naturally, the software is entirely open-ended but its parameters can be altered depending upon the student. This allows students to engage in experiments which are too costly and dangerous – this is just the beginning, who knows how far we will get in replicating reality in the future?

Topic 34

Artificial Divisions and the Learning Pipeline

Here we travel back a little. The earlier learning pipeline of school, which ran like a factory, was linear in nature and contained artificial divisions. If one did not understand Algebra I, it did not matter; we moved to Algebra II, there were no stoppages. If we were discussing theory, that was it. We did not overlap this with lab work (practical) and vice versa. Each part of learning was segregated – "artificial divisions were the limitation of the past, we should not automate our mistakes using computers." With the available technology we should not replicate our previous mistakes. "Now the following should be merged in a single interactive application, you cannot tell which is which." There are no longer divisions, theory and practical merge in a single seamless entity, where assessment too continually takes place. This is where the absorb, do connect and select organize and integrate leaning process is complete and learning and assessment coexists. The entire process is one of fun and discovery.

With the advent of interactive learning the point we need to understand is that the amount of learning is fairly constant, while learning time and style are variable. This is completely converse to what transpired in an educational system earlier. Earlier we used of my alma mater, Muslim High School, Multan; which much like other schools promoted students from one class to another despite the fact that their performance was not satisfactory. All students are sustained for a year in class and then collectively pushed to the next level. Learning was variables and the drop out issue was significant. This dropout issue is critical and has potential disastrous consequences for society as a whole. "The pipeline keeps on moving; assessment does help neither in comparison, nor for determining if they have mastered the material – the pipeline moves in any case." This becomes even more frightening if the material being taught is prerequisite to further material being taught.

Topic 35

Chasing the Rabbit

We now turn to a story from a book, chasing the Rabbit by Stephen J. Spear. The author is a graduate of MIT. He was given a very unique problem: as you probably know the car was invented in the States, where commuting distances are great. The first mass production car was the Model T, invented by Ford, which was priced to be affordable to an average consumer. From there they spread throughout the world.

I remember when I was in the sixth or seventh standard, around 1961-62, the famous cars in Pakistan included Volkswagen, but that was German car. The American cars were huge gas guzzlers Ford, Chevrolet and other and were quite popular. Something strange happened later the Japanese came up with their Hondas and Toyotas. Soon they had the American cars beat outright. By 2008, no one could match Toyota's total car production.

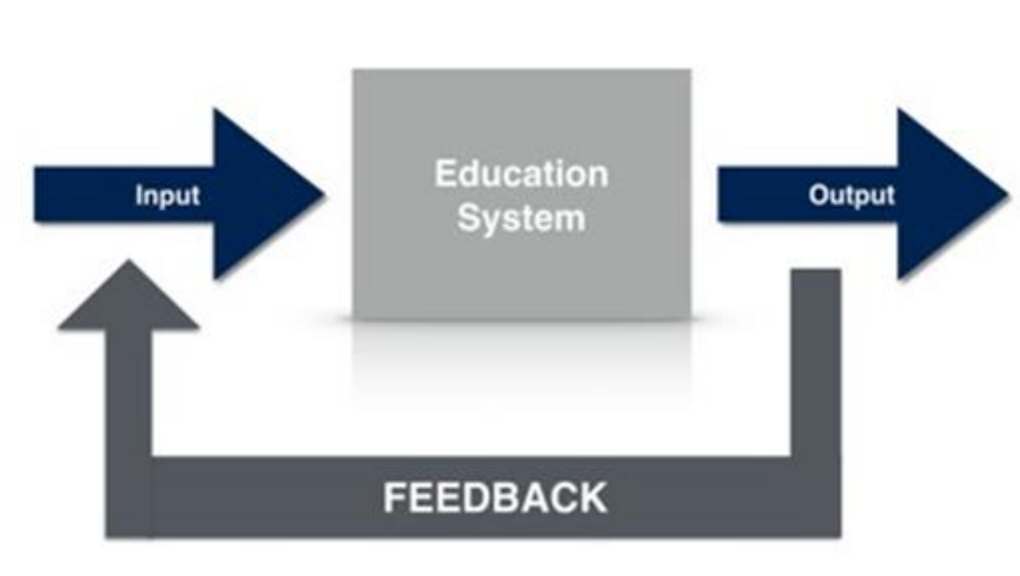
The project assigned to Spear was to study Toyota's famous production/assembly line in the States and see what distinguished it from its American counterpart. After all the labor, raw material and environment was the same, what was the crucial difference? Why has the industry where cars originated lagged behind so badly behind the Japanese? The problem also had a deep association with learning, which we will find about later.

Stephen decided to visit an American factory in guise of a worker to understand t their issues. He requested for a simple task on the production assembly line. His assignment was to fit the front seat in a prescribed time (58 seconds) and format. Each cog in the assembly line was critical and deviation from time and format would imply the standstill of the entire assembly line which would result in huge costs. Despite the fact that he was a mechanical engineer from MIT and the process only entailed four or five steps which were so simple that he was communicated these verbally, he was unable to complete the assigned task. What went wrong? As in education, assessment, which parallels inspection in an assembly line, was missing from the process. Both pipelines cannot proceed to next stage when a particular process remains undone. For a car this would imply a missing or loose front seat and for a student missing mastery or understanding of the subject. What we are doing with the educational system if it was done to a car manufacturer the plant would shut down in a couple of days. Stephen was given fresh instructions and ample time to relearn the process. It took him one hour to do four seats. This is clear illustration of learning being variable in relation to time. This is what is happening in our schools.

In car assembly inspection is not done once the entire vehicle is assembled, it is necessary at each stage to ensure a complete and quality product. Similarly, this needs to be done education yet we persist in assessing students once the entire course is done, leading to variable learning outcomes, despite which we still push them further up the pipeline.

Stephen now moved to the Japanese factory (Toyota) to understand their competitive advantage. He requested for the same task, i.e. fixing the front seat and he mentioned that he previously done this in Detroit. He was given the same task but was totally taken aback by the method. Initially, he was not put on the assembly line was asked to just place the seat properly. No next step was provided until he had mastered this step. He was asked to absorb, do and connect, once mastery acquired the next step was revealed – no prescribed time was given. He could it master it an hour or take the whole day. This may seem like a small step but can lead to a huge growth for an economy or conversely a meltdown. So as with a manufacturing education needs a fixed outcome, time can and must be variable. **T**esting an assessment at every step is essential. What will be the results? Stephen was able to master the first step and subsequent steps correctly in the first attempt at the assembly line. This was the difference between Toyota and

American car quality. “Assessment or inspection is interdependently woven into content delivery with fixed results. This minimizes the repair work at the end of the pipeline and there were essentially no dropouts. Without this the results would be catastrophic for Ford motors or a educational system.”



Another important aspect which needs to be understood is the feedback loop. “Technology and software provide feedback loops to improve themselves for different kinds of learning.” Each person needs to learn differently and the feedback loop provided us with the requisite information as to how?

In summary assessment helps in learning and learning helps in assessment - we have divided the two. We need to combine the two to create the requisite impetus for creating student who will define our future through discovery.

Chapter 5

Higher Education

Topic 36

Quality Control and Assurance

We were discussing that in car pipeline, inspection couldn't be done after 10 steps as we do in education after 10 years assessment. This happens in every step in pipeline so that there wouldn't be any compromise in the car quality but we do compromise in education and we do assessment in the end of the year and still don't learn anything from the result and promote them in higher classes, this a blunder we are doing. Alright, what happened next? He went to the Toyota company after coming out of Ford Company and said I'll set the front the seat here as well, although I have leant from that factory about seat fixing but you also tell me about the steps verbally. Then he got surprised there, they told him to be mater in 1st step first and then we will tell you the second step before that we will not tell you the second step. This was the basic difference and what happens because of this? This change and give impact on the economy of countries; progress and demolishment. Toyota defeated all the companies of America because of these reasons. These are the minute decisions which need to be taken. But if we will say whoever wants to be educated and he will be. If he doesn't learn so it okay then. They told him take one hour or six hour or one day to master the 1st step. But till the time you don't show us the full command on 1st step we will not tell you the second step. Learning time is variable but outcome is fixed. Very basic thing is this audience; this is the purpose of this course. Summing up it in one line we can say that we should make the learning time variable and fix the outcome. Student should get time in all periods to learn and to make mistakes, give them chance and testing and assessment is essential. This is the lesson which we have learnt, if you do that you will see the difference, difference in cars and difference in the pipeline of education. Stew fixed all his steps brilliantly and he is the same Stew who was unable to fix the seat in previous company. He was unable to fix seat in time and because of they stopped the pipeline and here lies the secret of excel of Toyota in company. You can clearly see more Honda, Toyota and Corollas rather than Ford. This is the major reason. Inspection is must on every step otherwise you can see the consequence. Now, I'm quoting Claton who says what should be our future? The result of testing and inspection, in education its assessment and in factory it's inspection. Testing and inspection at every step is essential. Assessment or inspection is interpedently woven into content delivery with fixed results. This should be our aim in the course of education by using technology. This minimizes the repair work in the end of pipeline and there were essentially no dropout after 6th class or 10th class, which these students are not able to study anymore. That is geostrophic for school students that is geostrophic for motors. Technology and software provides the feedback loops to improve themselves for different kinds of learners. There is another blunder that we try to teach everyone with same method, Learning styles come here. So audience summing it up, don't separate assessment and learning. Assessment helps learning and learning helps assessment that we have separated and experiments, we have separated completely. Experiments, labs of experiments, assessment and learning should be together like this. After that we will be able to produce scientist and they will be able to do discoveries.

Topic 37

Out of Our Minds

Dear audience, we welcome to this module, as you know we are doing this module "use of information technology in Education" here is another book of KEN ROBINSON, his book out of mind is very famous. There is his book which published in 2015 that we also have ordered from that we will also tell you that what we could learn from that. I'm telling you a quotation from his book "we will not succeed in navigating the complex environment of pairing relentlessly to rear view mirror" here you need to focus that we are not looking forward but backward. From this book we will discuss many thing with and along with it the book that we discussed with you last time, we will do thing from it as well. So in the last module we have discussed you must have remember that we discussed there could be two types of classroom education. 1st we could teach everyone with same methodology so are we doing from past many hundred years or we need to accept that everyone learns, think and works with different methods, it's prior knowledge could be different absorption could be different, do with different method, connects with different style, so for that there should be customized software. We will continue this argument before using technology practically; we need to realize that what is future demands and how technology can fulfill them in these days? 20 years before it couldn't fulfill today it can and in 10 years it could do in better way. This is what we were discussing and this conflict between schools. In schools standardization and customization for students need to be enhanced. Now the author of this book gives us business definitions here he always tries to see the business module which is being used in these days in education. This is interesting and different may because usually in past in happened that in all education we matched the role of teachers in serving. After industrial revolutions many changes occurred here and in abroad as well. And school education entered to industry after coming out from serving. If you see in 20 to 30 years public school had become reduce, its support had been reduced, and charity schools had been reduced. And business schools had been increased. Now I’m not talking about that this was good or bad but at least we need to understand it, that if it has become the business so we need to understand it’s module and how could we make education effective by living in this business module. This is what we will discuss in our module.

Topic 38

Business Architecture

Audience, we will use some business and industrial terms in this module. In every production, which we produce, in that production there architecture place. This tells us that these things we need here and these things are need to be connected, like gathering the learning modules can make a book. Where we attached two modules that place is called interface. In interface we could see the questions which interrelates the previous and further tasks. A product design depends upon its little parts. Now you can prepare all designs in same factory or in different factories and after that gather them in one factory. Professor’s quote could be explained that there could be conditions and something could not be prepared by preparing little parts from different factories they need to be prepared from same factory or same place. This could be critical that what can we divide where and how far we could divide it. Then the same company should develop the entire component either to develop different components. If architect follows this rule this could be beneficial in all industries like in pharmaceutical, car industries. If you see the air bus component all the parts were gathered from the different countries and it was not difficult to fit them together. This could be helpful and you give and module to make someone and whoever gives you cheaper module it could be helpful for you in working wherever you are working. Second module could be design in by any other specialized company. This modularity enhances your efficiency, this makes your pipeline easier and also highs up your cost as well.

Topic 39

Modular Design

I give you an example of modular design, you must have seen light bulbs, in these days we are using energy savers, old people of 40 and 50 years must know about that bulbs which contained filaments and that was fixed in a socket, that socket is called interface. This socket is still same and now if you want to change the bulb design of you want fix tube light there you have to change the socket, but engineers have made such stuff which could be adjusted in same socket. The engineers have ability to make such technology where they don't need to change the socket but we can change the internal technology. This is how our learning should be like if you need to change the module and we will need to change the module so we should make it that flexible, to modify this. This is the usefulness of technology that we can improve our learning but for this we need modular architecture. We need to check that by changing one module the whole system should not be changed as I gave you example of bulb. When Stew started assembles his Model-T car, he made its shape from any other factory by steel suppliers. Now I'll quote from this book that the language is quite fine. Now when he started taking that from different steel suppliers that couldn't be fixed in that time technology was not that advanced and specification couldn't be meet exactly so ford realized this and now specifications are clear now they also take things from Pakistan. "Fords could not solve it by its own so it integrated. So he interfaces it and decided to make things in his same factory to solve the problem. He made a big factory to make thing in Detroit to make his engineers able to see and make new things according to the need. So the purpose of my saying is that modularity has its own specifications and conditions. Because for that we need to think that factory should be that much advance to see each and every module specification should be told strictly. Suppose if you go to buy a car in

America they will ask about its specifications from engine to tire rims. You just tell us everything we will be customized thing and give you things according to you wish. This is the example of modular design that you can modify module according to the costumers will. This was impossible without modular architecture.

Topic 40

Customizing Education (Apple)

Another example I give you from the technology, which we use a lot and its pioneer say that the purpose of this technology is to make easier the learning and to customized. You must have guessed I am talking about apple computer. I-pad of apple and its learning applications are very good. But it has a fault in itself and that is its architecture. Although it's very beautiful machine and I use apple machines but their design philosophy is their where they don't want to compromise. This is their opinion where they don't want to compromise. The philosophy is this that apple always took care that the make whole computer at the same place. Their design is not modular, from the hardware to software and all applications, everything is interdependent. You can't change things from that system and you can't put any component from any 3rd party in its hardware. You already know its upside, apple is a wonderful machine and I really like this. Downfall of this machine is that in apple there in no customization or modification this is why it is very much expensive. What other companies do! They get different parts from different vendors, from the cheapest vendor. Now here comes the example of dell computer, dell has no component of its own. It is customized according to your will but apple can't do this. In past dell didn't allow its product to the dealer. They used to send their products by post and before they used asked their customers about their wills. Peeling the cover of dell reveals that dell doesn't make any component. Different companies manufacture its component and dell invites the customer that they will give you customized machine in 48 hours. Such a huge difference could be examined here and still I'll prefer apple. Professor Claton is taking us to the education industry and tells us that this happens which industry is not mature but when company becomes mature company needs to be modified. As we said that learners could be difficult, their thoughts and learning styles could be different. Therefore, applications should be according to that.

Topic 41

Learning Software

We gave you example of hardware now let me give you an example of software. That is more important for us because our interactive learning software will be software and can run on any hardware. In PCs Microsoft windows is very popular. Its architect her is pathetic. It is pathetic in the sense if you want to customize it according to your need. Then you will not use that software that is used by all because those features are not included in that software. Microsoft windows software is interdependent like apple hardware. Changing just ten lines of code should necessitate, rewriting, by millions of other. So you cannot customize it but not in the case of LINEX and UNIX. You can customize that, different people can do additions in that software; third party can use, change and add it. So the economics of interdependence mandate standardization. Economy is our big issue if we are moving towards interactive learning. Then we need to know how industries did production economically without take caring quality issues by using economics. So the economics of interdependence mandate is standardization and we live with it. Most of us are unaware of it and how our lives might improve if we had easily configurable operating systems at our disposal. It is just a luxury that has never been feasible. LINEX was operated on a big machine that was evolving since 60s and when reaches to 80s and 90s then LINEX was a logical conclusion. You cannot customize windows. UNIX technology has matured sufficiently. An open source operating system such as LINEX became feasible. LINEX architect her is modular, standardized and therefore can be customized. Witness how the open source programming community continually updates and enhances it kernel by kernel and line by line. It can be modified by anyone. It is the benefit of modular design that you can customize it.

Topic 42

Disrupting Class and Business

Now I will again quote from disrupting class as I was discussing business module in which different businesses are discussed in formal ways and how these industries came to its peak after maturation and where education lies in it. One is solution shops and second is value adding process businesses. One other is facilitated networks. In solution shops there is and R & D in which if you have a dispute then you will go to lawyer and he will provide you the solution. The lawyer has to generate solution according to your problem like a doctor who gives you medicine according to your deceases. It is called customization. Therefore, the lawyer diagnose the problem, recommend solutions, these from abilities to deliver values to customers are largely resident in the people who work there standardized processes are uncommon in a solution shop. We typically treat special education as a solution shop. Each student challenges or diagnosed and treated differently and uniquely. Manufacturing and retailing are the example of value added services. In value added services companies take material from different shops, mix them in a specific form then deliver it. Production and distribution of text books is also a VIP business. So, most schools currently operate in this VIP value added where there is standard process. Students are herded into a classroom at the beginning of the school year, value added to them and they are promoted to the next grade year end. Third type is facilitated networks like telephone, internet etc.

Topic 43

Public Education and Value Addition

Now we are going to discuss our public education in which there is a momentum that totally trying to fit education in that value added fiercely that we discussed earlier. Let me tell you what happened, how you can see education in a big picture? First of all we design courses in different fields, then we design contents of courses, then we prepare text books. There are different models of text book publishing like USA said we will not publish any book, there are private companies and private writers. They publish those books by themselves with there money and bring it to the market. Then their board will decide which book they will use as a text book.

Now what is the result of this business model: Subject matter creates text books and other instructional tools which codify the concepts to be taught and the method used for teaching them. Curriculum experts at state and at local level can make decision about which textbook to adopt. Teachers can delivered the content to the students typically and marks sometimes individually and the extent to which students learned what they were taught is assist to some extent. Teachers trainings sits in the middle and that reinforces how these steps work? Basically it is a factory model. When a big publisher publishes the book the benefit they take is that there is a fix cost and other is variable cos. Fix cost is high there when it will sale in mass scale the cost decreases. Therefore, the big companies can afford this but for this they will go to standardization where it can be fit or not.

Therefore, it is a basic fault of capitalist economy that big companies eat small companies there either they were possibly publishing the relevant books. In our country Punjab Text book board invite people to write books and they start writing standardized books. So it is called hard copy model. It will happen so for profit and publishing cost can be reduced by technology.

Topic 44

Text Books

Viewers there are an interesting thing that is discussed in this book is that. He said Physics book either it is for 9^{th}, 11^{th} or 12^{th} class must be written by Physics teacher. If he will be Physics specialist he will think differently and while writing the book he will think to write it at the mental level of that student. When that book will sent to the board for approval then it must be verified by Physics instructors. So for standardization there must be another subject specialist. We introduced a book in Oxford University Graph Theory and Algorithm where I was teaching graph theory. I have a psychologist named Yasir Hashmi and a student Komal Syed. They observed if a student who has not mathematical background can be taught this subject?

Text book architected typically reflects the architect her of knowledge in a special domain or field. The book defines the sequence in which key concepts will be introduced and how they are related to one another? Text books often comes with teaching aids, physical examination and other material to enrich the learning experience because these experts are from intellectual elite in which they have same thinking. The type of brain whose wiring is most consistent with the methods to solve problems in Physics as domain experts has trained them. Text books and instructional materials are one of the primary vehicles in which these methods understanding and problem solving codified in Physics, Economics and Mathematics teachers tend to have high degree of logical, mathematical, intelligence and those who write text in those domain draw upon this intelligence time frame and explain the problem.

Topic 45

The Business of Textbooks

Textbook publishers appreciate that because individual students learn differently. They need differentiation options. The economics of scale stop to do this if the book is in printed form. If you eliminate pages the matter will be solved. What they to focus on development of different books for each type of intelligence. There volume per title, profitability to decline market or this is so disrupted model. Most of intellectual and financial energy of this formidable industry focuses on creating and commercializing still more blockbuster books for large undifferentiated masses of students. There included standardization that should not be happened. The question is to find the solution. Why there are so many engineers notoriously bad at spellings? Why do so many students like literature love to struggle to master in mathematics? Why so many labors are dump athlete in the classroom when their bodily kinesthetic code at the genius levels the game after the game. One critical reason lies in the textbook adoption process. I have discussed about modular approach which will not costly but it will standardize. It is a necessity in education. In school there are many things like building, curriculum, textbooks etc. and at the end learning comes. If there is no learning that is not school.

Topic 46

The Business of Schooling

We are talking about core business of school and education which is learning, classroom learning, provides learning to students and if there is any deficiency in it then we can't say that school a school, that education system an education system and whole energy of the school, whole time of headmistress and teachers and whole time of board should be used on only one thing to improve the quality of student learning with or without using technology and if there is technology then it is very necessary to use it. There should be proper breadth and depth of it and it can also be introduce through technology because through physical presence of teachers we cannot offer many courses and a teacher cannot go to depth of anything. An electronic application can go to excessive depth. This is famous saying of someone "*Education is kindling of the flame not filling of the vessel".* You know that whose saying is this, by exceeding this , students are different, their interest are different , their learning style are different, by looking on all this if you forced them to rote it, it will not work, you know that it does not work, you know that in America how much school drop outs, here school are present, every child had same school, school provides books to every child, but why drop out is high, they made special programs, customized programs for it. The thing came again there, when they drop out, when any problem starts, when any disease come, when any problem emerged in the society, and when you know that how this problem break the society, then you take action against it. America starts customized programs for those Childs who become drop out from schools. So, that they can be re-engaged through personalized learning, so, listeners here in Pakistan it is not done, here those who are dropped are dropped due to their own mistake. We don't agree with it that they are dropped because of us, they are dropped because we fit them to one size. We do not care about their learning capabilities, we do not think about their special interest and style so, they are dropped. So, listeners an important question emerged that why not start with personalized learning in first place. In America they work when anyone drop out but now they work for others, but why we are not starting with personalized learning. Question is that why America does not start with personalized learning. It is said that it is very expensive. Now, we are going to answer this question similar modular architecture. Impossible as teacher cannot give personalized attention which is too expensive. There are two criticisms about it, that every teacher cannot give personalized attention to every child, in the same way we should keep one teacher to one child. Its going to be so expensive. Education is very expensive, this is the basic criticism on it, so listeners now I am going toward this book and the author says that you have standardized the education. Education is personal or it is nothing. You go to personal level and adopted their special needs or special interest or leave everything because standard method does not help anybody. He also says that it can be possible through technology that affords it for every child. Different content and learning style for every child. We have such tools: tool for promoting creativity, communication and collaboration become possible through technology.

Topic 47

The School of One

Dear students, time magazine was awarded innovative organization in 2000. It was a great achievement. It has middle school mathematical program in New York, department of education. It was started in 2009. It was called school of one. It means one teacher for one student and the interaction between the teacher and the students will not be physical. The innovative program of this school integrate the use of technology in the development and implementation of personalize curriculum. They use technology in learning to create learning environment. This school is a pioneer in new method of education based on each student individual learning requirements. This is called learner based learning or student centered learning. This approach provides students to learn from their personal learning experience. In traditional learning environment, teacher leads students to the curriculum search and each student is given the same material in the same time. In school of one, each student is provided a branded learning environment geared towards their individual learning needs. Assessment and test results are used to create students' play list or individual learning plan. This plan is suitable to the ability of students and their learning method. Teacher might be able to assess students in real settings. Teachers usually adjust their instructions according to the assessment of the students on daily basis. The classrooms of one are more students' centered around open spaces.

Topic 48

Individualized Learning

Therefore, I quote again this book. The school of one uses digital technology to develop individualized daily adjusted students curricula which the students accesses why an online portal. A computer based learning algorithm. He is seeing and controlling everything. Collects data to generate a daily lesson plan or play list. We don’t say it lesson we can say it playlist. There are games, educational applications and interactive learning applications included in it. The term is also changed now we don’t say it what’s the lesson of today we will say what the playlist of today is. Playlist for each student based on what is determined to best meet their learning needs. Also on the bases of what he did last time It functions as an educate scheduler to ensure each student is learning in his/her educational sweet spot as it collects the data algorithm generates the daily lesson plan and schedule for each student and teacher by analyzing factors including each student’s academic history, profile, assessment and previous work. We are recording second by second progress of every student and also providing feedback to students, their parents, system and teachers for the betterment of system.

Chapter 6

College and University Days

Topic 49

Higher Learning

Earlier, stories of my school days were narrated, now we turn to my experiences in college and university. Compared to high school: there was much more freedom; it was significantly more expensive; there was greater diversity in the student body, each with their own learning styles; and there was greater competition. The concepts or should I say a sense of innovation, creativity and entrepreneurship was missing; instead the focus entirely was on doing well in one's studies and securing a good job. This was equally true of colleges abroad and not solely in Pakistan. A fact which is in marked contrast to what is transpiring today - with innovation becoming the core focus. These days, innovation is not only essential for progress but in some cases survival.

In those days in Multan there were only two colleges; Government College Multan, Bosan Road and Liak?? Hussain Islamia College. As today, in those days very few students went on attend college. This is an issue which needs to be resolved through technology. Do we increase the number of colleges or do we enhance the student body in a particular college?

A teacher in college who I can never forget was A.B. Ashraf, who taught Urdu. I went to do my engineering from UET; later throughout my career if I enjoyed any advantage over my colleagues it was entirely due to this man. His lectures would be totally engrossing and all of us students would be transported to his world. Naturally, you cannot replace a teacher like this, but with technology you can greatly enhance his reach. While the forty of us sat in class in those days and took advantage of his lessons; this could be increased to four hundred or for that matter four hundred thousand. His dedication, knowledge and passion which he used to be able to impart to his students, was astounding. He expected in those days, a relatively new concept, that of design from his class: we needed to study the works of famous authors and then criticize them. I remember that for the summer vacation he had assigned two novels from Munshi Prem Chand. These and many other famous works formed part of our lives and the lessons they imparted remain with us till today. I still quote Munshi Prem Chand in all my technical classes in terms of his take upon different education and educational styles in a novel “Bara Bhai Sahib” (Big Brother or Respected Elder Brother).

Topic 50

University Days

It was a political era; a romantic era. I went to university in Lahore (UET) and for the first time moved to hostel life away from Multan. Being a pampered child the move was quite an awakening. In those days BSC students were given preference and if any remaining seats were available given to those who had topped their FSC results. I was lucky enough to be one of these students. In the engineering department the highest merit was reserved for electrical department and also possessed the most qualified faculty. Under Dr. Qazi the department enjoyed significant independence. A student could challenge a faculty member and debate with him intellectually. Concerning the brilliant faculty there were some interesting choices. Some were completely proficient in their subjects but did not really care if they could impart this knowledge to the students. Either they did not care or were completely unaware of relevance of pedagogy. We did not understand anything in class. Our computer teacher was a brilliant and very knowledgeable, yet perhaps because of his teaching style I relegated computers to subjects which one just passed and generally started to dislike the subject. I later went on to discover computers on my won and developed such a passion that I went onto do my doctorate in computers. From this example one can easily see what difference a teacher's passion, commitment and love for the subject can do for a student or not!

There were also teachers who became truly involved with the students. I do not know if this was due to some training or was an inherent ability. We had done some laboratory work in college, but it was in university that, for the first time, we were given our own independent work benches. It was also the first time that we tried to discover new things on our own and carried out open ended experiments. I remember how fascinated I was when in the second year I saw my first electromagnetic wave – a sine wave on an oscilloscope. It was strange then that a physical phenomenon, a mathematical function was observed by our naked eye. This was a time when technology was not as advanced; yet to be able to observe and abstract concept was truly astounding. This allowed us to see the connection between mathematics and physics and utilize the; observe, absorb, connect and integrate learning cycle. In terms of the state of technology in those days we had equipment like the oscilloscope, microwave, etc.

Topic 51

IBM and Other Mainframes

Our first computer IBM 1130 was used in those days. It was recently introduced in the market and was meant to be smaller and cheaper. The price for one was around US$32,000/. To grasp this we need to remember that in the 60s and 70's the most popular car was the Volkswagen. It was priced at US$1500 to 3000 or Rs.30, 000 to 40,000. These days an average car would cost around Rs.1, 200,000 or so, while a computer Rs.40, 000 to 50,000. What a drastic inversion in the price of the two products? The 11 30 only possessed 64K of memory, yet it was considered state of the art machine at that time. Imagine that today the memory in most of your mobiles is far greater and the price fractional?

When we began our computer course a clear division occurred in class. As mentioned earlier technology is addictive. Computer interface in those days was not user friendly, programming was done through computer cards, and each instruction was done on a separate card. These cards were deposited with the people who were running the computer and the results of your program would be available the next day. One small error, i.e. comma or stop would result in a format error. This waiting for your program results was a terrible ordeal for me. Conversely, my colleague Ali Haider became addicted to the computer. He and those of his elk became totally absorbed in programming. Let us look at some reasons why this occurred. In those days the only language utilized was Fortran. When they started teaching us computer our studies were confined mostly to theory. Each instruction was written on the board and explained. We discussed the issue with our instructor in Electrical Engineering, who had recently arrived from aboard with his Phd. He told us that programming cannot be taught by lecturing. It is similar to driving, you have to drive to learn. When we told this to our computer instructor he told us to ask our professor why does he and others do not teach their subjects in this manner – learning by doing.

Topic 52

Interactivity, Instant Feedback and Immersive Technologies

In those days the science of pedagogy was in its embryonic stage and I believe our teacher was not conversant in it. On hearing the instructor's response he went into deep thought. He could have said that there is a theory class and then a lab separately, where theory is verified, but he actually said he would give it a go. Though formally the learning process elements, absorb, do, connect and observe, select and integrate were not understood, many teachers tried to configure their labs to capture this and try to establish a link between theory and practice. Getting back to Ali Haider and his group, one of the reasons why a person behind technology addiction is that if you make a mistake in front of a teacher it is more embarrassing rather than a computer and especially one where results would be available the next day. This is also the principle applied by Salman Khan in Khan Academy, i.e. recorded lectures better since no supervisor. Corrective feedback should never be embarrassing.

Today the story is entirely different with interactivity, instant feedback and immersive technologies. Many people get completely lost in it. Computer remains quite unfriendly until the arrival of Apple's Macintosh. I was working with NASA in Virginia, when the Macintosh came to the market. We ordered one to see its performance. The initial reaction of the scientific community was not positive who had assumed it more "toy like." But soon Macintosh unleashed a revolution and it is surprising that these capable scientists could not foresee its utility. Computers provide a platform where learning by doing is possible – at times addictive.

Topic 53

The School of One Revisited

Having narrated my experience of college and university, we turn towards the school of One. It is imperative that we introduce technology at the school level to make it a more effective in terms of provision of education. It can be made engaging, exciting and fun and game based learning can be developed.

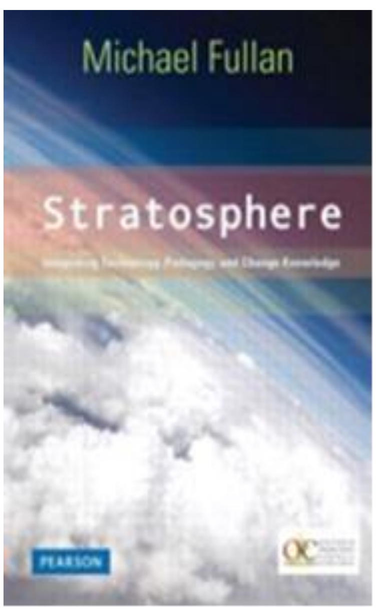
The question arises why was this type of school was developed in the States? After all every child has access to the typical brick and mortar school in the States. Before moving on conversely in Pakistan more than fifty percent children are deprived of access to school, which naturally increase as you move up to college and university levels. If they in States are saying that the existing brick and mortar framework is not suitable, why do we need to replicate this model? Why cannot we go directly to the School of One?

Topic 54

Stratosphere

A short book by Michael Fullen, Stratosphere has this to say to about education in States: it is too costly, too ineffective and deadly boring. We need to address these issues and move towards the One school. The author also says what you study is not important; this was never said in our days. “What you study in not that important. Can you solve problems never seen, with parts never used?” This is the challenge of schooling. Knowledge does not need to be reproduced but requires innovation. This is a skill not only essential for individual growth and survival but for the nation as a whole.

In the future Individual competition takes a back seat. Collaborative team based work is required and not subject based. Intrinsic motivation in comparison to extrinsic is required. The concept of ‘play it safe,’ an adage conveyed to us by our teachers and elders no longer applies. Now it is risk taking that is critical. There is no harm in making mistakes, these will only teach you.



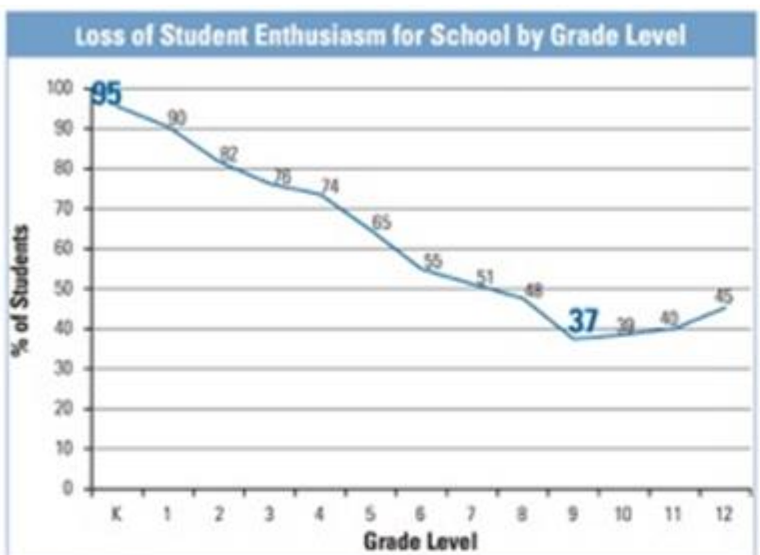


Exhibit 3.1

We turn to a graph which is illustrating students' interest in the US, from Stratosphere. It shows that as the students' progress in grades their interests lessens. We manage to take away their sense of wonder, excitement and interest. This can only be revived through integrating technology, pedagogy and change knowledge. The author says the drawback are an inherent function of the existing conventional school system and that we have already reaped whatever benefit we could drive from this system. They have become too boring, too ineffective and deadly boring.

Topic 55

Brick and Mortar Educational Cycle

The existing “brick and mortar’ schools have a conventional cycle associated with them. In the morning children are woken up by their mothers, have a little breakfast and then sent to school by cars, vans and other transport but mostly cars. In school they study, there is no measurement of what they understand until exams, which occurs with little frequency. On coming home they wither go an academies (private tuitions) or do it on their own seek help from their parents. Not everyone can afford an academy. In these academies what leaning occurs we do not know the entire emphasis is on grades? This endless cycle continues, with children wasting their time in traffic, their energy, the waste of fuel (imported), electricity and so on. Unfortunately, all elements within the cycle are equally destructive. We need to disrupt this existing system, this cycle is not sustainable for us. Despite the fact that some students can afford to be a part of the cycle, more than 70% cannot.

Technology, pedagogy and change can break this cycle. According to Fullen all three have evolved separately in the last forty to fifty years and require to be combined in education. By technology, in our context, we refer to computers and communications. Communication has become extremely efficient and cost effective, exactly the prerequisite for the One school. Concerning communications, when I was lecturer at UET and our son was ill we used to take him to doctor Anwar. The doctor would only give a appointment between eight to nine. We did not have a phone. I used to go our communication laboratory to get a connection to the doctor. Since the phone was always busy we had to ask the exchange for help – a rather tedious process. Imagine the availability and use of communication technologies now. With all the growth and innovation in all these technologies the time has come to consolidate them in a synergetic manner and make use of them.

Topic 56

Connectivity

Driving to the studios there were numerous mobile advertisement highlighting four GB connections. Now do we require 3G or 4G connections? Is technology advancing according to our needs or does it have life of its own? According to Fullen, it is the later. In comparison despite the reform which has occurred in pedagogy it still remains behind technology. If we start to design a particular pedagogy with technology, the technology might change tomorrow. So what we should attempt to teach is flexibility in design which can accommodate the relevant changes. We are living in a rapidly evolving/changing world, where initially the changes occurred rather slowly but now are coming at a mind boggling rate. In this context the right mix of pedagogy and technology is required for improved learning.

Topic 57

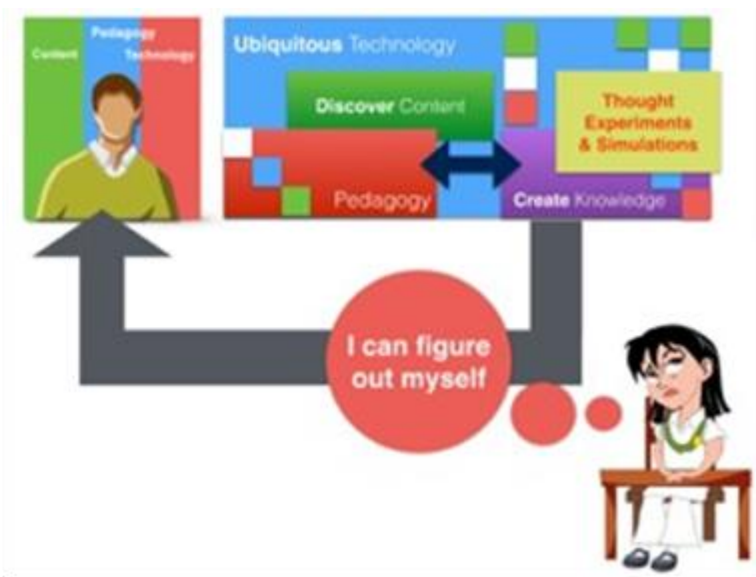
Content Design

Earlier teaching consisted of content given in the books which needed to be studies and then some problem solved. If that is the purpose of a school a tape recorder can also be utilized. We have to understand the difference between listening and understanding. This gap can be bridged with the aid of technology. We always had content designers, i.e. a physics teacher physics and so forth. Now we have experts in pedagogy and technology. When these experts pushed for changes in content there was resistance. But eventually small changes started creeping in: simulations and interactive examples through technology; examples, animations, etc. from a pedagogical perspective. With time the dominance of content lessened. The process is currently transpiring in Pakistan. Yet this is not sufficient. We need to combine the three in a manner that is synergetic and completely intermingled. This will lead to a game like immersive experience in education in which a student would be totally lost. At this stage, you will not be teaching. The students would be rather discovering their own.

Topic 58

Layers of Content, Pedagogy and Technology

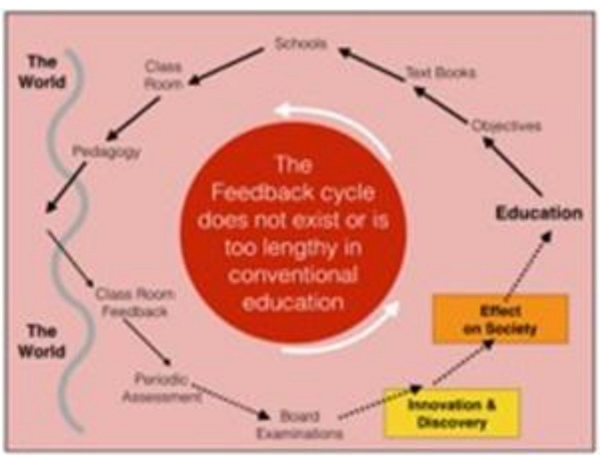
Now we turn towards content. For any subject the appropriate mix of content, pedagogy and technology should be present but not in a layered form. The three should be blended at all levels, to allow ease of discovery for a student. Apart from many advantages accruing from this; the greatest singular one entails the catering of student with different learning abilities, speed and levels. This is the basic model for one school, unlike conventional schools. A lot of work has been done on varying learning styles and abilities, especially by Gardner. There are visual thinkers, linguistic, mathematical, etc.: all these styles are catered to and no student singled out because of lack of ability. The problem is that we standardize all students learning.



Let us look at one learning style, with the right mix of content, pedagogy and technology, this leads to: “Irresistibly engaging, elegantly efficient, easy to use and technologically possible anywhere, anytime in real problem solving.”

Conventional education comes nowhere near this. This allows for lifetime learning through collaboration – making connections locally and from afar. Innovation, collaboration, entrepreneurship and creativity are critical, especially for a country like ours.

What are its higher learning/level objectives? The fundamental one is citizenship; human solidarity, collective problem solving and sustainability. Schools and places are required where creative and world class learning is possible. These do not require charitable donations or governmental support and run the basis of sustainable entrepreneurial models. Technology, pedagogy and change have the latent possibilities of creating a model, which can create a revolution. As mentioned earlier the existing ‘brick and mortar,’ model is costly, ineffective and deadly boring and one whose time is up. Conversely we have now access to models which are simple, low cost and immensely more engaging. The truly baffling thing is the lack of vision on our part; why are we not using these models?



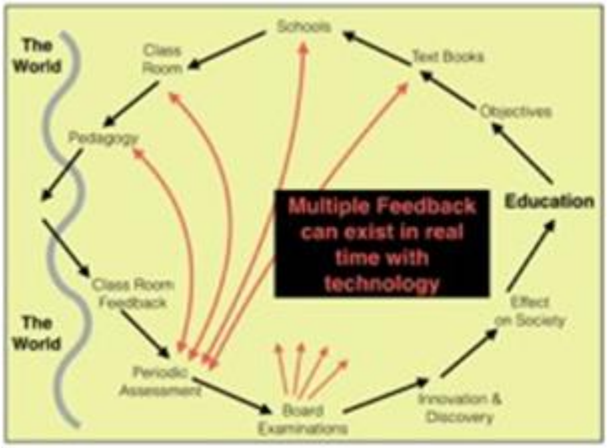
In the developed world each student has the opportunity and access to a typical ‘brick and mortar’ school. They have the resources to create this type of infrastructure. In developing countries like ours this is not possible. Even in countries like the States, despite having the required infrastructure, the consensus is that the “One” school is much better than a conventional school. The One school is not dependent upon a particular building. Earlier we had given an example of two persons involved in street theater. While one person performs and the other acts as an audience we have a valid performance. Similarly, the One school requires no formal premises. This can then be adapted for developing countries like ours to create access to all students, whether they can afford it or not, in providing a world class education.

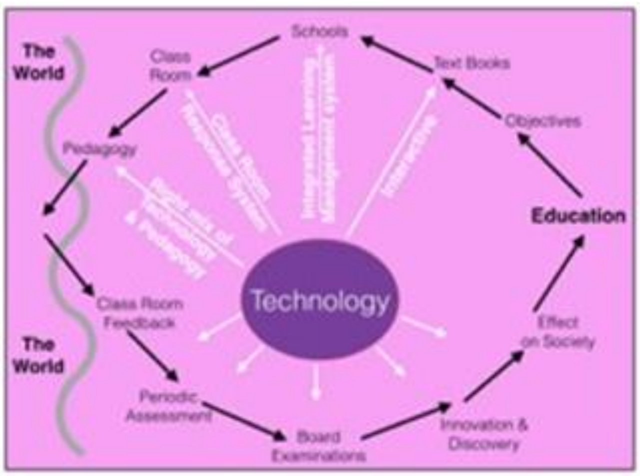
Topic 59

The Educational Cycle and Intervention

The processing be captured through a cycle; our central purpose is the provision of education, what are its objectives, what textbooks are required, what pedagogy is required in classrooms and then the question of type of school is raised. We can now see where we can intervene in this cycle to create requisite change. In a conventional school the pedagogy being taught in a classroom would be the standardized; one size fits all, additionally no element of instant feedback would be available. Finally, no correlation with new innovation or discovery is present, i.e. the content is fixed in relation to periodic testing which takes place - the discrepancy is great. Instead of an immediate revision in the objectives based on new findings, a static content is rehashed. Also, the impact on society is hardly considered. Do the students being churned out have a positive impact on society or are a liability? The conventional feedback loop is too cumbersome and obsolete. In comparison feedback, instantaneous in most cases, is built in at each stage of the new system. With technology this is possible. Apart from periodic feedback the system caters to input at the pedagogy stage; the classroom teaching becomes flexible. This flexibility is what sets the system apart. The system allows for instantaneous changes in class room teaching; are the students learning. Textbook modifications are possible: textbook would become interactive.

The integrated learning management system would allow for instantaneous feedback on what you have learned today, what are deficiencies, what areas need to be focused on? A similar analysis of the teacher would also be taking place, i.e. what mistakes made and how teaching can be improved? How this new school “One” will disrupt the existing “Brick & Mortar” model? Disruption in itself has negative connotations but here it implies positive change.


The World
Schools
Class Room
Text Books
Objectives
Pedagogy
Multiple Feedback can exist in real time with technology
Education
Class Room Feedback
Effect on Society
The World
Periodic Assessment
Board Examinations
Innovation & Discovery


The World
Schools
Class Room
Text Books
Objectives
Pedagogy
Integrated Learning Management system
Class Room Response System
Interactive
Right mix of Technology & Pedagogy
Education
Technology
Class Room Feedback
Effect on Society
The World
Periodic Assessment
Board Examinations
Innovation & Discovery

Topic 60

My First Watch

To grasp this topic we begin with a story. I was in the eight standards and one day my mother told me that since I was in high school I needed a wrist watch. It was tremendously exciting when we left the house to purchase one. We took a coach to the Cantonment, there was only one shop. We entered the shop but the proprietor was outside. As soon as he stepped in, I cried out that I wanted a watch. This was during the sixties when the Japanese watchmakers had taken over the market. The shopkeeper explained all the options available commencing from a Rolex, but explained that the new Japanese watches were comparatively very cheap and reliable. Based on his advice I chose a Citizen model. I was in love with the watch, which I kept under my pillow when I went to sleep and used to look at it a couple of times during the night. That was fifty years ago, my love affair with Citizen remains steady.

The watch I possessed now is also a Citizen. In those fifty years there have been tremendous changes in technology. What has changed with my Citizen? First there are no scratches; also one does not need to wind these watches –there are no cells. Despite the changes the front end remains the same. Technology wise we can say that there has not been a major change comparatively. Now we turn to another watch – an Apple watch. Apart from the price which is quite significant, it possesses a lot of functions, based on technology, which ordinary watches do not. For example one can receive telephone calls on it, communicate with it, and i.e. voice recognition. It also tells one his heartbeat; it is one's diary and calendar. In fact, with technology the whole paradigm has changed or 'disrupted'. Technically true disruption would occur when this new technology becomes significantly cheap and it will replace all its competitors. Similarly, we want to look at the school systems: how we utilize technology?


Floor standing TV sets versus a portable TV

Topic 61

Marconi and Radio Technology

As I had mentioned earlier that in Multan we had an old grand Marconi radio set. In those days radios, music players and TV sets were considered a part of furniture, both in terms of size and design. The two main companies, American, at that time were RCA and Zenith. They were sold through their own showrooms/sales centers where the models were displayed. In terms of technology they were based on vacuum tubes. The sales costs was based on low margins, there real profit was generated through tube replacement which took place every couple of months. Every time our radio was not working we would take the cover off ourselves and see that all filaments in the tubes were lit. When one was not it was time for replacement. Then came Sony; with their walkman and miniature radios. The target market was for those afford the large sets. Initially, the company went to RCA and requested them to carry their product in exchange of some share of the products. When asked their price they Sony informed them it would around five dollars. They next asked them about tube replacements. RCA was informed there was no tube replacement. From RCA's perspective it did not appear to be a profitable model and they did not venture into it. These small radios were transistor based in terms of technology.

Sony turned towards general stores and supermarkets. What happened next? Sony quality continued improving along with their sales. Soon RCA and Zenith realized that they no longer had their sales. This was an example of disruptive innovation; something we want to replicate in education.


Steve Jobs and
The Must-Have
Music Player
Everyone Is
Talking About
iPod,
Therefore
i Am

Topic 62

Disruptive Innovation

It is an inherent part of the Capitalist system; that based on technology that an improvement in quality, reduction in size, consequently price and improvement in features occurs, leading to disruption in existing offering – replacing businesses which are no longer sustainable. As discussed earlier Sony's Walkman replaced the large transistor based systems of RCA and Zenith. Similarly, Sony's walk mans were displaced by Apples IPod: a product which was more reliable and more efficient despite being slightly expensive.

Now we turn towards computers, a more relevant example since an integral part of our course. We had already discussed the IBM 11 30, which came in 1965 and was priced at US $32,000; its memory was approximately 64k. While I was studying the machine was available at our college. In those days only universities and other large institutions could afford these machines. We had also discussed that computer technology can be addictive since they provide feedback without embarrassment. How were then these replaced or rather disrupted? IBM still is one the largest global corporations which happened due to a lot of flexibility and maneuvering on their part. A fact, which can be illustrated by a change in their corporate culture, ten years ago ninety percent of their employees came to work and punched in their cards and on leaving punched out, to determine if they were complying with office hours. If they did not comply their salaries were deducted. These days seventy or so percent of their employees work from home.

IBM earlier competed with Data General and Digital Corporation DEC. IBM was focused on business solutions while Data General and DEC were focused on educational institutions. A person doing his PhD from the States in the 80s invariably used a DEC VAX, 730 750, etc. Turning to a book, a friend had gifted me with a novel, 'The soul of a new machine' by

Tracy Kidder about thirty years ago. The novel deals with the competition between Data General and DEC. DEC's 780 entered the market earlier. Data General wanted to understand what innovations were associated with the machine, prior to launching their computer. Their chief designer,

Tom Best called up a friend who had acquired a VAX -780 and asked if he could take a look at it. A question of the ethics arose here since after looking at it for a while he asked if he could take a look inside the machine. His friend agreed but asked him not to remove anything. Looking at the mother board, Tom commented that it was reflective of DEC administrative hierarchy. When a company reaches a certain critical mass the hierarchy (reporting relationships) hinders efficient design – less room for creativity. Anyway, learning from DEC's mistakes Data General entered the market with their own computer. It is a very interesting story and I would strongly suggest that you read it.

Topic 63

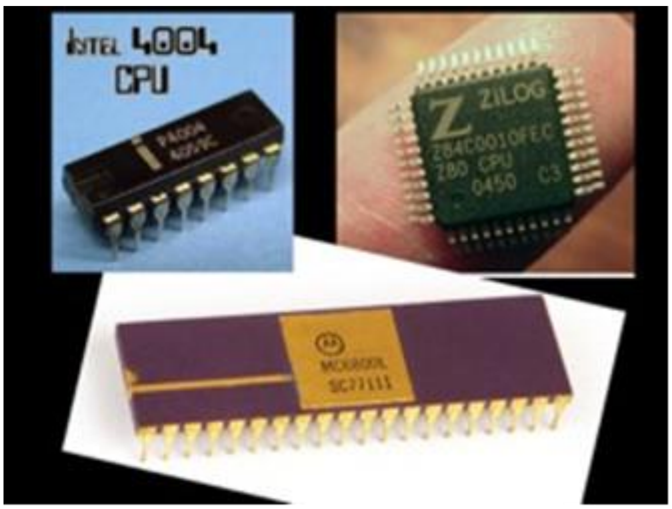
From Transition to Micro Processions

In terms disruptive innovation we had earlier mentioned how vacuum tube technology was replaced by transistors, which were replaced by integrated circuits and eventually microprocessors. Microprocessors were not initially designed for computers. A Japanese company Visicom asked Intel, an American company to design their computing machines. Every time they would ask for modification which meant the company had to redesign the entire things again. The solution was to come up with a microprocessor which was reprogrammable and modular in design. If any functions or capabilities needed to be added, a program was provided which would allow this. Naturally, this did not cover memory enhancement which would entail further memory chips. It was not completely modular but hybrid in nature.

Having made the machines programmable they thought of reducing prices which would mean the Japanese would switch over entirely to their design. This is how microprocessors, the first 4004, came into existence. Another Japanese company Nippon Calculating Machines also requested Intel for customized twelve chips for their Visocom 141 printers and calculator.

Intel tried a similar design. The set of four chips which they fabricated included a Central Processing Unit (CPU) 4004, a supporting read only memory (ROM), application programs, a random access memory (RAM), chip for processing data and other small miscellaneous parts.

The company then offered Viscom lower price but secured the rights to the microprocessor design and to market it for non-calculator applications. This was a defining and historical moment. Allowing the Intel 4004 microprocessor to be advertised in November 15, 1971 issue of Electronic News, it is then that Intel 4004 microprocessor became the first general microprocessor in the market – a building block. The chip opened a floodgate it has usage in almost everything, from toasters, washing machines, to camera, etc. Due to its extensive usage its prices naturally fell drastically. It is this conjunction of market forces with technology which leads to a revolution. It was this revolution that toys became computers. For instance the ZX 81 was priced at US$100. Compare this to earlier mainframe prices of US$32,000. Looking at these machines all the large manufacturers IBM, Data General and DEC decided they were for children. None of them realized the revolution in the making.



Topic 64

Buying a Computer for Our University

Next we move to how the first microcomputers came to the Pakistan market. While at the Engineering University we decided to purchase our first microcomputer and asked for quotations. Initially there were only three Commodore, Apple and Radio Shack. Commodore positioned its 64 machine through marketing it as a game machine for children; despite the fact that it was a general purpose computer. We spoke to the accounts department who objected since it was perceived as used for playing games. Next we turned towards Apples; the machine was US$2,000. Going through its catalogue the machine appeared to be for business, especially small. This was their marketing strategy. Again the accounts people objected since meant for businesses. Ultimately, this left Radio Shack TRS80. The machine was priced at US$700. Going through its brochures it was apparent that there was no comparison with Apple or Commodore. Radio Shack was not too clear on their marketing message and so decided on simply positioning itself as a straightforward computer. This finally appealed to our accounts department and we managed to purchase one. I have great nostalgic feeling about the machine since I did my MSc thesis on it. Looking at these computers the mainframe manufactures discounted the product and did not consider them competition. A fact which they soon rue and their machines became obsolete. DEC and Data General no longer survive and IBM had to go through many painful transformations before being able to continue.

Topic 65

The Apple Revolution

We now turn to the next story and look at the role Apple played in this revolution. First, the advertisement of Macintosh came. The machine introduced by Steve Jobs contained many innovations including its advertising. The major difference was that they eliminated the command line interface. This entails the elimination of typing commands. Apple people felt that this acted as an obstacle for its users. The interface developed by Apple was mouse based, i.e. one could click on appropriate options. This was much more user friendly. The elimination of command line interface on an abstract level has parallels with our existing education system. Abstruse concepts, much like command line interface, need to be eliminated. These need to be taught in manner which is fun and innovative. Macintosh also contained images, which again was an innovation. The elimination of command line interface was later copied by Windows. I distinctly remember the incident. When questioned by Apple, Bill Gates spoke to Steve Jobs and told him they too had done the same thing.

Xerox, manufacturer of photocopying machines, had invented an interface which involved in using buttons to specify number of copies and other photocopying specifications. When Macintosh was being designed two former employees of Xerox told Steve Jobs that Xerox already possessed this technology and had successfully eliminated command line interface. Steve jobs went to meet with the CEO of Xerox and asked him to allow them to look at the technology and in return they could have shares in Apple. These shares would appreciate ten times in six months and would help Xerox, who was in trouble at that time. The CEO gave his permission and Steve Jobs was taken to the manager in charge of this technology. The Lady in charge knew as soon as she showed the technology to Apple people they would copy it. She realized this was the future of computing and had been harping on the fact but nobody paid any attention to her in the company. When Steve Jobs and two other Apple employees visited the manger showed them everything except the interface. Steve was very disappointed and called the CEO again, who immediately called the manger. After her continued reluctance to show the technology she was fired. Later as Steve went to take a look he was jumping with joy. On the way back he was driving at 150 kmph and was pulled over for ticket. He told the police officer that his brain was traveling at 200 kmph.

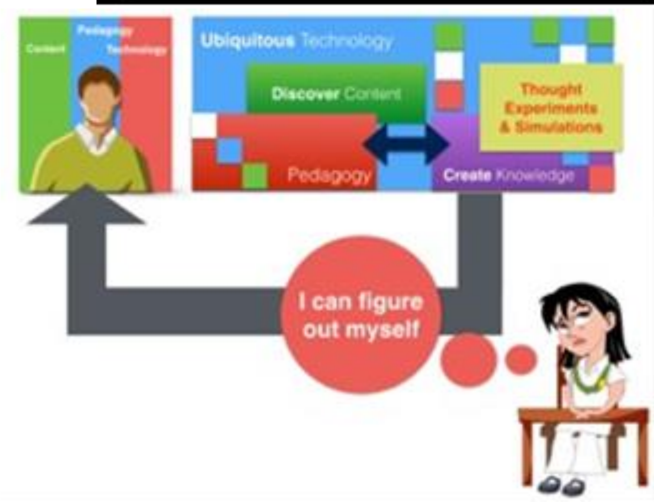
Topic 66

Xerox It

I remember quite clearly that in the Iranian revolution of1979, a brother of our close family friends Dr. Sial had to run from the country. Coming back to Pakistan he asked me to give a tour of the University of Engineering and Technology (UET), Lahore, where I was a lecturer. During his visit he also went to the photo production section and enquired if we had Xerox machine. At first I did not understand, since our photocopying machine was a Toshiba. This was the strength of the Xerox brand; you did not photocopy rather Xeroxed something. In those days Xerox mainly made large photocopying machines for large businesses and enjoyed a virtual monopoly.

Canon came up with a small cultured photocopying machine. They realized they could not compete directly with Xerox so came up with a unique marketing strategy. There point was that a small machine would look good on a senior managers desk; tied it to prestige and individuality. For Xerox you would just send your job, which would go in a queue and would be delivered to you on completion. Another point they made was that some documents are too confidential to be publicly photocopied. The Canon machine was also cheap in comparison. Xerox reaction, much like many large firms mentioned earlier, was that it not really our competition. As they say history repeats itself, Xerox lost out completely in the photocopying market. To compete with revolutionary changes a drastic reconfiguration and change is required. This is what we believe is also required for the existing educational system.


Canon disrupted Xerox?


Ubiquitous Technology
Discover Content
Thought Experiments & Simulations
Pedagogy
Create Knowledge
I can figure out myself

Topic 67

Prior Knowledge as the Foundation

We welcomed you in new module. I hope you are enjoying this course ICT in new education. I have told this quotation many time, in future I will tell you some one. May be you remembered the name. It was quotation from very famous learn Science scientist. “Most important in learning is your prior knowledge" Prior knowledge is the foundation of the building. If the foundation is weak, we cannot construct a building properly. We have to check our prior knowledge, is it correct or not, it is on certain level and technology help us. This slide you saw many times, and i show again because we will do some real example. I am telling you stories and philosophy till; we converted into picture, so you can view it through different angles. In this slide we are showing technology, pedagogy and content. We can never separate them. We have to combine them and strange thing happened after combination. Children try to discover and enjoy be self. Children become excited and intrinsic motivation. Then a strange play started after little effort. You can do wonders. The second most import thing in learning how does you integrate new knowledge with prior knowledge. The first test technology does. Is your prior knowledge appropriate or not. The second test is how you integrate new knowledge with prior knowledge. I repeat this thing may time. We have tools for pedagogy, which are ABSORB--DO-connect. This thing comes everywhere. In another book this tool is written in another way, select-organize--integrate. Prior knowledge is most important, where we start it. Second most important thing how do you integrate it. Technology tries to help you on every stage and have you where something happens not correct. Our all student are intelligent and sharp as compare to other nations. If we learn to use mixture of pedagogy and technology, they do wonder. Responsibility is ours. We start from discovery base learning. One person came with prior knowledge and he have to reach the top of hill which his final destination. In term of learning, there are so many path. This is our work to find which path is most suitable for which children. Different children will choose different way pedagogy and technology help them to reach there. How much you do struggle with excitement and enthusiasm. The combination of technology, pedagogy and content help them to achieve their goals. This programme can be seen by medical, science, pre engineering, arts and different discipline of children. You can find the example of every type , some are close to physics, math , English language and some are simple. Today we selected the example of "finding the area of something" What is the area? Before I tell you what is the formula of area? How do you calculate it? First we know that what the area actually is. Some picture does not construct in your mind about the area. How many book do you read and memorize the formula of area, this is not deep learning. When I pronounce the word area, what is the thing come to your mind? Would you please think about it for two minutes? We will start this thing from the next module.

Chapter 7

Finding the Area (A Case Study)

Topic 68

Not a Formal Definition

Talking about area, one does not require a formal definition; rather the interest is in what pictures come to mind. I often quiz my senior students to enquire what context is area used: what area is the size of your plot; how much larger then Pakistan is India; how much area did the Israeli's capture from the Arabs in the 1967 war; what is the area required to build a school? In terms of area everything begins with a dot. There are no dimensions to a dot on the other hand it contains all dimensions – a very integral point in Sufism/Spirituality. You cannot measure a dot. From a dot/point arises the dimension of length, which also connotes distance: i.e. what is the distance between two cities. What is the distance that we need to cover to reach work or children to school? Sequentially, after one dimensional distance comes two dimensions, which is area. Here we are not trying to arrive at a formal definition; rather we want to arrive at a conceptual feel of area. For example rice is cultivated in certain areas of Pakistan. With the aid of technology arriving at area is a relatively easy proportion. The units of area and distance are different. Earlier we had defined square kilometers as the unit of area. Now the question arises why square. If you are painting a wall, which is a rectangle, you requires it area. Now the paint you are using has different units of measurement, i.e. volume and measured in cube. If you want to paint an area of ten by ten meters and require one container of paint; what if the dimensions are extended to twenty by twenty? Would two containers be required?

Topic 69

Fiction of Area and Methodology

Before we turn to actual methodology for calculating area, we needed to develop a conceptual understanding of area in our minds; to allow the two to integrate. This goes back to learning cycle of Absorb, Do, and Connect and Select, Organize and Integrate. We now look at examples of technology deployed in teaching this concept, mostly through the web. Initially, we turn towards the wrong blend of technology, pedagogy and content, i.e. the shortcomings. In the first site there are eight different areas and associated formulas, much like most school text books and consequently existing teaching methodology. There is no pedagogy or technology involved; that is appearance of data on a computer screen in no way implies use of technology. In the next site, the formulas are also given but in addition a woman is trying to explain these formulas. There is motion, the woman is pointing to the area and explaining the length multiplied by width gives you area. Is this pedagogically sound? In reality we have just captured the textbook mode of teaching and converted it onto a movie/film medium; which can be rewound and seen repeatedly, yet does little else. There is actual pedagogy which would assist in selecting, organizing and integrating. You will find this type of learning in most applications. An explanation would be followed an exercise where you answer question from the topic covered. If the answer is wrong it takes you back to beginning and you go through the process again.

In another website we begin with a definition: “A rectangle is a quadrangle with four right angle, the opposite sides are congruent and parallel.” This goes back to the earlier story of my time in school. The explanation is too complex and entirely boring and guaranteed to putt off most students. We need to forget that our basic purpose is not to have children memorize definitions and formulae. Instead we need to generate passion and excitement. Even a parrot can memorize but, hopefully, has no feeling of excitement in understanding calculation of area? After providing a definition it gives you a formula and asks you to utilize it to calculate area. Why is this particular formula used; there is no explanation. Here we are imposing ideas on students, which is also a certain kind of pedagogy. The teacher possesses the requisite knowledge which is imparted to students who do not have this knowledge – a giving and receiving relationship. This form pedagogy is no longer applicable but unfortunately lingers in most educational initiatives. Our website too is a victim of this.

Topic 70

Improving the Learning Experiences

We turn towards another website: there is some improvement. Here we are told that we have certain squares with the area of one (sq. km/m). We have a large quantity of these unity square areas. Next we are asked the height of a rectangle in terms of rows? Here the reference is to rows and not meters. The problem is being divided, which will then lead to absorb, then a do function will be created leading to connect. This is a reflection of pedagogy, i.e. information is being selected in one unit square areas, leading to organization in rows and columns and calculation of area through this methodology, i.e. how many rows and columns fit in that rectangle, finally leading to integration of this knowledge. Also, no formula is provided instead the students can derive the formula on their own. The strategy used in this website was one of divide and conquer. At large, complex problem are being broken down into smaller and easier segments.

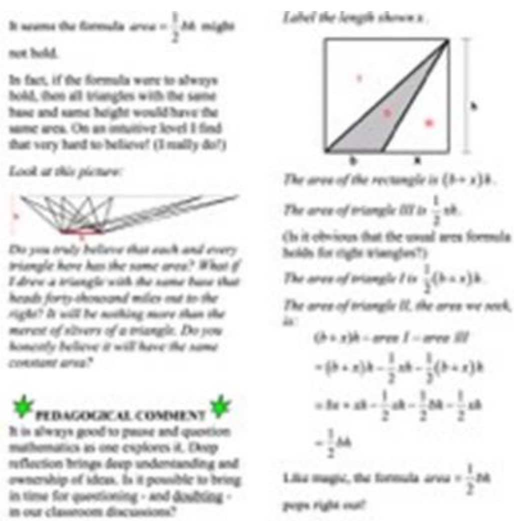
Now we move towards how we would solve this problem by extending the ideas developed in this website. We also look at what technology and pedagogy would be required? Presuming that an area of a square of side one – prior knowledge which initially needs to be tested. Initially, we are assuming that you can calculate the area of a square. As we had mentioned earlier prior knowledge is a critical factor in learning. In the last example this square was being repeated in many different forms in calculating area. We are moving to a square with two sides. Initially, we need to visualize the area, i.e. how many squares would fit in. With the aid of technology we can actually place these squares within an area. How many one square meter squares have? How many two meter square have. What we are saying is that the area of a rectangle is being calculated in terms of unit squares. This allows an intuitive understanding for students instead of a formula being imposed upon them.

Moving to a triangle and things become interesting. A triangle with all three equal sides and angles; how do we calculate the area? Our prior knowledge consists of being able to derive the area of a square. With the aid of technology we can superimpose the triangle on the square or vice versa. Bisecting the square into two rectangles, and all this can be actually seen and does not need to be communicated, if we derive the line from the point of a triangle. Half of the area remains within the triangle and half does not. This form of discovery can also serve as a game or the students; let them observe, select, organize and integrate on their own. All that is required is some basic simple knowledge, i.e. area of a square of size one. The basic unit can act to build all other shapes, much like Lego bricks. Let them make new shapes and derive areas on their own.

Topic 71

Incorporating Technology and Pedagogy

Moving to a more complex shape with eight sides, an octagonal, we need to see how area can be calculated. There is no need of a formula rather by fitting the square in the octagon we see that the area left consists of triangles. We know how to calculate areas for both shapes and consequently work out the area for an octagonal. One step leads to another; standing at the bottom of a mountain it may seem unattainable yet the journey begins with one step. On the way one enjoys the various sites and challenges, which become part of his experience. We need learning to be in this form where it becomes deeply etched into a student's mind. Now how do we calculate the area of a star? Can the squares be superimposed? We need to actually do this and forms a critical part of the learning process, i.e. trial and error. The making of shapes has always fascinated children and by teaching them in this way it becomes a game for them.


It seems the formula $area = \frac{1}{2}bh$ might not hold.

In fact, if the formula were to always hold, then all triangles with the same base and same height would have the same area. On an intuitive level I find that very hard to believe! (I really do!)

Look at this picture:

Do you truly believe that each and every triangle here has the same area? What if I drew a triangle with the same base that heads forty-thousand miles out to the right? It will be nothing more than the merest of slivers of a triangle. Do you honestly believe it will have the same constant area?

PEDAGOGICAL COMMENT
It is always good to pause and question mathematics as one explores it. Deep reflection brings deep understanding and ownership of ideas. Is it possible to bring in time for questioning - and doubting - in our classroom discussions?

Label the length shown x.

The area of the rectangle is $(b+x)h$.

The area of triangle III is $\frac{1}{2}xh$.

(Is it obvious that the usual area formula holds for right triangles?)

The area of triangle I is $\frac{1}{2}(b+x)h$.

The area of triangle II, the area we seek, is:

$$(b+x)h - area\ I - area\ III$$
$$= (b+x)h - \frac{1}{2}xh - \frac{1}{2}(b+x)h$$
$$= bh + xh - \frac{1}{2}xh - \frac{1}{2}bh - \frac{1}{2}xh$$
$$= \frac{1}{2}bh$$

Like magic, the formula $area = \frac{1}{2}bh$ pops right out!

Topic 72

The Methodology of a Circle

So far we had discussed shapes which were based on linear pattern, regular forms. We now move to a circle. In a website they have tried to use our earlier method of superimposing squares to work out its shape. First we fit in the whole squares, and then estimate the remaining areas on the bases of squares, i.e. half, quarter. By this we get to an approximate area. How can we reduce the error in differential between actual and approximate area? We reduce the size of the squares, till they are the size of a dot. Naturally, this is more for visualization purpose then practical. What we can do is increase the size of the circle, increase its diameter, while the size of the square remains the same. With increasing diameter the error in area is drastically reduced. We can now turn to another methodology of calculating the area of a circle. Yet there is a problem, in terms of prior knowledge a lot of people have difficulties with the measurement of an angle. We all know that measurement of angle is made in degrees. I used to do this with my senior class. While most were easily able to understand degrees, they had trouble with radians. Two pie radians is equal to 360 degrees or one pie to 180. Similarly, pie is a number with no end. Both add a level of complexity which degrees do not – but why? In most cases we were not correctly connected with pie or radians and their importance.

There is an animation in Wikipedia which illustrate the concept of radian. To get to an explanation of radian you have to engage in an activity – the do part. For measurement he has taken a small circle of unit radius. The radius line is shown and marked red. Now these are mapped on the circle creating an angle of one radian. The segment of the circle equal to the radius, allows us to arrive at an angle of one radian. The activity of mapping allows us to arrive at this. Now half of the circumference of circle with radius one is equal to pie. What connects the radius to circumference of circle is pie.

Another animation from Wikipedia show a circling wheel with thread around it which appears to unwinds as the wheel turns. This is another way of showing the relationship between radius and circumference through technology. Now that we understand radian and the importance of pie we can calculate the area of a circle. On the circle we overlay a triangle with three equal sides. If we say that the area of circle is equal to the triangle, it does not sound right. The overlap in areas is too much and at the best we can arrive at a very bad approximation. If we swap the triangle with a square the approximation becomes a little better. By altering the size of the shapes through technology the website allows you to experiment. So for a pentagon or any other shape we can work out the dimensions and visually see this taking place. Technology can in reality convert the entire thing into a game, which allows for the correct pedagogy in terms of doing activity, absorbing and connecting. The built in flexibility also allows for individuals to learn in their own style and pace.

Topic 73

Triangulating a Circle

Dear students, we were trying to find out the area of the circle, we defined the radiant; we understood and recognize the importance and beauty of pi. It's very important. Now we come back to our method, you can see the slide of the circle, we have made the triangle on the circle; see the triangle its three sides are equal to angle. We say that the area of circle is equal to this triangle, it's not correct as a lot of area is remaining. It would be a very wrong approximation but it is still an approximation and a method. Let's move to next step by making a square as the approximation will be little bit improve, we know the area of the square. If we now approximate the area of the circle to the area of the square then there would be less error in our answer , if you want to make more less error, then here technology works that after clicking its sides became increase. In this web site there is a benefit that you can reduce the number of sides of regular polygon, when you press the button then you can easily judge that how can the errors are going to be reduced. Now see we can also find out its area as the area can easily find out in triangles i.e. pentagon in it there are also triangles then here the formula of triangle will be used. Let's move forward, see it, here technology gives you an interesting and beautiful shapes, it becomes a play and game. Now approximately it has become equal to the circle, how many sides it has ,on ten sides .Now we have 34 sides as it has become very difficult for you to distinguish that either these are triangles or polygons and the area which is composed by the combination of polygons is comparatively less than the circles. You can never notice it. It's a very important thing. So viewers by this method which i tell you , now what will we do ,to find out the area of the small triangle by any method as we are moving towards the limit so multiply the area of the triangles which we have . We know the area of the triangle so after multiplying according to the number of triangles we will easily sort out the area of the circle. But here another interesting thing has happened and i took it from Wikipedia .i am again telling you method one to find out the area and you can easily do it here with technology. Open the circle, when you opened it and if radius is R then below the total distance would be R pi. Now you will think how it happens open it then you will come to know. It all comes in doom and this is the power of pedagogy that you have to do the activities to derive the area of the circle. So you have to do, select, organize and integrate the activities. It would be R into pi .Do you know what is pi? I.e. circumference of a half circle. If the value of the R is one and value of R is R then R becomes into pi. right, we have done it already .It has become an rectangle and its long side is R pi and the small side is R .Here, now by which method we will try to find out the area of the circle. You can easily do this as there is no need to tell you. So viewers you are seeing another method and i am trying to show you with different multiple methods and my friend Usman Yaas has sent this method. It is very important that to climb up the hill from this place you want go here so to reach on that specific place there should be many ways and any way which suited to person, he should try to go from this path. You should give him some hints and show him some pictures. With technology you can easily do this. Therefore, your only task is to give him hint. Therefore, viewers what we discussed today if i tried to summarize it that area of a circle and area of a triangle as i showed you in a prior slide that teacher plays such a role, i know the knowledge ,i am a guardian of a knowledge and this is knowledge so take it. We didn’t adopt this method, we said NO we want to empower you to discover the knowledge by yourself and technology helps you so much that you can’t imagine it would become a play and game.

Topic 74

Indigenizing the School of One

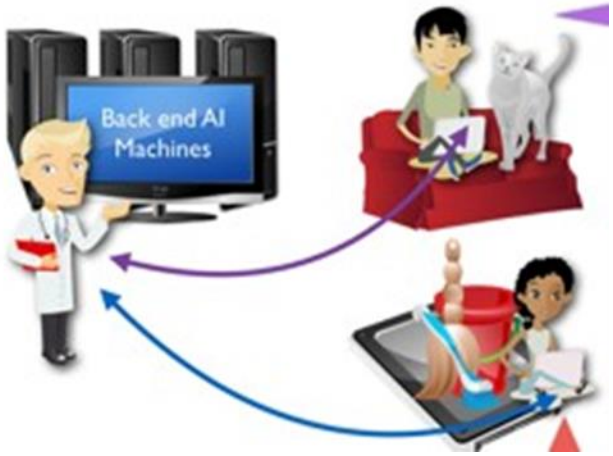
Previously we had discussed the concept of school of 'One.' As you probably realize that in our context the traditional 'Brock and Mortar" schools are not possible due to lack of finances and resources. Conversely, the One school makes sense, but how would it be adapted to our environment and circumstances? To conceptualize envision a privileged students comfortably resting on a couch after attending an elite school. In contrast the girl sweeping the floors gets very little time but is trying to study through access from a smart phone or a tablet, which will soon be available to everyone. "Ali studies in a college, while at home he is logged into the campus account. A reminder pops up indicating the mistakes he made in the last quiz in the last class. He pulls up a Wiki??? To view progress on a collaborative research project; downloads yesterday's chemistry video lecture which he missed somehow; and submits the mathematical assignment by email before going to bed. Zainab is registered in an adult education program, where she logs in her spare time. Various reminders popup of various exciting interactive learning applications; some advertisement of better jobs; and she can improve here English pronunciation by an exciting application which provides instant feedback and she enjoys immensely."

Now imagine this scenario in poor a neighborhood; there are children playing in the street, as they do, when the candy man comes in. The children crowd around him and those with money purchase their treats – a typical scene in our country. Now how does this scene need to change in context of the One school? The candy man still comes in but also carries a Wifi hotspot. The children with the aid of smartphones or tablets, individual or shares, download their homework and upload their new assignments. Why do they accomplish their homework? Their assignments are made into games and are very exciting, competitive and fun. Once the candy man leaves each child is engrossed in his homework.

How much money is required for this type of learning? Does it require an actual building or a teacher? No! All that is required is exciting, learning game applications. These can all be developed locally in Pakistan. This interactive learning also has application in conventional schools where it can act to augment the existing educational methodology. "A learning object is explained by the computer and by the teacher. The system intends to check the learning outcomes in real time through a surprise quiz. The quiz is answered and checked in real time. How much learning in each class by each individual would be recorded and available: centralized monitors in the principal's office would contain and display data from various classes instantaneously. The instant feedback would also highlight areas where most students went wrong, or what was taught wrong and how to rectify these areas. The process is repeated and individual progress recorded which is then shared with them and their parents.

In a conventional setup today's topic is the second law of geometry. The students have submitted their assignments which have not been graded. It is not easy to check a hundred assignments on a daily basis. Without the assignment, relevant prior knowledge, it is futile to proceed with our geometry lesson. While being taught the children sit in the class and doodle. In contrast in the school of One, there is no formal classroom. The class is being held outdoors in the fresh air; the teacher is not too highly qualified, since acts more as a facilitator. A story concerning the first principle of geometry is narrated, which is then quizzed before proceeding to the second law. Apart from the teacher, the computer acts to provide each student with personalized teaching. For instance, if you solved the third law of geometry on your own your pace will be enhanced. Homework too is based on individual progress and customized to account for a student's inherent abilities. This is a brief glimpse of the school of tomorrow.


Back end AI
Machines

Topic 75

A Case Study

Meray charagar ko naveed ho

Safay dushmana ko khabar karo

Good news for friends who solace

Spread news to ranks of the enemy

The debt that burdened life

That debt today redeemed with life

We begin with an example or rather an activity involving pedagogy and technology, within the framework of theories of learning which we had discussed earlier – select, organize and integrate and observe, absorb, do and connect. Before turning to the example we need to remember a few things: the interactive learning applications should be a blend of assessment and learning; and content, pedagogy and technology will not be compartmentalized rather it would be blend of all three. If we succeed in this, which is not an easy task, the students would be innately able to learn on their own and have fun while doing so.

Before moving on we turn towards the book "Islamic Art and Architecture – The System of Geometric Design, by Islam al Saeed. "Islamul Saeed an artist an architect, died suddenly in December, 1988, before this book was published. The last five years of his life were dedicated to his researches on the methodology and mathematics of geometric proportioning in Islamic architecture, which was the subject of his Phd thesis; under the supervision of professor Miles at the University of Newcastle upon Tyne. This book presents key extracts from his thesis which at the time of his death was not complete. Al Saeed's obsession with geometry started two decades earlier, when he began formulating the design concepts for constructing geometrical patterns:

determining a formula used by craftsmen and master builders in Islamic art and architecture - though never recorded as a design process. His research led him to investigate the foundations and principles that he later identified as “Aassul”, which he conceived as the system of creativity in Islamic artistic heritage.” Whether it is Bukhara, Samarkand, Damascus, Iran, Turkey, Spain (Al Hamrah), Pakistan or any other country with Muslim heritage, you can see a similar patterns running throughout. “The inherent geometrical proportions in Islamic patterns which he pursued in his designs, paintings and research were seen by Al Saeed as the conceptual essence of “Al Meezan” (The Balance), as mentioned in the Quran.

“And the sky he exalted and established the balance” – Al Quran

The secrets contained within this balance and balance is truly fascinating. Unlocking its secrets is aptly described by a poet:

If only my pain acquire a tongue

If only I find the essence myself

That I acquire dominion over creation

That I acquire the riches of two worlds

“Geometric patterns the vocabulary and language of Islamic art. The structure of architectural design concepts and town planning were the domains where his forte and enigma lay. This involvement developed alongside his understanding, irrespective of region or area and he delved into theory and practice to reconstruct their elements. Whether in music, calligraphy or architecture he sought to analyze geometrically the underlying abstract layers of patterns, woven by a perfected system of design, which inspired and enriched the Islamic artistic heritage. In this realm of investigations there was no separation between arts, culture, science, mathematics or between compasses or computers.” A universality of vision which encompasses in totality: an aspect of education which only the thirst of a true student can quench. “Thus he was able to recreate the same systems used from pre-Islamic times to establish the methods that characterized and inspired creative expression.”

Topic 76

Discovering Islamic Architecture

"This also endorsed theory that all Islamic arts were governed by the science of preparations in the realm of meter, rhythm and the form of interval in music." Imagine a point, where all the arts culminate? "As developed by Muslim scholars and craftsman, seeking to reestablish the sciences and mathematics and acknowledging their methodology, he considered that the main reason for the gradual disappearance of Islamic theory of design in contemporary works and practices was the inaccessibility of the scientific geometric knowhow acquired by the traditional master craftsmen. The quality of which was manifested in the methods, materials and designs skillfully and cleverly integrated while based on the same geometrical principles that generated the creative dimension of Design. It was the geometric method of Proportioning in which the execution and aesthetics of composition were systematically determined which engaged Al Saeed in the Islamic theory of design and the infinite possibility of its application in contemporary art and architecture. He has made an exceptional contribution in fathoming the depth, beauty and vision of a distinguished culture and that is our culture." This note was written by his mother.

Similarly his advisor had this to say. "Islam ul Saeed felt that achievements of Islamic art and design had been greatly underestimated and he expressed this point of view in the introduction of Geometric concepts of Islamic Arts, written with Ayesha Paraman and published in 1976. The first chapter of the book traces the use of geometrical patterns to earliest methods of measurement of space in architecture, by the Egyptians and other people. In later chapters the concept of repeat unit was developed. This was determined by the use of a circle to demonstrate pattern making based on the square and the root two system of proportion, followed by the hexagon and root three systems; the use of pentagon and decagon produced with the use of golden ratio. The golden ratio or section was shown to create yet another series of patterns. Finally, the circle was divided into twelve equal parts with two hexagons inscribed within the circle to form a fifth series. The study went on to analyze geometrical patterns in the planning of historical monuments; the mathematical basis of Arabic calligraphy; examples of Arabic poetry; the music in the Muslim world; and patterns used in the works of applied art including carpets created within the Muslim tradition. The ideas put forward proved to be a source of reference for many publications, notably the British museum's Patterns of Islamic Design. Islam continued to be fascinated by geometrical principles of design. Being a practicing artist and designer was particularly interested in the practical methods used by the generation of craftsmen to create sophisticated and complicated patterns and space composition. Although they worked within a well-established tradition and often under the direction of masters, he was convinced that the use of the compass, straight lines and whole numbers could account for these beautiful and intricate designs. He wanted to develop and extend these ideas and decided to study the degree of doctor of philosophy at the school of architecture in University of Newcastle upon Tyne - a degree he could not complete."

"He continued to practice as an artist architect. A commission design for a mosque in Baghdad was intended as a working demonstration of his thesis; the methodology of geometrical proportioning in Islamic architecture. Tragically the construction of the mosque did not proceed, at the time of Isam's death and his thesis remained in a fragmentally draft form. Dr. Issam el Said???? had managed to assemble the surviving documents and enlist the help of Dr. Frithjof Schuon, who edited two of the projected five chapters and prepared them for publication. Fortunately these two chapters comprised the basic ideas and the principles of this thesis." - A highly recommended reading, or rather an activity book for those who want to understand the fascinating and rich cultural heritage of Islam.

Topic 77

Calculating the Area of a Polygon

Based on the earlier work we turn towards actual examples. We begin by calculating the area of a general, regular convex polygon. We had discussed this earlier but were doing this on an estimated basis for each individual polygon and had not arrived at a generic formula. Another point to remember is that the clearer and more precise the drawing the simpler it is to calculate its area. Turning towards some pictures we need Observe and Absorb in terms of the learning cycle. We begin with a triangle in which all sides are equal; a shape which can be considered a polygon. Next we look at square, a shape whose area we also know how to calculate – if we know the side it is x2 and for a triangle ½ x2. Next we turn towards other regular convex polygon with increasing side, getting more complex, how do we calculate their area? On a seven sided shape we have drawn a circle to illustrate a point, i.e. as sides increase we approach limit, where the shape becomes a circle. This can be show even more clearly with the help of technology – an animation in which a regular convex polygon is show with increasing sides until it acquires the shape of a circle, where the perimeter and area become equal; the concept of limit. Here the Do and Connect part of learning are also involved. The tools for today's exercise solely consist of a compass, a straight edge and pencil. Naturally, this can also be done through the use of a computer or a tablet.

Here we present another small activity book, which is being utilized for a seminar – Islamic Art and Geometrical Design; activities for learning by Metropolitan Museum of Art. "Surface patterns on works of art created in the Islamic world have been prized for centuries for their beauty, refinement, harmony intricacy and complexity. Fine examples of Islamic art from the seventh to nineteenth century can be seen in the Metropolitan museum collections - this publication features a selection of those objects. By using these instruments teachers will be able to show their students how Islamic artists applied their imagination to an underlying geometrical framework to create the patterns in these outstanding works of art. Students will also learn the principles of geometrical patterns and be able to create their own. We hope that these activities will spark, in your students, a lifelong interest in art design." Who knows one of these students might be you, to further the lost legacy of Islamic art and design as the great craftsmen and master builders of the past.

Topic 78

Works of Art

What follows next from the book has great implications for pedagogy. “Works of art naturally can be stimulating starting points for interdisciplinary investigations leading students to an exploration of history, social studies, geography and culture -science and arts combine together in work of arts.” Unfortunately, we have managed to segregate the two and it is our fervent wish that we manage to combine the two wherever possible. From a pedagogical viewpoint this would be very helpful in learning mathematics and sciences. Once you manage to appreciate the element of beauty in art the hidden science behind it would be easier and more interesting to understand. “Less commonly but no less intriguing, art maybe a stimulus for exploring concepts in mathematics and geometry: this is something which a math’s instructor must try to understand.” There are many students who have been turned away from the subject, who could have been brilliant mathematicians, due to its dry nature and memorization of formulas. The creation of the universe was based on a singularity which contained symmetry, proportion and design in a consolidated form.

Topic 79

Incorporating Art

"The humanities teacher will find that the close study of works of art will lead students to a greater understanding of artistic and cultural concepts and heritage. Math's teachers can use the activities to reinforce geometrical principals. Art teachers will find that students become absorbed in the creation of geometrical patterns and science teachers will recognize that many underlying principles of these patterns have corollary in the natural world. While geometrical ornamentation may have reached a pinnacle in the Islamic world, sources for the basic shapes and patterns already existed in the late antiquity - Byzantine and other ancient empires. Islamic artists appropriated key elements from the classical tradition and then elaborated upon them to invent a new form of decoration that stressed the importance of unity, logic and order." The concept of unity Tawhid is a central and deep tenant of Islam. "Essential to this unique style for the contributions made by the Islamic mathematicians, astronomers and other scientist whose ideas and technical advances are indirectly reflected in the artistic tradition.

The basic instruments for constructing geometrical designs were a compass and a ruler. The circle became the foundation for Islamic pattern, in part a consequence of refinements made to the compass by Arabic astronomers and cartographers. The circle is often an organizing element. The underlying element of vegetal designs plays an important role in calligraphy, which the Arab's defined as the geometry of the line and it structure, all the complex Islamic patterns using geometrical shapes. These patterns have three basic characters: they are made up of small number of repeated geometrical elements; the simple form of the circle, square and straight lines are the basics of the pattern; these elements are combined, duplicated, interlaced and arranged in intricate and beautiful combinations -so simple yet so complicated: so beautiful yet so intriguing.

Some geometrical designed are created by fitting all the polygon shapes together like the pieces of a puzzle, leaving no gaps and therefore requiring no special interplay between foreground and background. The mathematical term for this type of construction is desolation. The conception of space in Islamic art is completely different from western models, which usually adopt a linear perspective and divide the picture shape into foreground, middle ground and background." In Islamic art the extension the reference is to infinity and which can be extended infinitively in every direction –there is unity, logic and order. They are not designed to fit within a frame they are independent of constraints of time and space. "Geometrical ornamentations in Islamic art suggest a remarkable degree of freedom. The complex arrangements and combinations of elements are infinitely expandable." The expanse is as endless as the flight of your imagination. This is heavenly something which is not confined by this earthly realm. "The frame surrounding the pattern appears to be arbitrary and the basic arrangement sometimes provides the unit from which the rest of the design can both be predicted and projected. "The geometrical patterns of Islamic art are often said to arise from the Islamic view of the world. To Muslims these forms taken together constitute and infinite pattern that extends beyond the material world. To many in the Islamic world they concretely symbolize the infinite and therefore un-centralized nature of the creation of Allah and convey spirituality without the figurative iconography of art in other religions."

We now turn towards some pictures from Wikipedia of arches from Muslim architecture – Al Hamrah (Spain). I was lucky enough to be invited to a conference on pedagogy in Spain. Visiting the Al-Hamrah mosque I came up with a few lines:

In the arabesque arches of Al-Hamrah

In the verdant greens of Granada

When history on itself smiles a little

Rendering an ode to lost glories!

From the snow clad mountains of Sierra Nevada

When the ice laden winds blow through Al Hamrah

From the palace doors, of dedicated cavalry

A ground for the sounds of clashing sabers

A message of loyalty to love emits

Topic 80

Islamic Geometrical Patterns and Architecture

The arches are Islamic patterns in three dimensions; a sight which bewilders the imagination. On observing them the first time one was faced with mixed emotions; happiness that this wonders belonged to our heritage and sadness on what was lost.

Turning towards analysis we state a problem, a problem by the craftsmen of those days who had no computers, calculators or slide rules to help them. In those days two under root could not be worked out. Can you draw square of area two or given the square of area x, can you draw a circle of area 2x? Do we just the initial area? That would be wrong since we would get four times the area. Looking at this visually this gives the clearest idea. Visual proof is a key methodology in the science of pedagogy.

What we are trying to do is to establish a pedagogical methodology in arriving at solutions/ proofs which are not solely confined to the current area problem which we are dealing with. Even if provided with the appropriate methodology we should understand the why the method works– how does it work?

Topic 81

Area of the Square

We are given two squares and an area of unit value. If one side is given as one the area must be one unit. First step we draw a circle with a compass which touches all four sides of the square. On that circle we draw another square, the sides of which are tangent and we should arrive at a square whose area is double that of the initial square. How since difficult to understand intuitively or prove? What we do is that we rotate the square and suddenly from observe, absorb and do – something in which we are already engaged – we arrive at connect part. Some people might have grasped the proof by now but some require further effort. This is how we employ pedagogy. We add two further lines which create four squares. If it is still not clear we need to do something else. We further divide the four squares into halves. Drawing polygons is fun, analyzing them greater fun; making a connection between the two is fascinating. Arts and mathematics, combine the two and enjoy.

Topic 82

Discovering Polygons

Apart from his poetry, Rubaiyats (quatrains), Omar Khayam was also a famous mathematician. Based on the last module we now look at some shapes. We began with two squares and a triangle; from this develops a polygon. The drawing of a polygon is fun, especially for children who are able to draw. When these polygons are analyzed they become a part of mathematics or specifically geometry. The transition from art to mathematics is truly fascinating. This mathematical pattern is evident throughout Islamic art and architecture. Whether it is Bukhara, Samarkand, Iran, Turkey, Spain (Al Hamrah), Pakistan or any other country with Muslim heritage, you can see a similar pattern running throughout. The confluence of art and mathematic and its byproduct is truly wondrous.

In those days what formulas and instruments did they utilize? There were no calculators or slide rules; but they did have compasses and straight edges (rulers). This is in itself an amazing that despite these drawbacks they were able to create such marvelous shapes and designs. A fascinating subject which will help us in mathematics, teaching, architecture, music, history, calligraphy and various other discipline.

We next move to a puzzle. We take a rectangle whose base is equal to triangle; superimposing the two shapes, the height of the rectangle being equal to the triangle, the rectangle shape is segregated into two. Based on this diagram a few questions arise, which you may find interesting. The answers we are looking for do not involve your usual proofs of theorems, i.e. this implies this hence, etc. We want instead to appreciate the beauty of the shape. The rectangle in front of you is diagonally divided in two. Now compare this shape to the previous rectangle. Can we explain about the areas of the shaded portion in the two rectangles?

In the first shape, this is quite obvious, the triangle bisects the rectangle in two equal portions and the area of the triangle is exactly half that of the rectangle. In the other shape when we draw a vertical line to represent the height of the triangle, we see that half of the rectangle consists of two triangles. What is the relationship between the two? The two colored areas appear to be the same. This shows that the area of this triangle too is half that of the rectangle. To derive a formula by oneself based on understanding is much more preferable to memorizing formulas and is more fun. In our example we have tried to derive and appreciate something; the activities of observe, do and tried connecting. This gives us the area of triangle as ½ BH (B= Base & H=Height), which is half of the area of a triangle BH. Now does this hold true for all triangles, since in our examples we had shown a right angle triangle and one with two equal sides? Here we have superimposed the earlier triangle with a new triangle. We can see by moving the remainder of the triangle area that area still holds to be ½ BH; yet if we move the remainder to the center of the two triangles what happens. We will discuss this later. We now move to discuss volumes and surface areas and observe how we connect these. In this we will also discuss structures and all sorts of pyramids and how to derive their areas.

Topic 83

An Obtuse Triangle

In this module we again begin with this triangle, which is different from those discussed in the earlier module. The triangle under discussion is an obtuse triangle, a slanting triangle. If we regard the side labeled B, as the base of triangle is the area still ½ BH? Let us compare the two triangles; by enclosing the earlier triangle by a rectangle we were able to determine the area as half of a rectangle. Now how do we enclose the obtuse triangle in a rectangle and prove that the area of a triangle is ½ BH? This allows us to go through the learning process of Observe, Absorb, Do and Connect. Now that we have gone through the observation and absorption phase we turn towards Do. We start rotating the triangle and soon you can quite clearly how the shape configures in relation to area. This in reference to pedagogy and technology has implications for us. In terms of technology if we had an interactive book we would actually show the object rotating. While if a static one we would show the various transition involved in the rotation. This clearly illustrates the utility of the Do activity, especially if a fun activity, in creating the requisite connection in our understanding.

Next we move to right angle triangle which had been divided into strips. Technically this then becomes a collection of rectangles. If we take the rectangles and continually reduce their width we arrive at a shape of a triangle. Arriving at these progressively smaller limits and summing the area of each rectangle, since we know the base and height, we will arrive at the area of the triangle, which would be ½ BH. In the next triangle we rotate it; naturally this does not affect its surface area or volume. By rotation we create a mirror image of the original. From this we can see that it becomes a slanting triangle or an obtuse triangle. Next we move the rectangle, not changing their areas, rather moving them; we see that the area becomes the same – another way of visually understanding derivation of area of triangle.

Topic 84

Islamic Architecture and Art

Going back a little in history:

In the arabesque arches of Al-Hamrah

In the verdant greens of Granada

When history on itself smiles a little

Rendering an ode to lost glories!

The book “Islamic Art and Architecture,” by Islam al Saeed; what was infact his Phd thesis. A thesis which the author did not remain alive to witness its approval; his mother submitted his research finding after his death. The thesis is an attempt at capturing the lost mathematics behind the historical Islamic patterns – an attempt at reverse engineering. The author gave his life to his passion:

The debt that burdened life

That debt today redeemed with life.

These days we have a vast access to technology; what was available in those time? The two main tools were a compass and a straight edge. Here we will try to replicate these beautiful patterns, a do activity, which have no parallel in the past or might have in the future. We are taking an example for Islam al. Saeed.

Create a circle; attach two other circles which pass through the center of the first circle. The area, diameter and radius of all three are equal. Next we highlight the points where the three circles intersect. By intersecting the three the initial circle is segregated into six parts. The inception of a polygon should be clear by now. But before that we draw another circle, this too passes through the center of the original circle. The pattern that begins to emerge stretches towards infinity on all four cardinal directions. The representation of the boundless nature of the Creator in Islamic art is a critical element. The conceptualization of infinity is remarkable. The final emerges is a self-repeating one, in all directions. The emergent polygon captures the flower shape within; this forms the basic building block and can be found in most Islamic motifs. We salute those architects, geometricians and above all artists.

Topic 85

A polygon with six sides

Turning towards the Polygon shape, in which all six sides are equal and symmetrical. If we connect the points from each side to the center of the shape it would be divided into __ and each triangle would have an angle of_. The reason we do not provide the answers is that in the pedagogy which is being attempted to teach involves no direct teaching; rather you are being involved in a historical activity which has great resonance with us. If a student is provided with such a motivation there is ho holding them back and who knows where they can end up.

If the points of shape which was discussed earlier are connected in a different format, a star shape emerges instead of a polygon. The star shape has six sides and also contains a polygon which too has six sides. The center of the circle is also the center of the polygon and the star shape: an emergent pattern, which can be repeated indefinitely in all directions and which integrates with other similar shapes seamlessly –in fact even in three dimensions. The patterns in Al –Hamra are in three dimensional representation of this – a remarkable achievement in understanding of geometry and algebra. Upon lose observation of this pattern you will see amazing patterns. The triangles formed also form a unique pattern. Similarly, three dimensional cubes are also in evidence. Moving ahead we take some triangles within the shape and mark them in red; a whole new pattern emerges; an astounding achievement that this was all conceived with only a compass and a straight edge. Now that we have studied the formation of these shape, the Observe, Absorb and Do phases are over and we move towards the connect part.

The important take away from this section would be the flight of imagination which people were able to display in capturing abstruse concepts like infinity. Sadly this ability has shown a remarkable regression. The whole purpose of this course is to be able to discuss the *appropriate blend of pedagogy and technology which will allow our future generation to follow that boundless flight of our predecessors.*

We move to an eight faced polygon, which is constructed with the aid of triangles and its mathematics. First we bisect the area of the polygon into two. The area of the four derivate triangles doubled gives us the area of the polygon. Similarly, if we unfold the area of the polygon, all the black and white triangles appear. The shape now changes from a polygon to a four sided figure- a slanting rectangle. Now we can calculate its area which is Base into Height. We now look at an animation from Wikipedia. A circle is revolving like a wheel (search for area of a circle); its movement is captured in snapshots. You have to discern what is the right sequence? As the wheel rotates its pieces in the form of triangles fall away from the shape, till half the original circle is left. Once this is done we insert the breakaway triangles into the remaining shape. The area of these triangles and remaining shape is equal, resulting in formation of a rectangle. Now we know the circumference of a circle is 2Pier and half would be Pier. Having the radius we can easily calculate the area. In the exercise the interesting part is the pedagogy, involvement in an activity leads you to an understanding of the area of the circle – Observe, Do and then Connect.

Having seen the animation the question arises does this provide an approximation of the area of the circle or an exact estimation? Closely observing the triangles you will observe that their smaller side is circular, i.e. not an exact triangle. If this is the case than the shape is not exactly a rectangle: but once the circle is distributed into an infinite number of triangles the approximation becomes closer to the exact area until we arrive at that point. From as approximation we are able to derive an exact figure.

As you can imagine these derivations capture the essence of the science of pedagogy which we are trying to instill. We selected the required data (circle) than Organized it (multiple circles) and then Integrated the concepts (infinite replication).

Topic 86

An Eight Faced Polygon

Polygons, Major and Minor Radius Part 1

We now observe a circle contained within a square. By shifting the square we form a triangle within, with possibility of three others. All the triangles would be right angled and represent the area within the polygon. In a sense we have divided the circle into four quadrants. If we extend the side of the polygon the two circles will be begin to meet. Moving to triangles we see two sides one smaller and one a larger. If we draw a perpendicular line on the side of the small polygon and similarly for the larger polygon; a limiting case applies, the more you increase the sides of a polygon the closer it will approach to a circle. Again the area of the circle can be calculated by multiple triangles.

Now we turn towards developing a regular polygon; how many sides should it have? This again is a Do activity, using a compass, a straight edge and for your convenience a D for finding the appropriate angles. How would you determine the size of the sides? Size depends upon what? This depends upon the angle. Now if you want to create a six sided shape, we divide 360 by six, i.e. 60 degrees. Similarly, an eight sided polygon would be based on a 45 degree angles. It is important to remember that a polygon cannot be created for certain angles.

Topic 87

An Eight Faced Polygon

Polygons, Major and Minor Radius Part 2

There is a major cycle and a minor cycle in each polygon. If the sides of polygon are increased the major and minor cycles converge and the polygon becomes a circle. There is a major radius and a minor radius; whose ratio determines the convergence. As this ratio approaches one the polygon will become a circle. How can we determine the perimeter of a polygon with n sides? First we determine the perimeter of a polygon, assuming it has infinite sides, resulting in it approaching a circle whose perimeter can be worked out. Similarly, how do we workout the area? First we calculate the area of a polygon, again increasing the sides of the polygon, minor and major radius converge towards equality, resulting in the polygon becoming a circle, which can be easily worked out. If we start a polygon with a triangle; major and minor radius are very different and circles differentiate significantly. But if we make this into a square it provides a better approximation.

In terms of pedagogy a multiple approach to the same problem is encouraged and this is what we will attempt to do now. If we take a circle and create many smaller individual circles within it; if we color them so that they represent strips, we can approximate the area of a circle. These things are visually evident and what we are doing is that we are unfolding the shapes. Here we have opened the circle into strips and this becomes a triangle. The height of which is r (radius) and the base is 2pier; i.e. the area becomes 2pier*r/2 becomes the area of the circle. We have encountered these strips before when we working out the triangle with steps or approximating them. As the number of strips increase we arrive at a limiting case and the area no longer remains approximates but becomes exact.

Topic 88

Universal Principles of Design

We begin with the discussion of immersion, i.e. one is totally absorbed in an activity to exclusion of all else. Formally: a state of mental focus so intense that awareness of the real world is lost, generally resulting in a feeling of joy and satisfaction. This is the state we desire through the interactive technology and learning games which you should aim to develop.

We move to Universal Principles of Design: “When perceptual and cognitive systems are under taxed people become apathetic and bored. If they are overtaxed people become stressed and frustrated.” This you would intuitively agree with; even in games the same phenomena occurs. If you continually win or lose you would not want to play again. Immersion occurs when perceptual and cognitive systems are challenged at near capacity without being exceeded.” This is extremely important in designing an immersive interactive learning experience. “Under these conditions the person loses a sense of the real world and typically experience feelings of joy and satisfaction. Immersion can occur while working on a task, playing a game, reading a book, painting a picture or writing a poem. Immersion is characterized by one or more of the following elements: challenges that can be overcome; context where a person can focus without significant distraction; clearly defined goals; immediate feedback with regards to actions and overall performance (critical); a loss of awareness of the worries and frustrations of everyday life; a feeling of control over actions, activities and environment; a loss of concern regarding matters of the self, awareness of hunger and thirst; a modified sense of time – hours can seem like minutes.

Topic 89

Area of Circle

Now we turn back to the earlier discussion of areas. We had tried to determine the area of a circle through an immersive exercise. We are sure that you create more novel, fun and innovative methods. Commonly in textbooks the area of the circle is determined as x2+y2=a2. This in isolation has no context; we to follow the learning cycle observe, absorb, do and connect. The circle is symmetric with respect to x and y axis, hence we will find the area of a quarter circle and multiply by four in order to obtain the total area of the circle. This is clearer but if we had highlighted the quarter circle in a particular color the experience could have been more immersive.

Next we see that we need to solve for y in the equation. Why is this; it is critical that a do activity is part of the process which involves you further in the learning experience. The Y axis is not shown on the diagram; instead we are assuming a vertical strip of Y length at a distance of X. As you know as the distance of X increases, the value of Y decreases, i.e. forming a circle. Provision of this intuitive understanding is critical. Moving ahead Y=a2-X2 under root 2 – the root causes a lot of problem for people. Variant of the above semicircle is given by Y positive; a is taken out of the equation since constant, we get 1-X2/a2 root. Once this is done we use integrals, i.e. integration.

Topic 90

Integration for the Area of a Circle

In this methodology the knowledge of integration is a prerequisite. Even if we do not have a thorough knowledge of integration we need to have a conceptual understanding for its application.

Area of circle is equal to integral 0 to a, since working out the area of quarter circle: a (underfoot – 1-X2/a2 dx. The concept of dx and strips, which need to be integrated to work out an approximation of the area, are not defined here creating a lot of problems - a typical pedagogical mistake. With pedagogy in combination with technology we can actually show the strip approaching infinity (as dx continually decreases), a limiting case to derive the area of a circle. Introducing sin and substituting Xa by sin t and dx is a cos d t, which provides the area of a circle. Again a complex formula which usually in taught contextually rather memorized – how and why are trigonometric functions introduced? It is obvious from these examples that pedagogically there are a lot of steps missing from the process, which needed to be explained. We could have instead said that a body moving in a circle, angular velocity being constant, its X component would commence from 0 sin t and cos with cosin. X2+Y2=a2; if we replace the values of X and Y with sin t and cosin the requirements of the circle are satisfied. Now what is the relationship of sin t and cosin with a circle: this can be clearly demonstrated through the use of technology with an animated sin waves in relation to a circle?

Now we use trigonometric identities (formulas). The induction of time element is new, where does it come from in calculation of area of circle, since there is no moving body? Here we are assuming that a body is moving and its X and Y components in relation. Moving further ahead we see that even the limits have changed 0pie2. The point here is that all this seems like magic – abracadabra and area is derived. This is a completely wrong methodology in terms of teaching.

Topic 91

Circles Upon Circles

We continue with an area of a circle. Earlier we had drawn many smaller colorful circles within the circle and had started unfolding them; initially a quarter than half and so on- that was an immersive experience. The shape that was unfolded was that of a triangle. The smaller the circles the more precise the triangle, otherwise it would be in the form a stepped triangle – the area of the two would be equal and the area became 2pier*2/2 pie r squared. In terms of this example the Do part of the learning process was important. If we take the rectangle strips within the triangle, if moved in a manner to retain the triangle's shape the area remains the same: yet it also generates new ideas. If the triangle is completely inverted, or made into a mirror image and if we try to bring in the red cross section into the center, followed by the yellow and not align them with the sides we get another triangle, which is also equal to the earlier right angle triangle with the same height and base.

For me Facebook acts as good medium for feedback and often interesting ideas popup: when I posted the idea of opening up a triangle an interesting case came up. A triangle fits into a square; another right angle triangle also fits into the square, which implies base and height are equal and thus their areas are equal. A student of mine recently posted a question? If we want to see what height h of a triangle is and we know what the base is? In this right angled triangle in the beginning the base was 0 and height in totality and its area B. Next the height begins to reduce and base increases. In the other triangle with two opposite sides equal minus the base, the inner area we assume to be C and height as h. The question then becomes if the height of two triangles is the same are the areas same, i.e. B=C and can this be proved? Going back to our strips, which segregate the area of the circle, we see that the area remains the same since the length of the rectangle strips does not change. The answers from the proof that one got were of great variety: some did not get it, so a diagram was provided; some said this did not hold true. A MIT graduate professor at LUMS and gave the following mathematical proof: here is its formula;

Mariam a student at NUST, who was doing a course in MS in IT, Masters in innovative technology in Education, which consists of blend of pedagogy and technology provided the following proof. A small movie was sent in which triangles are interchanged – an interesting and cute case which creates the requisite immersive educational experience.

Topic 92

O-Level Mathematics

Now we take a jump and shift towards volumes. A very popular book for the O-Levels, Mathematics 6th edition, will be examined. We will look at chapter seven concerning surface areas and volumes. The chapter begins with a shape of chocolate cone ice cream, the beginning of an immersive experience, followed by the question as to how does the manufacturer determine the volume of ice cream in this serving? It is interesting that a critical industrial problem is addressed in the example, as well as creating a connection with the real world; another aspect of the immersive experience. Each chapter commences with a page of what the learning of that particular chapter will be. In this chapter the following points are highlighted: draw sketches of pyramids, cones and spheres – a Do activity for the learning process; draw the nets of pyramids and cones (a type of origami) – another activity which reinforces the Do part, also this activity too has real world application in terms of paper and packaging industry; find the volumes of pyramids, cones and spheres, after the first two steps this should be intuitively simple to do; solve problems involving surface area and volumes of composite solids made up of combinations of pyramids, cones, spheres, prisms, cubes and cylinders – this is a typical example of a constructivist theory of learning (you create a foundation on which you use building blocks to construct. Another key point which makes this an immersive experience is the layering of learning, i.e. if you do not understand a particular step, you go no further (feedback); a design problem which can be addressed with the aid of technology.

The section on pyramids begins with the great pyramid in Giza, another interesting subject with immersive associations. Next different triangles are examined triangle based, quadrangle based, etc. If we were to induct technology at this stage (a rotating view of these triangles) the differences would be clearly illustrated. At this stage the questions begin and we arrive at volume of the pyramid. After defining the volume of a pyramid, triangle based prism and triangle based pyramid are discussed. Next part of the exercise entails nets, a part which could have been introduced earlier. The book contains diagrams which can be photocopied and actually cut and then pasted together to form the required shape. This is an excellent blend of low technology and powerful pedagogy, the shape develops in front of you in3-D. Naturally, this could be done on a computer based module. Next a new do activity is created; the relationship between the volume of a pyramid and prism is derived trough an experiment – another Do activity. Fill in a prism, pouring sand from a pyramid. The results give us the answer that the volume of a pyramid is one third of a prism.

Topic 93

Surface Areas and Nets

We now turn to total surface area of a pyramid. Again we begin with nets as an activity. This allows us to observe that the constituent parts comprise of four triangles and a square. If we calculate the surface area of individual shape we can arrive at the area of a pyramid – an interesting, intuitive and immersive exercise. After examining further shapes, their surface areas and relationships the book moves to an experiment by Galileo addressing volume of a sphere; using the same technique as Archimedes, who discovered the formula to calculate the volume of a sphere. A diagram is shown of a sphere of radius r and a circular cylinder of base r and height 2r. Archimedes filled the cylinder with water and put the sphere into it -an activity which can be attempted on one's own. The conclusion from the experiment was that; Archimedes found that the volume of water displaced, by the sphere, was equal to 2/3 of the volume of the cylinder; one of the greatest discoveries. From the experiment the mathematical analytical methodology was derived. The volume then becomes 4/3piercubed.

From volume of a sphere we turn towards the surface area of a sphere; again a formulation which was arrived at by Archimedes. In the diagram we see a hemisphere with radius r. One end of a piece of coin is threaded and rotation becomes a sphere – again a Do activity. What would the length of the rope be? Archimedes actually stuck a piece of twine in the center of the curved space of the hemisphere by a pin and then coiled it around the curved surface completely. In the next diagram a circular cylinder is shown with base of radius r and height r, i.e. equal. One end of the twine is stuck at the bottom of the curved surface of the cylinder by a pin and again coiled around the surface completely. Archimedes found that the two pieces of twine were of the same length. You can see how Archimedes arrived at his formulation; first a Do activity (experiment) and then derivation of Connection (connect activity). This is not how we were taught. The formulation is 4piersqaured. These Do and Connect activities constitute a critical part of any design solution in context of learning.

Topic 94

Learning Framework

We begin this module with two great names. Charlie Chaplin, a name you are all familiar with. Your elders would be even more familiar. Using silent movies as his medium he was able to explain what he wanted to convey through gestures and his actions; he was able to achieve phenomenal popularity. How did he mange this?

The other great name, which everyone is familiar with, is that of Einstein. Here we will not discuss what he said about education and technology; this will be dealt with later. What I want is to narrate is his meeting with Charlie Chaplin, in which Einstein had this to say: “What I admire most about your art is its universality. You do not say a word and yet the world understands you.”

From a learning, technological, multimedia and pedagogical perspective this ability, to be able to explain what you are trying to convey, is critical. In reply to “Einstein’s comments Charlie Chaplin said, “It is true, but your fame is even greater. The world admires you, when nobody understands what you say.” Now this could be taken as a bit of levity of Charlie Chaplain’s part or a serious comment, since at that time technology was not sufficiently advanced to allow verification of Einstein’s theories. Even through mathematics - a lesson we try and will try to convey in all mathematical teaching, that actual interpretation of equations and their result to actuality may differ -Einstein reached some conclusions which even he considered erroneous. The x in an equation has to mean something and how it relates to us; on its own it has no relevance. For instance one of Einstein’s discoveries of phenomena with infinite mass and negligible volume, where everything was being pulled towards it, even light; was something which he could not intuitively comprehend. This link/relation is critical and unfortunately for the most part missing in mathematical pedagogy and to some extent in physics. We do not develop the required intuitive correlation. Having rejected his own findings, it was later discovered by scientist, through modern technology, that Einstein's prediction about Black Holes was quite correct.

Now turning to this course, it is about; Mathematics, Physics, Chemistry, but more importantly the ability to understand and the ability to convey through the use of technology to make it more effective. Utilizing technology we can perhaps comprehend things which earlier eluded us, for example in the instance of black holes. Einstein also said that due to gravity space gets curved. What does this imply mathematically, what are its equations and ramifications? ***When Albert Einstein met Charlie Chaplin, Einstein said, "What I admire most about your art is its universality. You do not say a word, and yet the world understands you! It's true, replied Chaplin. But your fame is even greater; the world admires you, when nobody understands what you say!***

Topic 95

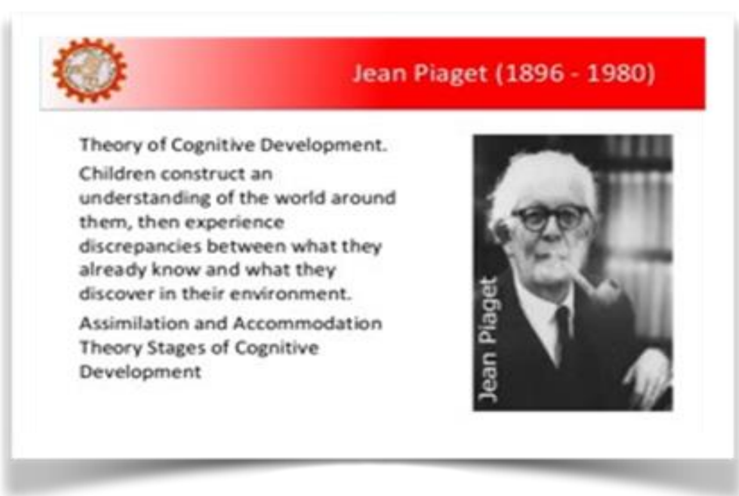
Learning Theories and Technology

We have discussed this earlier, that despite the fact that we are studying information technologies in education, we also have to understand learning theories. The text book covering this, and shown here; Learning theory and online technologies - the mixture of two, technology and pedagogy is critical to explaining any learning problem - by Linda Harisham, some chapters needs to be looked at to understand how the book unfolds. The critical chapters are: Introduction to learning theory and technology; Historical overview of learning theory and technology, this allows an understanding of how the two parallel and augment each other, in fact, it is usually learning theories which lag behind technology and is the case presently, one of our challenges to bring them on par; Behaviors? I am talking about learning theory, the most primitive learning theory; Cognitive learning theory; and Constructivist learning theory. Here I would like to remind you that, despite highlighting various chapters, we will not be following the book line by line. With that in mind we will discuss Constructivist learning theory and its ramifications in education and learning application design. For instance if you want to create a specific lecture on a subject, what would be appropriate blend of technology and pedagogy in a real life scenario; which is our actual challenge. The author discusses the intersection of technology and learning theory. Intersection is a critical point through which numerous opportunities have arisen. Unfortunately, we have not been able to fully leverage these opportunities. The book discusses how this could have been done. How to transform, how we think about learning and how as professional we face challenges in blending of technology and pedagogy. As newer technologies rapidly develop how do we incorporate them?

Again quoting from Einstein; “there are only two things which are infinite, the universe and human stupidity and I am sure about the former.” Another thing which Einstein pointed out is that, “the only source of knowledge is experience.” Constructivist theory too states this; only by experience does one learn. As is the case with children you cannot explain something to them by telling them; you have to put them through that experience for learning to be effective. Here we are not discussing the book, which deals with this in great detail; rather we rely on a person who was not directly involved with pedagogy and learning. The creation of appropriate experience and providing opportunities to experience is the critical element which needs to be developed through the right blending of pedagogy and technology. Einstein had another thing to say; “the only thing which interferes with my learning is my education.” This education is what we are trying to rectify. Concerning Paige constructivist theory Einstein said that; “it is so simple that only a genius could have thought of it.” When you go on, utilizing technology and pedagogy, to create a learning experience remember the importance of simplicity. Jean Paige, 1896 to 1980 theory of cognitive development states that; “children construct an understanding of the world around them and then experience discrepancies between what they already know and what they discover in their environment. Along with assimilation and accommodation constitute the three stages of cognitive learning and their criticality cannot be overstated. A little more about Jean Paige, as the Director of International Bureau of Education, he stated these cognitive principles in 1936. In Pakistan, today pickup any newspaper and you will run across numerous relevant examples of this. As 1973you know there are increased incidents of violence/explosions in our society. Jean Paige had this to say; “only education is capable of saving our societies from possible collapse, whether violent or gradual. Unfortunately in our society the change is veering towards becoming gradually more violent.

Seymour Papert, a leading mathematician, computer scientist, educator and one of the originators of artificial intelligence at MIT, in a column in Newsweek is the one who emphasized Einstein reference to simplicity. He goes on to mention that; the theory advanced by pioneering Swiss philosopher and psychologist, Jean Piaget that children do not think like grownups, is crucial. They think differently; off course it does not take a theory or a genius to find children's utterances, cutely surprising or exasperatingly illogical. It takes both to understand, as Piaget began to suspect after thousands of conversations with children. With children, there thinking has its own kind of order and logic. Children use their own knowledge, experience and mode of thinking. It is imperative that we keep them within the same framework and try to explain things based on the same thinking and logic patterns.

An interesting story about Seymour Papert: his early work focused upon how people speak. If someone had difficulties with his speech or is speech impaired, how we can help him through the use of pedagogy and technology. Ironically, while traveling to conference in Hanoi, he suffered an accident and his brain was damaged; impairing his speech. Yet, it was his techniques based upon blended technology and pedagogy that helped him to recover.



Topic 96

Constructivist Conversations

In this module we discuss how Paget interacted with children. The important point is that they should be dealt on their own level, with consideration and respect. He began by enquiring what makes the wind. This is not a standard text book question and one which children often ask. Now let us look at how children think. He put this question to a five year old girl. Her answer was the trees. Piaget did not rebuke her, rather he engaged her in further conversation to understand her reasoning – the why. Julia replied, I saw them waving their arms. Now this is an interesting concept are the tree waving due to the wind or their waving causing the wind? Any intelligent person can conceptually confuse the two and we cannot say that Julia's answer was wrong. The phenomenon entails an observation based on a particular perspective - what is the cause and the effect. Piaget enquired further, how does their waving their arms cause wind? Julia waved her hands in front of Paiget's face and said this is how, but the trees are bigger. Naturally, Piaget felt wind on his face. Here an important point needs to be mentioned; that children learn from their experience and interpret information based upon this. Here through a small action on her part she has sought parallel in large event. This is termed as learning, despite the fact that the answer may be incorrect. Piaget got the girl to interpret, through conducting a small (her hand) experiment, a large phenomenon – a brilliant achievement. We can achieve this through technology.

Based on this he moved on to the question that what makes the wind on the ocean. By eliminating the presence of tree, Piaget was trying to create cognitive disequilibrium in the girls mind. "Piaget's concept of constructivism relates to his studies on how knowledge is internalized and how people learn. Humans according to Piaget internalize knowledge through experience and make sense of these experiments through adaptation of involving processes of assimilation, accommodation, equilibrium and disequilibrium. It is through these three processes that we learn, outgrow some ideas and adopt new ones. Now let us observe how the little girl attempts to outgrow her faulty thinking. The absence of trees causes her to contradict her earlier thinking. This dissonance and conflict in her mind is crucial to learning. An instructor for example seeks to stimulate conceptual change by challenging a student's existing concepts, in order to create cognitive disequilibrium. The student will try to restore equilibrium and resolve a problem through a process of disequilibrium and re- equilibrium, the student construct new cognitive structures.

Topic 97

The Wind Dialogue

Taking this conversation further let us looks at how children use their innate curiosity and look in the process of understanding. On Piaget's enquiry about; how wind was created in the ocean. The little girl replied that it blows there from the land. But thinking further and considering that there is great distance between the land and the middle of the ocean, she tried to correct herself. The disparity in her answer created an inherent tension within her and created cognitive disequilibrium. Trying to correct her answer she replied the waves. Now we have to understand the importance of this discussion, even though the conclusions which are being derived seem to be wrong. Jean Piaget had this to say about the conversation: "He recognized that Julia's answers, while not correct by any adult criterion, are not incorrect either. They are entirely sensible and coherent within the framework of child's framework of knowing." This issue is inherent in multiple choice tests where there is only a yes or no option and does not shed light on the thought process behind the answer. "Classifying them as true or false misses the point and shows a lack of respect for the child." An important point to note; in our classrooms, we not only show disrespect but manage to bruise their very tender egos. "What Piaget was after was a theory that could find in the 'wind dialogue,' coherence, ingenuity and the practice of a kind of explanatory principle, in this case referring to body actions, in other cases much harder to state; that stands young children in very good stead when they do not yet have enough knowledge or skills to handle the kind of explanations grownups predict." On a side note; it is interesting that in the last fifty years most of the people we will be studying in terms of learning technologies and theories which we need to include in our pedagogy were not educators. Most were scientist who brought their specialized knowledge to the field.

For instance Marvin Minsky, a computer scientist, who used artificial intelligence to understand and explain learning. “Piaget too was not an educator, and never enunciated rules about how to intervene in such situations; but his work strongly suggests that the automatic reaction of putting the child right away will be abusive. Practicing the art of making theories may be more valuable for children than achieving merit logical, orthodoxy. Also, if their theories are always greeted by something like, nice try and the real explanation provided, this is how it really is; it would be very beneficial in terms of creating a learning experience. Children have a real understanding only of that which they invent themselves, which they discover themselves – make them discover knowledge. This is crucial and we need to teach children in a similar fashion. They are not empty vessels in which knowledge can be poured. Our job is to create appropriate learning experiences which allow them to discover, and importantly fun doing this.

Topic 98

The Big Brother

We are turning aside for a while to Urdu literature and great masters who had no inkling of cognitive theory of learning, yet managed to contribute significantly to our learning. One outstanding name is that of Munshi Prem Chan, a great humanist writer, famous for short stories and novels, but in reality a school master. 'Baray Bahi Sahib (Big Brother),' a very interesting story about teaching, and one which needs to be read by all of you. "My elder brother was five years older, but he was only three classes ahead of me. We had both started studying at the same age, yet in this my brother felt haste was not appropriate. He wanted to build a strong foundation to this building." Interestingly in terms of constructive theory we use the analogy for a building – the requirement of a strong foundation for a building. The same terminology utilized in this story and more pertinently the approach of construction of knowledge; a gradual step by step approach rather than some mysterious transference of knowledge. An example of a teacher not formally introduced to a particular learning theory, yet having an innate understanding of the correct methodology of teaching. "My age at that time was nine; my brother wanted to lay his foundation with great care and of monumental strength and took two years to complete a year's work. I was younger and he the elder; my age was nine and his 14. My correction and supervision were his birthright." These terms, usually associated positively, in context of education: yet these terms usually imply that I am supervising you to see that if you are working correctly; leading to a constricted environment and a teacher' attempt at molding a student in a specified cast. These terms should have negative connotation instead of positive.

"My obedience lied in considering every utterance by my brother as a command." The sarcastic manner in which this is presented implies that the author disagreed with this relationship. Piaget too understood this and insisted that there should be no orthodoxy in a classroom. The teacher on his high perch should not dictate right and wrong and take decisions: let the children decide, let them discover. "He was truly hard working and remained preoccupied with a book in hand." What did he mean by hard work here and how does it relate to understanding? "On these books and copies, perhaps to rest his tired mind, he would draw the pictures of bird, dogs and cats." What does this say about his absorption of knowledge? We see the same thing in classrooms, but the fault does not lie with the student rather with the teacher. "Sometimes he would jot down the same name ten times; a stanza copied ten to twenty times in beautiful handwriting; notes which held no meaning. I tried, numerous times, to find meaning in these meaningless notes, what he was trying to construct, but was unsuccessful. Often I turned to enquire why he was sitting down for hours and yet capturing nothing. He was in the ninth standard and I in the fifth. Understanding his work was a big task for which I proved too small. I did not find education fun." This at least remains constant; children still find education deadly boring. "Even an hour spent with my books was like an eternity." Constructivism and other learning all focus upon student attention spans; most findings discover an approximate maximum limit of ten minutes. "Finding any opportunity would escape from the hostel to the playground. Here I would throw pebbles, play with paper butterflies. If lucky enough to find a companion, would jumping walls and swinging on gates. But being back in the room and seeing my brother's face, my spirit would shrink, and all the fun forgotten. His first question would be where I was." Here the author is comparing study versus play. We want to invert this equation; study should be as, if not more, fun than play.

Topic 99

A Typical Classroom

Earlier, we were discussing student attention spans and the classroom environment. In the slide before you there is woman in a beautiful sari, and girls in spotless uniform are listening to her in rapt attention. Do you think there is meaningful education occurring here? Is there meaningful interchange happening? Here are more scenes of a typical classroom. Let us first look at concentration; all the students are engaged in staring at the blackboard. They are silent, they do not talk among themselves, and they do not interrupt - they have been trained so. Do you think that from Piaget's perspective is there any learning occurring here? Is any cognitive disequilibrium established? Is there any assimilation occurring? Is there any discovery? The entire existing classroom, where are desk aligned to face one blackboard; an arrangement which cannot be altered; you cannot stand, move or walk around; listening to the teachers in absolute silence is critical. Do you feel this environment is conducive to learning? In this picture my grandchild, who we have discussed earlier, does not want to go to school, to which I readily consent. I enquired of him what the reason was. His answer, and which my son verified, was very strange. My son and grandson went to supermarket in the neighborhood, on seeing a teacher from his school; my grandson became quite anxious and asked his father to let him go back to the car. Earlier, when he did not go school, the headmistress called the parents in and asked for an explanation for why he was not attending. The teacher was called into the meeting and she provided all the details on when the child was absent. She narrated that he was only present, at the maximum, for four months in a day: she also stated that these days the parents did not really care for their children and the children did not care for their studies. My son had no explanation but only responded with the supermarket incident. The principal was shocked; she enquired of the teacher of the child's fear? There can be no education based on fear; education can only thrive in atmosphere of love and respect – can only be taught through a conversation/dialogue.

Here I would like to reiterate the main things which you need to consider both in terms of education and when designing learning application technology with the appropriate pedagogy.

"When you teach a child something you take away forever his chance of discovering it for himself." This implies that you never teach anything to a child also that the requirement of a teacher is minimal. I realize that what I am saying is rather controversial and would probably come under a lot of derision. But the important take away here is that teaching should be the least important objective. We have also discussed earlier why it is impossible to teach in a large class usually comprising of thirty to forty students; individual attention and learning cannot be provided to each student. Again according to Piaget; “the principal goal of education is to create individuals, who are capable of doing new things and not simply repeating what earlier generations have done.” This Piaget say is only possible if you do not provide them with existing knowledge rather you allow them to discover this, on their own.

Now let us take a look at some snap shots of my classroom: this is about a very intelligent student. My effort would be to not provide an answers; rather problems supported through encouragement and tools to enable them to solve them. Now let us look at the student; he is visual students and uses his hands a lot while thinking. He tries to formulate a theory to solve a particular problem and is faced with cognitive disequilibrium, which you can see by his perplexity; at times he smiles at others he looks quite anxious. Through this process he tries to modify his theory and assimilate new knowledge. When he manages to accomplish this successfully his excitement and happiness can be easily gauged.

What he learns through this process of discovery he will never forget. These sequential pictures were taken through my cell phone and without the student’s knowledge. This type of student likes to learn in isolation in comparison to group based learning. Now to example of group dynamics, who were given a problem to solve? Look closely at the faces of the students and the tensions on their faces – a necessary thing. Some are talking, some listening, some thinking and some trying to convey their point. A necessary collaborative experience; which will have great utility in the future when in their careers they try to solve problems in collaboration with other colleagues. No memorization, copying or cheating will help. A collaborative experience which can also be replicated during examinations: after all the purpose is to solve a particular problem.

Here we see various collaborative groups comprising of different number of students;

meanwhile a single students sits alone and is observing these groups closely. Look at their reactions on reaching a milestone in terms of arriving at the correct methodology for solving a particular problem. Observe that even girls have been drawn in to argument and joined in; quite contrary to our societal norm. Note that the individual sitting alone also gradually gets drawn into the discussion. The importance of the excitement generated can be gauged from this fact. In these groups there is continuous assimilation, disequilibrium and re-equilibrium. Moving to next scene, we see a problematic area. The students have arrived at a theory, but the solitary student who has joined the group has undertaken the task of shooting down this theory.

The happiness reflects the fact that he is really enjoying this task. The next image captures the counterattack when a person in the group argues back. This is what is integral to learning and something which is hard to replicate for a teacher in the classroom environment. The next image is important where finally though his exasperation he hold his head in his hands, which reflects his theory being demolished. These emotions are necessary. In another picture, in a university classroom watch the fun environment, curiosity, the excitement can these be provided to every student?

Topic 100

Asking Question

We commence this section with a romantic couplet from Parveen Shakir:

> Sub say nazar bacha kay wo, mujh ko tha aisay dekhta
>
> Aik dafa tou rook gai gardish-e-mohosal bhi.
>
> Hidden from other's look, his glance for me such
>
> For an instance the sun and moon's motion stilled

If we look at this from a pedagogical perspective and enquire as to what images does this couplet bring to mind? We were talking of constructivism theory of education. Another pertinent book related to this and dealing with learning is; 'Make Just One Change' – the one change that will still the sun and moon's orbit.

"Teach children to ask their own questions." Mike Rose, author of 'Wise School,' had this to say about 'Make Just One Change.' "This book begins with a seemingly simple request; to get students to ask their own questions." Here the reference is to questions which arise in young minds and not interpretation by adults as to what these questions should be. Most course books contain questions at the end of each chapter, which are derived by adults and focused towards examinations – these are not required. "But at heart it is a book about creating a classroom alive with dialogue, enquiry and respect for student minds.

We will now look at some quotations from 'Make Just One Change,' in significant detail, "I learned that when you ask your own question, you can actually learn more." According to me this statement should actually go further and state; to learn anything and not learn more. "I learned that asking questions is such a simple thing but at the same time can open up so many opportunities to learn. When you ask your own questions you are basically challenging yourself.” Infact you are challenging everyone. We tend to underestimate the efficacy of questions; it is the facility of enquiry which sets us apart from animals:

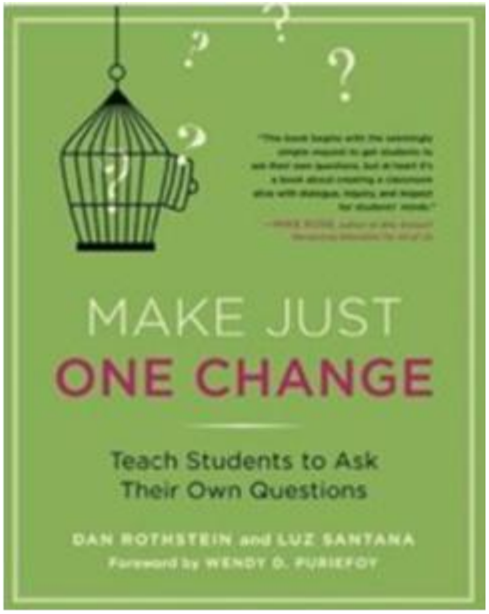
Khol ankh zammen dekh, fiza dekh,
falak dekh Mashriq se ubhar tay hova suraj ko dekh
Open your eyes, observe the earth, the wind, the sky
From the east the rising sun observe

The point here is to observe – question the phenomena and not merely see. This faculty of enquiry is what set us on the path to evolve to our present state. “The more you ask questions, own questions, the more thoughts come to your head and it helps expand you knowledge.” These appear to be very passive questions; perhaps more radical ones are required. The question formulation technique which is discussed in detail in this book, and here we are not talking about answers but questions. Do not let them remain silent, make them question. “The question formulation technique gives you an outlet for further expanding

You’re learning through asking more questions. We end this module with another couplet from Parveen Shakir:

Barti mudat kay baad mujhse ous nay gila kiya mujh
Masnat-e-dilbari pay kiya mujh ko bahal kar diya
After a long time, he a grievance presented
On the throne of love perhaps placed again

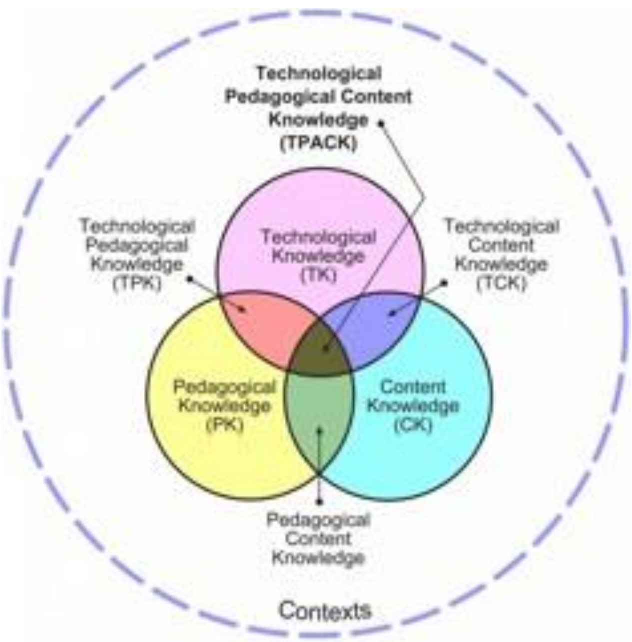
In the couplet there is an implicit question, secret longing. An appropriate reflection on what we are trying to convey here.


MAKE JUST
ONE CHANGE
Teach Students to Ask
Their Own Questions
DAN ROTHSTEIN and LUZ SANTANA
Foreword by WENDY D. PURIEFOY

Topic 101

Intersection of Pedagogy, Content & Technology

In this module we look at how technology, content and pedagogy intersect: The triangulation of three contains a numerous hidden issues and what combination of expertise and multidisciplinary approach are required.

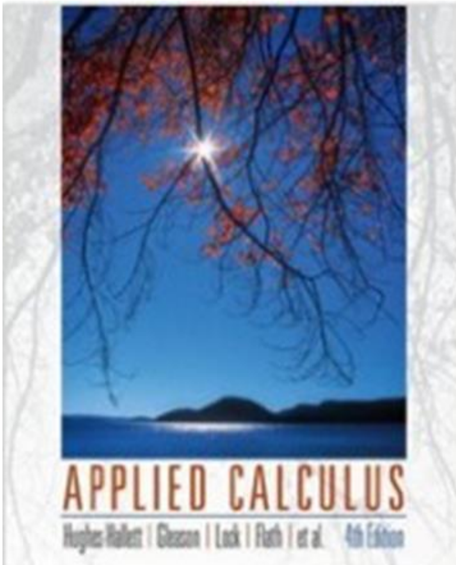


The appropriate person needs not be an expert in all three fields but should have working knowledge of each. The diagram presented here of constructivist technologies contains three circles; of technology, pedagogy, and content. At the intersection of three is where we want to create interactive learning applications. Currently, the most useful innovations, which most people would assume to in the field of a singular discipline, i.e. computer science; are in fact being done at the intersection of multiple disciplines. Graduate students should need to remember a fact. For instance a computer science would not solely be asked to create program in C++, this program would be created to deal with a real life problem, requiring specific knowledge. I have enquired of many PhD's in education a simple mathematic problem concerning a circle, which is usually dealt with in the 6th or 7th standard. Their immediate reaction is to keep mathematics out since their field is pedagogy – it does not work this way. Similarly, if the technology people start saying that they will not deal with pedagogy, in Physics Newton's laws, and just do programming in C++ - nothing will come out of it. Those universities imparting multidisciplinary knowledge and those individuals with these tools will be able to face the future successfully. Turning to content: suppose we have to design a content for a 9th or 10th standard book, an interactive book or for that matter a learning application or a learning game; the users while immersed in the experience should have their minute to minute progress recorded, their learning styles recorded. Naturally, there has to be content. It could be pure sciences or social sciences. From the social sciences geography is particularly suitable. One could transport the students to specific destinations, utilizing three dimensional animations, Salt mines in Khavera or Niagara Falls in Canada. The next element is pedagogy and here we address this in reference to constructivist theory, which is currently the prevalent methodology. In this we have to understand how people learn, epistemology, and how people do not learn and why do they not learn; the second part of the equation being of greater importance. Some people may have the prerequisite knowledge and intelligence yet have difficulty learning. Is their learning style different? The important point is that it is not their failure but rather ours. It is the fault of the pedagogical, technological content or the teacher.

Topic 102

Harvard Calculus

Earlier we were talking of the triangle of pedagogy, content and technology and how this relates to constructivist theory. Children learn by constructing knowledge bit by bit and layers by layer. In the last fifty years, the progress in learning technology and learning theories was mostly the work of individual not directly connected with education, as discussed earlier. Apart from the individual some movements also gained currency. Where like-minded individuals came together and pushed for a particular viewpoint, i.e. the Harvard Calculus. The movement focused on capturing learning styles. They took the example of mathematic textbooks: the presentation and symbols contained were daunting for the average student. Especially those students who did not want to go on take mathematics for further studies. Mathematics is required for all disciplines and not specifically for mathematicians. In mathematics there are certain calculations like integration and differentiation, where you are trying to find the value of one function (x), with respect to another (y). No child can relate to this in terms of prior experience, as propounded by constructivist view of learning. The alternative was to present the calculations through stories and linked intuitively to other disciplines and the arts. A revision of all high school, college and university books was undertaken, surrounded by much controversy. Purist claimed that the removal of theorems and proof was not the way to teach but statements that this implies that and hence this, intuitively appeal to very few people.



Turning towards learning technology we have to understand this comprises slightly more than Word and PowerPoint. The technology person developing these applications would also require working knowledge of pedagogy and content. Animation technology and artificial reality are also critical. These days you can utilize software which is very user-friendly. Graphic design, especially three dimensional spaces is critical. For instance Archimedes by placing a circle in a cylinder, containing water, and measuring the water displacement was able to measure the volume of a cone.

To be able to describe this, sphere and similar shapes need to be developed. Two dimensional representations are no longer applicable. Technology is growing at a phenomenal rate and we need to catch-up with it and utilize it along with an appropriate pedagogy and content in learning.

Topic 103

Intersection of Technology

An issue which exists in most schools globally is the comparison between teachers? What defines a good teacher in comparison to a bad teacher? Is it the students' behavior or their feedback? Another consideration we need to keep in mind is whether the teachers should be trained/improved or learning? In the last fifty years or so most schools have been focusing on creating world class facilities (buildings) and classrooms.

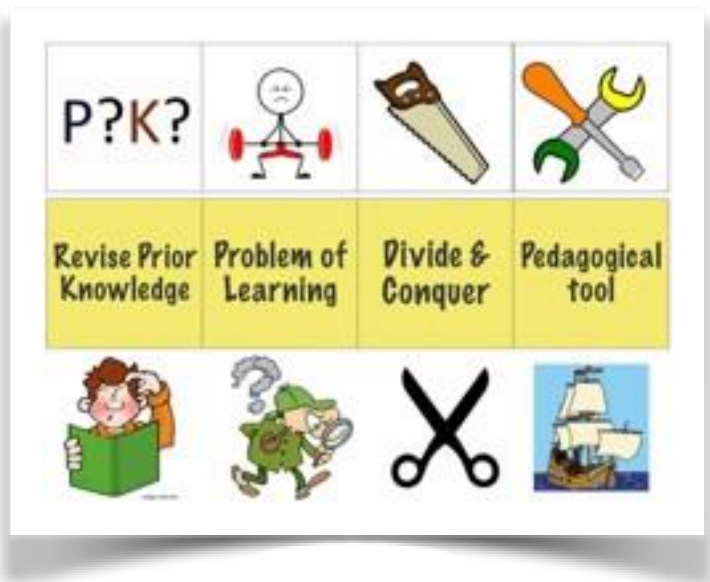
Has this improved classroom learning? Highly qualified, well paid and continually trained teachers inducted. Has this impacted learning in a positive way? Why do we not, instead go to the students directly and measure their learning in the classroom? Exams are not a good indicator. Based upon proper preparation, at home or an academy, or perhaps by a fluke a positive result is acquired – this is no indicator of continual learning. There must be at this moment millions of students, say in the 9th standard, studying a particular subject, a particular topic. What we need to gauge is what impact is taking place on student learning in each of these classes. With technology it is possible to measure this change in learning. The technology required is not very sophisticated or expensive. Yet there are no attempts at doing this. It is much like going to a doctor; who measures your vitals. If the values are not alarming then there is no emergency. Why cannot this be done for education? In fact we need to do this on a daily basis; after every period, after every five minutes.

This leads to recording of learning styles. I should be aware at a particular moment, what every child studying in Pakistan and how he is being taught this. Based upon his learning style; is the education being presented graphically, linguistically, analytically or in an appropriate manner. Based upon successful results I would need to verify this through employing similar methodology for further learning. The textbooks of the future will capture this through multiple modes of presentation; an impossibility in the existing printed format. An electronic book can accomplish this in a click of a button. Moreover we would be able to build in feedback, through technology. This minute to minute data, from a learning perspective, would be invaluable. Also, consider the number of information technology related jobs we would be creating; to handle, sort and appropriately assign this enormous database. This feedback allows us the flexibility of self-correcting and adaptability in context of further learning. We can also allow for different learning rates and progress. Depending upon a particular student's learning speed we can allow for faster progress in comparison to one who is slower. This does not apply solely to intellectual ability but suppose a student also works part-time, and consequently comparative learning is slower. All these possibilities are a reality due to technology and ones which a typical brick and mortar school cannot handle.

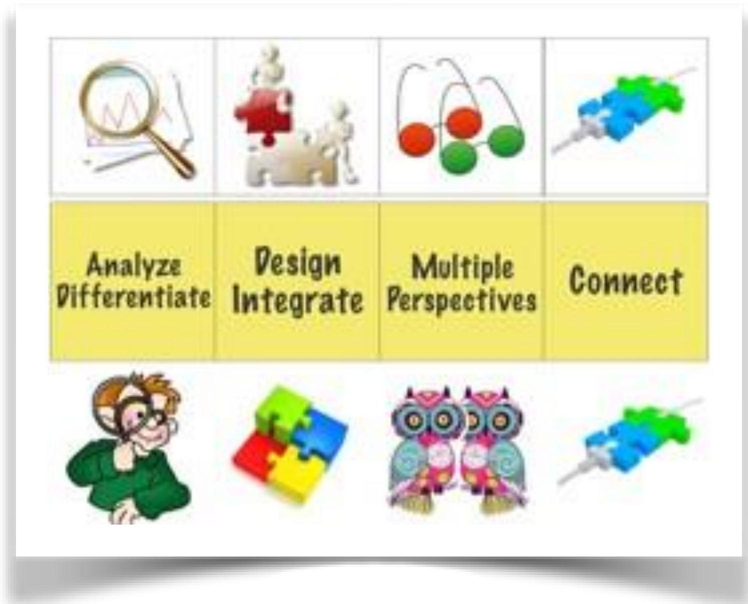
Topic 104

Revisiting Constructivist Theory

Reverting back to constructivist theory and as you may have noticed I have tried to insulate you as much as possible from its technical aspects but some aspects need to be explored further. “In the most general sense Active Learning means, encouraging students to participate and act; such as conducting a real experiment.” Not a typical experiment conducted by a teacher where the outcome is predictable. But a real voyage of discovery, fun and excitement – naturally with all constraints in place from a safety angle. “Rather than passive learning listening to a lecture or reading a book, active learning is typically student centered and the role of the student is to engage in an activity such as constructing and testing a theory, hypothesis or strategy.



Students then reflect on and discuss what they are doing and how their understanding is changing. The teacher must understand the students preexisting conceptions and misconceptions help guide the activity.” Even ‘guide’ I feel might be strong; I believe in minimal intervention by the teacher and strongly encourage leaving children to learn on their own. My description of a good teacher would be: a teacher making him/ herself redundant.



Creating independent learners is the epitome of teaching. “Guiding the activity to address and build on refine preexisting conceptions.”

“Constructivism seeks to tap into and trigger the student’s innate curiosity:” curiosity; which we seek to strangle at every opportunity. Think how a child comes into the world, full of curiosity and how gradually this erodes. Lugging his overstuffed bag to school and faced with anxiety about his performance, the child no longer seeks to seek. No amount of rationalizing, reward and punishment can rekindle this ability; echoes of the earlier behavioral theories which were in much vogue then. “Innate curiosity about the world and how things work.” Children ask inordinate amount of questions, which are usually addressed by grownups to an extent. After which they are asked to remain silent. “Students are not expected to reinvent the wheel, but attempt to understand how it turns and functions. They are engaged by applying their existing knowledge and real world experience to the problem. Learning to hypothesize, test their theories and ultimately draw conclusions from their findings.”

Now all the earlier discussed issues, however patient and understanding a teacher, cannot be achieved in a classroom; catering to varied learning styles, respect for their curiosity and learning speeds. However well-meaning and well paid a teacher this is a herculean task.

We now look at a small summary of ramifications due to constructivist approach to learning/ pedagogy and some pictures:

The P &K with question marks illustrate revision of prior knowledge. A teacher's task is to clarify that sufficient prior knowledge exists and has been revised to form the basis of future learning construction, through the use of appropriate technology. Technology would allow the students to be identified and segregated at this crucial stage. Those that do not have the requisite knowledge will be kept until they acquire the required knowledge. The teacher and those designing content, pedagogy and technology should be well versed in problems of learning. These obstacles would be scanned for continually and learning further refined: more tools given to overcome particular problems. A way of handling this is the age old adage of 'divide and conquer'; breaking down problem in small constituent units, the appropriate division is critical, which can then be analyzed – this is basic function of a pedagogist.

Topic 105

Constructivism Summarized

Analyze and Differentiate: For an average student learning is a challenge. As an example if I ask you to write an essay describing the difference between a cat and a dog, you would be hard pressed. Similarly, if you were to create a computer program to do this, it would be terribly problematic. Yet a one to two years old child can easily distinguish between the two; no matter how small a dog is or how long its fur. Categories are established. Consider a sphere, cylinder and a cone; what is the relationship between them. One surface of the cone is also in the form of a circle. We presented this problem to second graders who were able to identify this relationship. According to them if you looked from the top it was circle, from the bottom also a circle and from the sides a triangle – note their ability to analyze and differentiate. For a sphere they said it was circle from which ever direction you looked, which incidentally also its definition. Looking at a cylinder form the side, they were able to identify it as a rectangle. From the top and bottom a circle. One child asked why all the heavenly bodies were not cone shaped instead of spheres? One has to be ready for these kinds of perplexing questions arising out of innate curiosity.

Design and Integrate: Apart from pointing out the difference we also have to highlight the similarities. We have to point out that if this and that combine what is the result, i.e. how does a cone combine with a sphere to form a cylinder?

Multiple Perspectives: The entire information has to be presented from multiple perspectives, i.e. if I was showing a cone and only looked at the bottom; it would appear to be a circle, similarly, from the side a triangle. The old Sufi story of an elephant was in the dark, where each individual in a dark room tries to determine what the object is quite reflective of this. Connecting information is critical. I happened to be listening to a song which began with I am alive, which in itself is quite an arbitrary statement and has no relevance. But then the artist used a connecting proposition of “but” and ended with, what is life. What is life is also quite meaningless, yet the combination of two - I am alive but what is life has many shades of meaning; demonstrating the importance of being able to connect.

Topic 106

Breaking the Shackles

We begin with a little recap: we had discussed constructivist theories, in which prior knowledge was critical since it is the foundation on which future building of learning occurs. These are the problems of learning, which need to be addressed by teachers. Divide and conquer, breaking down problems into smaller component which are easier to explain. Analysis and integration of this information should be done and then making the appropriate connections should be made. We should look at a problem from multiple perspectives. What pedagogical tools are required?

In real life situations it is rare that problem appear exactly as did in textbook. We have to look at these problem in terms of similarities and differences, which then will be handled through a combination of learned technique and modifications made for the differences. Information technology can greatly facilitate this.

The knowledge associated with constructivist theory and based upon learning mostly developed in the last twenty or thirty years. How our brain works and learns; why it fails to learn and how we can address in a pedagogical and information technological context is important.

The implications are obvious we will need to create excitement in the class. Teachers will have to be empowered, reeducated and trained. An important point to remember is that classroom learning based upon constructivist theory, but without utilization of technology will result in complete dependence upon the teacher. Teacher dependent learning styles will probably beyond the ability of a teacher to sustain since too demands. As it is we have a shortage of teachers. Reeducation and training of the remaining teachers is also problematic. Another issue associated with constructivist theory is that traditional classroom discipline no longer applies.

Students are allowed to collaboratively build upon their prior experience; in constructing new learning. The teacher's role becomes minimal; guiding students in construction of this new knowledge based upon individual learning styles, of which they should be familiar. The alternate scenario we are describing, if not deployed correctly, will result in chaotic situation bearing more resemblance to a fish market. What then become critical or should we say catch all is the employment of technology. Constructivist learning in the classroom with technology makes this task economical, convenient and above all possible.

Topic 107

Outside the Classroom

Using technology and constructivist theory based pedagogy we acquire additional advantages, which even the larger and famous schools here do not possess. Apart from what is transpiring in the classroom, what is happening outside too can be monitored and constructed collaboratively within the constructivist paradigm. Class assignment and projects will be handled outside the classroom, collaboratively, with help acquired from all possible sources including the internet. The emphasis upon collaboration is critical since this is what actually happens in real life and in a professional environment. With technology we would be in a position to monitor and record what is happening within the class and outside the classroom along with categorization of different learning styles; learning problems which occur; and a feedback loop which will make the deployed interactive or adaptive lesson to be refined further. Now taking this one step further; imagine constructivist learning with technology outside the classroom, without a classroom or a formal instructor. This is heartening for someone like me. In our country where millions are unable to attend school, even if you forgo fees and provide them with books, since they are earning a livelihood. Their education is very dear to me. Moving away from the conventional brick and mortar school will open up numerous avenues, much beyond our imaginations. We will acquire out of the box solutions for education, especially for that segment of the society which cannot currently attend school: a powerful paradigm which can cause immense disruption in the existing schooling system. This disruption is applicable for the developed world where everyone has access to education. For the developing world this will bring in revolutionary changes. There is a technological revolution set to happen; do you want to a part of this?

Turning to slides shown here; the black and white picture shows children playing in the dirt, their houses are broken. A candy vendor comes and is chased by these children, with very few having the money to actually purchase any candy. Rectifying their economic situation is a tougher challenge, and beyond our purview. Yet by focusing on their education we try to provide them with a tool which allows them to move away from poverty. With the induction of technology; all we require is one android phone for each household, approximately Rs.6,000 - not an improbable financial demand. This cost is similar to buying the entire course for the fifth standard, which is over Rs.5, 000.

Notebooks and stationary is naturally extra. A Smartphone/android, for each household, will be a viable reality in the next two years. In fact, the government is currently working towards this. Even without an internet connection, we would be able to load their assignments onto the smart device. This would be available for all the students in the house. The experience would be entirely immersive and fun- much, akin to playing a game. While they are studying their progress is also measured and recorded. The next time the candy vendor comes, apart from his usual fare, he would be carrying a Wi-Fi Hotspot provided to him. The children would still flock to him for candy but perhaps more importantly to upload their existing lesson/game and acquire the next lesson/game through the Hotspot. Through the appropriate use of technology this is the future one envisions; in which the currently disfranchised children will be able to access quality education, if not better at least on par with what the privileged are receiving. Hopefully the brick and mortar myth, which had been earlier propagated, will finally be shattered. Earlier the conventional thinking by many well-meaning individuals was to endow a school; the first step of which to create a building – this would be no longer applicable. Similarly, if you want to endow a college or a university, please do not conceptualize a building instead begin with learning itself.

Topic 108

Brick & Mortar Model

We now look at some examples of technology required for the effective utilization of the constructivist framework. A major issue globally but specifically in Pakistan is the segregation between pedagogy, technology and content designing. Bringing these three functions together is our biggest challenge. In terms of High School education what are the prevalent problem created by conventional education, expensive education, though the typical brick and mortar school. The creation of this school, building, is an expensive proposition to say the least. Acquiring of prime land, constructing a grand building, employment of qualified teachers, requires enormous investment/capital expenditure.

We conducted a survey of, what are considered, the top educational institution in Lahore, including schools, colleges and universities; in parallel to very poor schools in the outskirts of the city. For schools the study was focused on 6th and 7th standard students and based upon a singular question. The question was not focused on memorization of content but was rather more basic in nature and based upon observable natural phenomena: why, in Lahore, is it cold in the winters and hot in the summers. We allowed them to consult with each other and even use the internet if they wanted.

We asked them to consider their personal experience; was it contingent upon the place or room you were in? For instance the kitchen is impossible to enter in the summers while welcoming in the winters. Their observations were correct and in line with constructivist framework of learning. Next we showed them some pictures: Muree, a hill station, covered in snow; the same place in summers; and another picture of a girl unrelated to weather. This is necessary from a constructivist viewpoint to provide the right cues to the mind. We moved to further pictures returning back to our theme of weather: penguins in the arctic region where it cold all the time; a Van Gough summer scene of pleasant European summers. The point here is to remember the necessity of integration and differentiation, in terms of constructivist theory.

I recently purchased a book about Leonardo da Vinci, an artist, mathematician and scientist. The book's focus in on how he thought. The interesting thing was his attempt at synthesis of art and science: a possibility which we have veered away from by compartmentalizing the two. If you remember earlier we had discussed Parveen Sahkir's couplet:

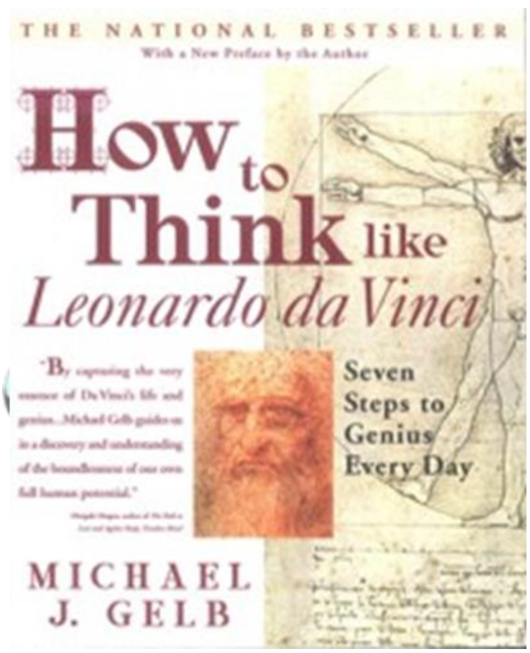
Sub say nazar bacha kay wo, mujh ko tha aisay dekhta

Aik dafa tou rook gai gardish-e-mohosal bhi.

Hidden from other's look, his glance for me such

For an instance the sun and moon's motion stilled.

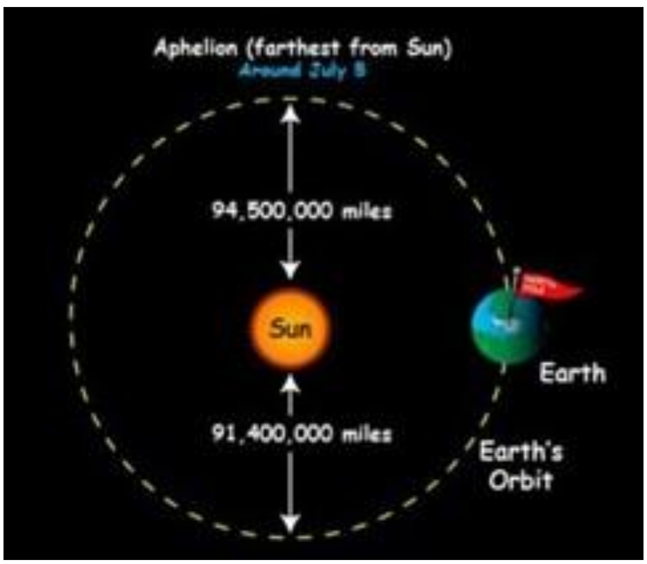
The interruption of the orbit of the sun and moon is pertinent in context of our discussion of seasons.



Topic 109

Summer and Winter

Turning back to our earlier survey, we must remember that an answer to a question is not as important as the process of arriving at the answer. In the next picture shown, we a see a globe. We are slowly moving towards the question of seasons. During the survey we use to take the globe along with us and enquire of the students as to why it was tilted, as is every globe. Does this have any relation to seasons? Children, like my granddaughter here, have this tendency to spin the globe every time they pass it. What is the Earth's spin related to; the seasons or day and night? Let us turn to this picture of a leafless tree, a victim of winter.



Khizan kay zard patto ki machalti sarsarhat may

Tumhary pyassay hoto ki molaim muskhrat may

Chahat kay mithay lamho ki musalsal yaad ati hai

Vohi manoos si khushboo hamara dil jalati hai

In the whisper of yellow leave in fall

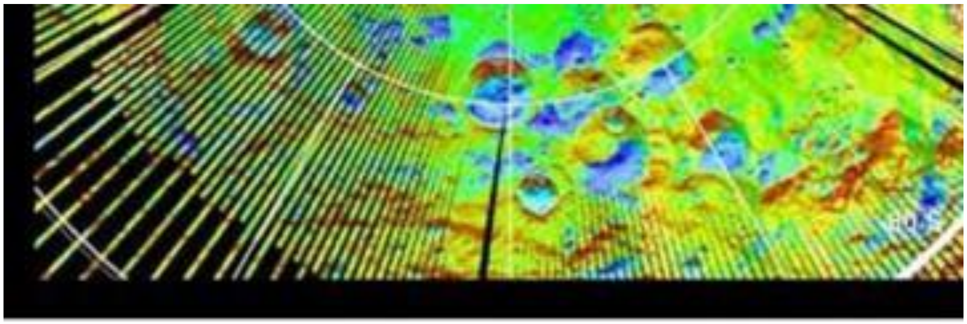
Of the soft smile on your parched lips

Of spent moments of love, the memory continual

That familiar scent a cause for a smoldering heart

Similarly, you see pictures of the spring season and then the summer season. Initially, to encourage divergent thinking we allowed students to come up with any and all reasons. One reason put across was the size of the sun. But this does not change in the summer and winters. Yet, with this answer we were able to eliminate one possibility. The size of the Earth, could be another determinant; along with distance from the sun. Next we consider the orbit of the sun. Here perhaps lies the intuitive answer. Is this a circular orbit? This point arose during a brain storming session; where children are encouraged to think out aloud. If the orbit was circular what effect would this have? One student replied that the distance from the sun would be constant; whether it is summer or winter. If the orbit is such that the distance varies, that might be the cause of a change in the seasons. Intuitively approaching an answer based upon your prior experiences is critical and what a constructivist approach advocates.

In this slide we see a man coming in from the cold to a heated room; his happiness apparent. But if he was put too close to the heat source his happiness would fast turn into distress. These examples were provided by students and were reflective of the process transpiring in their minds that the distance from the heat source perhaps was the determining factor in change of seasonality. Based upon this reasoning I am sure you can appreciate the how strong this process is; in terms of being able to encapsulate and explain a phenomena whose complexity and scale are enormous. If you remember this survey was conducted for both types of schools - those catering to the very rich and those to the very poor – and also extended to famous colleges and universities. The percentage of correct answers in comparison to wrong answers, in totality, was equal. For an intuitive answer based upon prior learning and in accordance with constructivist theory the answer is correct and should be recognized as such. The unanimous consensus that seasons were due to the distance of the sun from the Earth now needed to be tested for validity.



LRO Diviner Lunar Radiometer Experiment surface temperature map of the south polar region of the Moon. The data were ac
when south polar temperatures were close to their annual maximum values. The map shows the locations of several intensel
traps for water ice as well as a range of other icy compounds commonly observed in comets.

Credit: NASA/Jet Propulsion Laboratory

Topic 110

Presenting the Problem

Basically there are two methods, which can be used in conjunction with a constructivist approach. Whatever the answers these should not be dismissed and the students should be encouraged to think further. One way is to test the repercussion of this theory, assuming it to be true; i.e. that in the summers the sun is closer to the Earth while in the winters further away. Are the results in line with our thinking? The entire scientific process begins with an observation, leading a question for which you develop a hypothesis, which if correct after testing leads to a theory. Children should be allowed to go through this scientific process on their own; instead of providing them with a question and the right answer.

Currently, as the dean at a university, we have a specific course designed for this process of thinking and which is open to all disciplines. Turning towards the second method, we leave the first method at this juncture, which we will revisit. The second method is the direct method, i.e. can we directly observe the results. Now we cannot go and directly measure the distance between the Earth and the sun; yet with the available technology, access to an internet enabled device allow, access to an internet enabled device allows you to find this information rather quickly. It is an enjoyable process which should be done by students on their own. Anyway, going to required webpage, it was written that the 24Tuesday, March 8, 201619724Tuesday, March 8, 2016 Earth is the hottest when furthest away from the sun in its orbit. This statement was written in red and bold. I believe the author was as shocked as the students. Infact, the sun is the closest to the Earth in January. The author’s conclusion was that the seasons are not caused by the distance of Earth and the sun. On January 2nd, 2016 the sun reaches it closest point to the Earth. Similarly, on approximately July 5th the sun is furthest from the Earth – 94,500,000 miles compared to 91,400,000 miles in the winter. An interesting stage in the pedagogical process; you develop a theory and own it. Ours was based on proximity to a heat source which was then projected to the question of seasons. The knowledge built on this suddenly collapses; the results completely contradictory to our predictions, cognitive disequilibrium in terms of constructive theory.

Moving further along with our question, let us look at the moon. As you know this orbits the Earth and is roughly equidistant from the Earth and the sun. When the Earth gets closer to sun in winters the moon follows and vice versa. Are there seasons on the moon? A whole array of exciting possibilities and questions open up. We are currently on the divergent trajectory. Possibly when we arrive at a convergence, all these questions might be answered. Looking up information on the moon we find that the temperatures in the day are extraordinarily hot, about hundred degrees centigrade. While at night minus 173 degrees centigrade; survival would be improbable.

This wide divergence is due to the fact that the Earth's moon has no atmosphere. We are arriving at some answers but are at the moment unable to connect the information or converge.

The absence of atmosphere implies no heat being retained at night and in the day its prevention. The moon rotates on its axis in about 27 days. Does this imply a lunar day which lasts 27 Earth days? This is all very mysterious and this type of mystery we want the children to get hooked on a whodunit.

Looking at this thermal imaging of the moon, we see areas which are very hot and also areas such as caters which are extremely cold. Why is this? Many people believe that the Earth is closer to the sun in the summer and likewise it is farther from the Earth in the winter. Although this idea makes sense and what is important for us pedagogically, is what makes sense. Anything which is correct but is nonsense, we don't want. "It is true that the Earth's orbit is not a perfect circle, it is a bit lopsided. Earth is closer to the sun than at other times however this does not cause winters or summers".

NASA website, we now look at some cartoons. Many people believe the Earth is closer to the sun in the summer and that is why it is hotter and likewise they think it is farthest from the sun in the winter a serious misconception. The cartoon then, talking about South America, states that for the winter holidays bring your swimsuits and not your skis. If we agree that the sun's distance from the Earth determines seasons; when there are summers in Lahore, would there be summers in Australia too? Based on this we realize the fallacy of our earlier argument, based upon direct evidence and inapplicability of its repercussion. Is this a sad commentary on the plight of our universities, colleges and schools that significant majority are not aware of why seasons change? This is not true there are enormously talented and intelligent students here. The processes of thinking and construction of knowledge are globally valid.

Topic 111

A Global Misconception

I have been working with similar problems over the last ten to fifteen years based on which I had started a program in NUST – MISTE (Master in Innovative Technologies in Education). This was similar to a program offered at Harvard (TIE – Technology Innovation in Education). In Pakistan there is no convergence between technology, pedagogy, content, innovation and entrepreneurship. Globally there are efforts to combine all these aspects of education. For the program I had introduced I had to repeatedly go back to the Harvard website to lookup courses, which could then be modified for Pakistan. While doing this there was a popup which caught my attention.

Before I turn to what the popup contained, a little about the earlier survey. While thanking the administration at very universities for allowing the survey, on hearing my question about the season, there was smile on their lips. What sort of question was I asking? But when I went back to them with the results, including their star PhDs, they were rather shocked. They specifically asked me to refrain from posting the results on my webpage and especially my Face Book page, which I tend to do often. We are getting back to the popup: Teaching teachers what kids are not learning. Think about this; what they are implying is that teachers will need to be taught what the kids do not know. This is Harvard we are talking about. Anyway, do you assume that if you graduated from Harvard you would know why the seasons change? A survey of the graduating class on their graduation day in 1986, most could not answer the question.

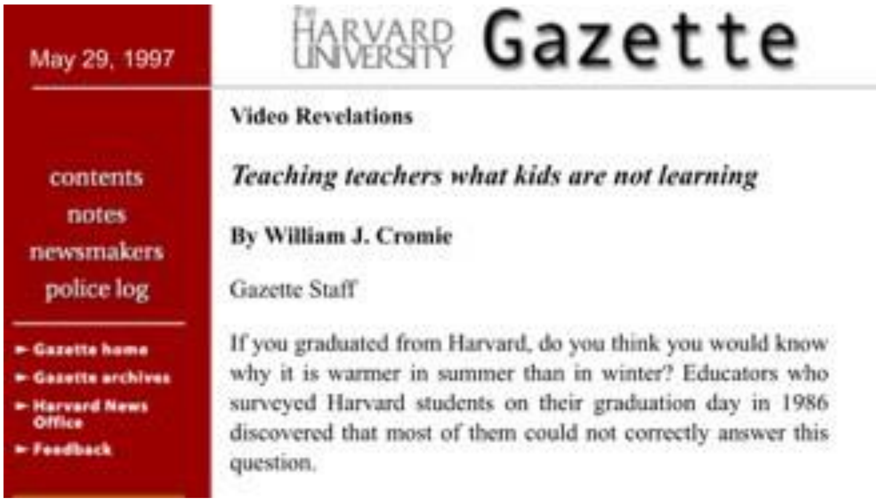
Topic 112

Surveying Pakistan

We begin with a brief roundup of pertinent points from the earlier modules. We have done a survey encompassing major universities, colleges and schools belonging to the entire range of the spectrum, i.e. for the very rich to the very poor. The question involved the difference between summers and winters. A majority of the students could not accomplish this successfully. The answer even if remembered through rote learning, could not be supported or explained logically. This does not only apply to Pakistan; the situation is prevalent internationally. In front of you is the prestigious Harvard University's gazette (May 29, 1997) and it contains similar results in a local survey of a graduates. Common questions such as why there is day and night, summer and winter the wind blows, why the sky is blue, were put to the students. These are not intricate scientific problems like quantum physics and should have been addressed. Based upon this particular issue a newsletter was published called, "Teaching Teachers- what kids are not learning." The implications which can derived from the topic are; teachers do not know what the children are failing to understand and why. When we are in a position to teach teachers, that they should understand that the students do not understand a particular topic, then we would be in a position to approach the why. The inherent disconnect between teachers and students in terms of learning needs to be understood. In context of our course, The role of Information Technology in Education, our primary task then becomes teaching teachers what the students are not learning and then with the aid of various pedagogical theories and related scientific learning theories, why the students are not learning. Here I would like to reiterate the gravity of the problem and its prevalence in teaching. We had discussed the specific pedagogical problems in learning in the earlier modules in conjunction with how a nexus between technology and pedagogy can lead to appropriate solutions. Perhaps this allows you to comprehend the importance and imperative nature of this course.

Having discovered this problem, institutions like Harvard designed numerous measures to create awareness of this issue, i.e. films containing examples of how think or not think and how they learn. The basic thrust of which was that a teacher's function was not solely confined to giving lectures but extended much beyond. Next they took quizzes from quality institutions like MIT and Harvard and looked at what common mistakes students made to understand why. Usually, we only use this as a measuring standard to judge levels of learning and more often than not to penalize students and not as analytical tool. Introduce technology and you are able to firstly create many more quizzes. While I was in LUMS, I use to focus on quizzes and gave numerous to my classes. Since we were provided with a teaching assistant, a major difference in comparison to other universities, my task was simplified. Yet, in all honesty, I never focused on why a particular student was repeatedly making the same mistake. With technology this can be achieved relatively easily.

As discussed earlier we had introduced a course entitled, 'problems of learning.' This course was project based and included a final project. A student from the course came to me and told me that in a particular discipline of mathematics; which was being taught by the same professor, using the same syllabus for the past five years – he along with others in class fared quite badly. Due to his curiosity, and perhaps friendship with the teaching assistant, he analyzed the quiz data through histograms. The usual histograms contain data distributed normally; but in that particular the results were abnormal. This should have raised a red flag in the institution, but did not since no one was looking for it. Anyway, when he approached me I told him to look at the results of earlier quizzes from the same class for the same topic. The results were the same for that particular topic. Technology allowed us to analyze this critical fault. That was earlier; with the current technology we are in a far better position to detect or diagnosis this malady, more importantly cause and ultimately the treatment which is our role.


May 29, 1997

THE HARVARD UNIVERSITY Gazette

contents
notes
newsmakers
police log

► Gazette home
► Gazette archives
► Harvard News Office
► Feedback

Video Revelations

Teaching teachers what kids are not learning

By William J. Cromie

Gazette Staff

If you graduated from Harvard, do you think you would know why it is warmer in summer than in winter? Educators who surveyed Harvard students on their graduation day in 1986 discovered that most of them could not correctly answer this question.

Topic 113

Minds of Their Own

Reverting back to our earlier question of the difference between summer and winter, we look at the correct answer: but through a voyage of discovery, i.e. how we can lead them to this answer. In the before mentioned Harvard gazette, a headline is of interest to us; they have a mind of their own. The statement apparently seems to be quite simplistic. Yet its depth requires understanding. The gazette then goes on to explain how they approached this issue. A one hour documentary was distributed to all departments which showed various teachers giving world class lectures; full of knowledge broken down into easily comprehendible examples. In these the imparting of knowledge was due to lack of effort on the teacher's part. "Giving detailed explanations of various scientific concepts, the material is presented clearly." These films can be seen on Harvard's website. Next, the students attending these lecturers were interviewed in great details. It was observed that a significant number still gave incorrect answers on the lecture material. The common point, whether the students are from prestigious schools and colleges or otherwise, that their fundamental concepts are not clear. In good institutions they are accepted and worked upon, while in our case most not even accepted, let alone corrected.

In Pakistan both public and private educational institutions, whether through the tax payers money or bank financing focus on creating large edifices. This is not helping education in anyway. The most impressive classrooms add little to student learning. For us then the question is how we can use pedagogy and technology inside and outside the classroom; or for that matter without a classroom – perhaps even without an instructor.

Turning to this old picture of a classroom where three students are being taught and paid individual attention. The teacher tells the students that having learned the first principle of geometry yesterday, naturally the teacher had managed to check this; we now turn towards its second principle. We begin with a story, but before doing this he turns towards one students and tells him to wait, since he had not correctly understood the first principle. This is what we refer to as ‘individualized attention, ’one school, one teacher program. He explains that he will get back to him shortly having dealt with the other two students – instant feedback. Turning to another student, he says, that having seen your homework, it is obvious that you have managed to familiarize yourself with the third principle on your own. Consequently, I will assist you in progressing faster adaptive learning. Conversely, looking at our modern, fashionable school, we see the teacher telling the class that today we will study the second principle of geometry. “Before that about your earlier homework; it was not checked and will be checked with the new homework.” The large number of students equates to a teachers hardly or not at all being available: this implies the unavailability of individualized attention, instant feedback and adaptive learning. The air-conditioning and other comforts in no way address the core issues of learning. In reality we require no classrooms; what is required are low priced tablets. Through these we can provide each child with individualized attention, instant feedback and adaptive learning.

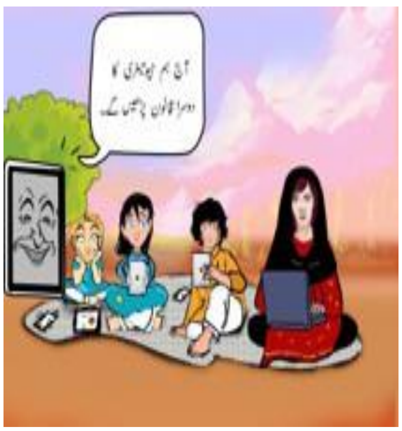
Technology allows us to capture the performance of each student minute by minute; their learning styles, his strengths and weakness in relation to particular subjects or topics, allowing for correct understanding of their learning process. Homework too is individualized and posted, based upon student needs. One size fits all no longer applies. Technology allows a low cost solution, which mitigate the enormous capital expenditure on buildings and huge operating costs.

Now to a critical question: how do we implement this technology? From the earlier cartoons you can see that each child thinks differently and makes different mistakes; each child should then based upon his learning mistakes allowed to learn differently. A principle on which all learning theories, science and experts agree upon, involves the teaching of a particular concept, whatever discipline, and its utilization and use is solving a new problem, involves patterns in learning. For example if you have a thousand students, they will not make a thousand separate mistakes. The distribution of mistakes will fall into 10 to twelve different patterns; dependent upon individual learning styles. If can identify these ten or so mistakes and feed the data into a computer, we can easily identify what mistakes a particular individual will make and how to overcome this.




آج ہم جیومیٹری کا دوسرا قانون پڑھیں گے۔


سب بچے اپنا اپنا ہوم ورک کر کے لے آئیں۔
پچھلا ہوم ورک چیک نہیں ہوا میں وہ اس ہوم ورک کے
ساتھ ہی بعد میں چیک کر لوں گی۔


آج ہم جیومیٹری کا
دوسرا قانون پڑھیں گے۔


تم نے تیسرا قانون
ختم نہیں کیا میں
تمہیں ایک کہانی
سناتا ہوں۔

Topic 114

Reasons for Seasons 1

For example going back to our problem of the difference between winter and summer in Lahore, the misconception or false response spread and depth was the same across all class levels, colleges and universities and between them. The common misconceptions are presented in front of you:

The sun is closer to the Earth in the summers and further away in the winters – this was the most common, about 60% to 70%. We had earlier discussed how this was logically incorrect and how it could be addressed.

- The other main one was that the Earth spins about its axis. This answer was mostly based upon earlier, stored knowledge, but the problem with this is that this was disconnected information. Connected information implies synthesized knowledge which can be connected with existing problem and can be used logically for solving future problems. If the information is disconnected it has no utility in terms of learning. Now the spinning of Earth about its axis is a significant contributing factor for change in weather, but the question is how and why. This is where most failed.
- Another answer was that the Earth spins and rotates about the sun: the Earth's spin responsible for alternating between day and night and its orbit around the sun, the seasons. Again partly correct but the actual phenomena is dependent upon many factors and their integration seemed to be the problem. Until all the pieces in the puzzle do not fit and a holistic picture created the answer remains elusive.
- Some people believed that the tilting of the Earth's axis was responsible for the alteration in seasons. We will look at this in detail and see what effect this could have on the seasons.
- The Earth has atmosphere, this too is a contributing factor. Earlier we had discussed the absence of atmosphere on the moon and the resultant extremes in weather and the absence of seasons. This should provide us with an appropriate clue as to the role of atmosphere.

- Apart from the absence of atmosphere there are no winds on the moon. We could correlate this factor to seasons too; but is there true causation. We could indefinitely extend this logic to all sorts of factors; even frivolous ones, i.e. the absence of human beings or for that matter cats on the moon and equate these as a cause for change in seasons.
- That the Earth spins around it axis, orbits around the sun, its spin is tilted and the absence of atmosphere all seem significant contributing factors. We need to integrate intelligently all these factors, there effects and repercussion to arrive at a comprehensive answer. Incidentally another misconception put forward was that the sun rays angle on the Earth's Poles, while center towards the equator. Is this correct; if so this must be also true for the moon but no seasons exist on the moon.

Now all these common misconceptions can be aggregated and through the use of technology, we can feed to a computer program. This program can then create a list of these common errors which can then be correlated with each students answer to identify their learning mistake. More importantly this diagnosis allows us to correctly tackle their learning deficiency. This enabling technology, we are discussing, is not very sophisticated. A person could use Keynote in Apple and PowerPoint in Microsoft windows to create an if-then scenario; i.e. if this is the answer, then, this methodology applies.

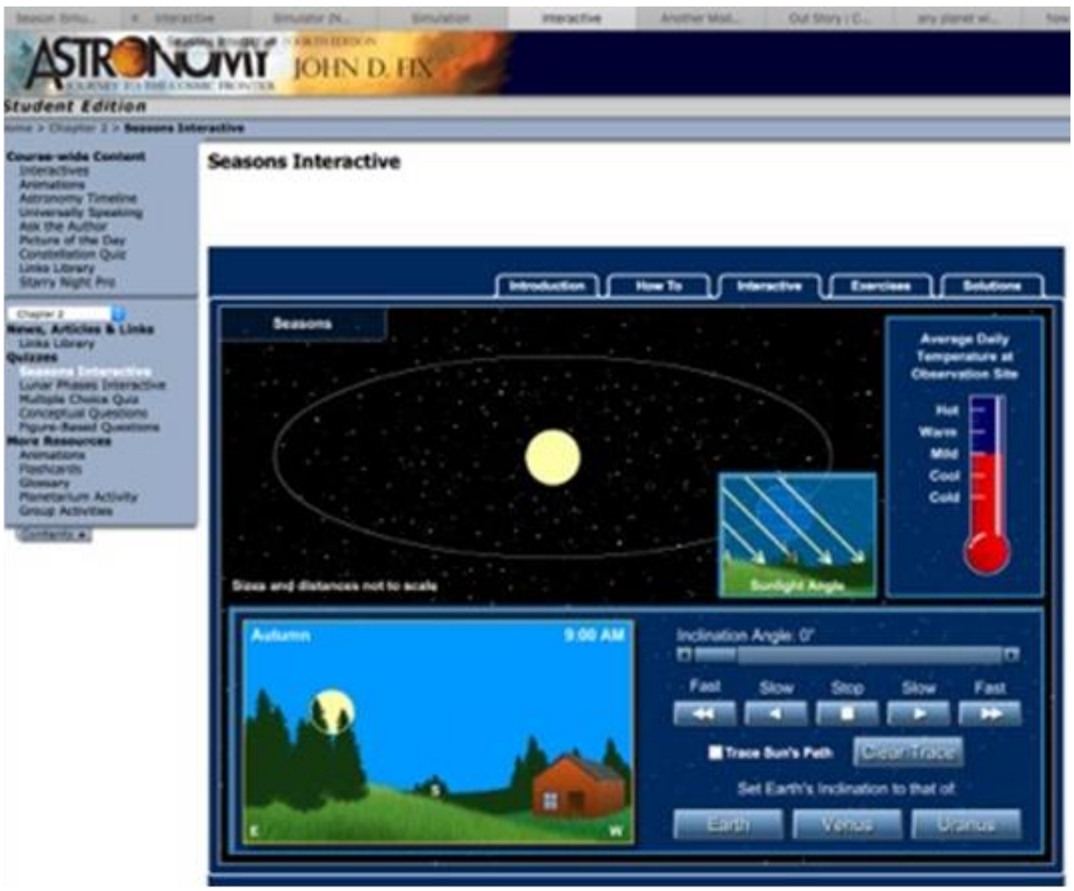
Topic 115

Reasons for Seasons 2

We have already discussed the elements in first layer of the puzzle which would provide us with the answer to the reason for change of seasons. The second level of this decision tree or layer of the puzzle would involve other questions.

In terms of an alteration in distance of the sun from the Earth, if you assume that as the Earth moves in a circle with the sun at the center, your logic is faulty. If the sun is at center around which the Earth orbits in a circle there cannot be variations in distance. Similarly, if we assume that the Earth moves in an elliptical manner with the sun at its exact center. This assumption would entail its own mistakes, which if shown to student visually, would lead him to understand his mistake. Our job is not to censure the student rather to lead him towards a realization of his own mistakes. Another option would be that the Earth moves in an elliptical manner with the sun at the far corner; what would transpire then? All these scenarios can be visually observed and easily available through the internet on your computers or android devices. This learning phase would be superimposed upon the earlier layer; where a student would not be discouraged but allowed to explore. The process can be captured in the form of a flowchart, similar to a computer program or an algorithm with a built in feedback (instant) loop. This stage is critical in terms pedagogy for clarifying and setting right a student's mind to concepts which may be entirely counterintuitive – the sun is closer to the Earth in the winters in comparison to summers. In a problem solving class today an example, one which we had discussed earlier, cropped up: if we are close to a heat source say a heater, why do we feel hotter than when we are at distance from the same source? Explaining this I told them while this was true suppose you were at a distance of five kilometers from the heat source? Now if you moved a meter closer would this affect the temperature in anyway? The answer was still positive; a minimal effect, creating a true pedagogical challenge. What we need to do is to show them, through a simple experiment, what actually transpires and that there are other reasons which offset this effect of closeness.

Trying to create a paradigm shift in learning; we can try to explain to the students what is transpiring, through observation of various concurrent effects and analysis of the consolidated factual picture. Or we could invert the entire equation and make this a ‘design problem.’ The design problem apart from being an exciting and fun activity allows for the development of numerous learning applications.




An Educational Game?
You empower the student to move the earth significantly closer or farther


The Earth is stationary - neither spinning nor moving around the sun? With and without Air around it?
Will there be days and nights?


The Earth is stationary - neither spinning nor moving around the sun? with or without air around it?
Will there be seasons?

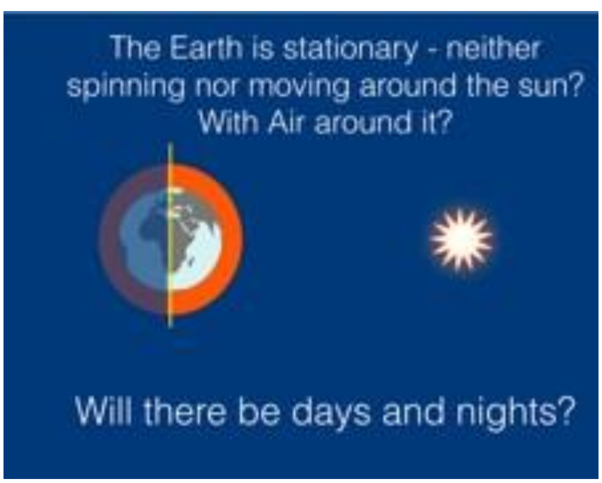
Topic 116

An Educational Game 1

For this new paradigm now days we have access to the requisite technology. We can now approach the students and ask them to play a game. In this game we allow you omnipotent powers and in front of you are the sun and the Earth, whose distance we can alter at will? This allows students to indulge in a 'do' activity from the earlier constructivist framework. What if he half the distance between the Earth and the sun? To make things easier we assume that the Earth is not spinning on its axis or in orbit. This allows us to tackle one factor in isolation. If we bring the sun too close to the Earth it will burn; too far and its freezes. Right now we are somewhere in between, a point whose realization will now be simpler for students to comprehend. The learning game/application will assist them in this process by providing them with the temperature on Earth, depending upon the distance of the sun. The conclusion should be that, holding all other factors constant, we are at an optimal distance where minor (relative) changes in distance do not affect the temperature. Actually we are aware of the fact that the converse is true; in winters the sun is closer to the Earth.

Once this is grasped we move to the next factors, through thought experiments, which can be part of game/learning applications. During play they will be transported in embarking upon a voyage of discovery, a bumpy ride, but one whose destination is of understanding. Again assuming that the Earth is stationary and there is no wind around it: will there be days and night? This simplifies things and depending upon their answer; yes or no two lines of reasoning branch out. A second related question is will there be seasons and if there are what part of Earth hot and what part cold? You can see this is the diagram.

We now revisit our previous question but with factor changed; now there is wind. Will there be days and nights; seasons; which parts will be hot and which cold? Additionally, how we would compare these answers to earlier ones where we had assumed no wind. Here we are not trying to provide you with an answer, rather we are putting forwards questions in context of each possible factor entailed in determining weather, which lead to further question, before creating a composite and logical framework. Thus, the new variable could be that we assume the Earth to be tilted, what effect would this have, remembering that earlier we had assumed that the Earth was still both in terms of turning on its axis and its orbit. Next we assume that the Earth is spinning on its axis and is tilted; will there be seasons? We can continue doing this for each variable but as you can probably appreciate an impossible task for teacher in a classroom context. But undergoing this process is imperative to any true learning. Now with the help of technology and through learning applications and games this process can be engaging and exciting. If can still this sense of discovery and more importantly questions in the mind of students, one is certain they can tackle any knowledge on their own.



Topic 117

An Educational Game 2

Since are discussion centers around planetary bodies, the changes in the seasons and the alteration of day and night today we begin with Faiz Ahmed Faiz's, Nusaqa Hai Wafa – Remedy of Love:

Aab saie ka imkan or nahi
Parvaz ka mazmoon ho bhi chukka
Taro pay qamanday phaink bhi cukkay
Mehtab pay shab knoon ho bhi chukka
In aankho say kiya piyam keyjiyay
Kis khwab kay jhutay afso say
Taskeen dil-e-nadan keyjiyay
No scope remains for further effort
The subject of flight already tackled
Lassos around the stars already flung
The moon at nights already a victim
What further message with these eyes convey
Of what dream in delusion remain
The simple heart console!

We had concluded the last module on importance of questions. Asking questions- the right questions- is a technique and exercise, whose importance cannot be, stressed enough. When faced with a complex problem, which one is having difficulty tackling, the breakdown of the problem into more palatable pieces is the appropriate methodology. In the slide in front of you the Earth is spinning around the sun, there is no air present around it and it is tilted and spinning around its axis. How we would compare this scenario to one where the Earth is not tilted, and numerous related scenarios, we had discussed earlier. We had not provided a specific answer to the question of change in seasons, since this is not the objective of the course. The point is that most people are not aware of an explanation for this phenomenon, which we experience every day. Through the earlier simple questions in particular scenarios we had tried to point the way towards the right explanations; contingent upon you asking the right questions. Going back a little, now that you have had time to mull over the earlier questions: empowering student to discover on their own; the only job of a good teacher, we get back to the question at hand.

Topic 118

An Educational Game 3

We begin some thought experiments. Even though actual physical experiments are critical the importance of thought experiments can be gauged by the discoveries of Einstein, Newton and Galileo. These thought experiments can become the basis of a very powerful design of collaborative, interactive learning applications. We can design a similar application to handle our problem in an interesting and fun way, which addresses all the questions we had discussed earlier and the confusion surrounding the concept. Most of the bases for this confusion created by us. This cannot be achieved in a classroom, since a teacher does not have the time to clarify each individual student.

We now begin with question; hopefully will result in other questions, ultimately allowing you to discover the answer on your own. The earth is stationary; neither moving nor orbiting around the sun, with and without air around it: will there be days and night or seasons? If this was the case how would life look like or for that matter exist? By removing air from the atmosphere, would life be possible? Naturally, I do not expect a scientific answer to this; but I do expect some serious thought. The extension of this thought process is necessary. With the technology available these day including the internet, we have little excuse. In this picture three students are observing the earth. Would the child furthest away, towards the dark be the coldest? Would all three feel the same intensity of heat? Perhaps your answer, as with most people, would that those on the poles feel the least heat. To surmount the lack of air/oxygen we assume that they are astronauts and have breathing apparatus in their suits. In comparison, those on the equator must be feeling the most heat; since the sun rays fall directly and not at an angle, as with the poles. Now suppose we remove the earth from the picture; leaving only the three children.

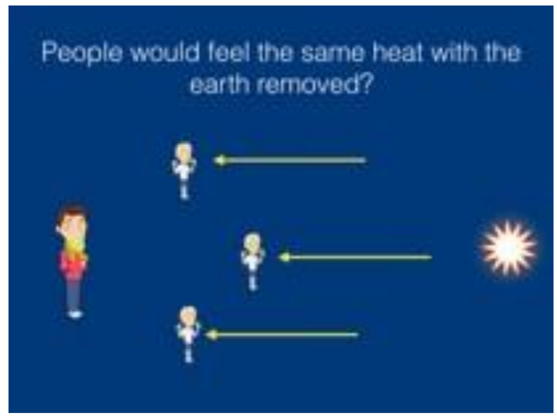
Angles no longer matter since all rays are now falling in parallel. Would the child in the top of the picture still feel the same amount of heat? What about the other children? Would we want to the earlier scenario? The whole point of asking such questions is making you question the logic of your earlier questions. This is a key feature and strength of interactive learning applications. This uncertainty leading to modifications in a student's thought processes is a highly desirable state in terms of learning.

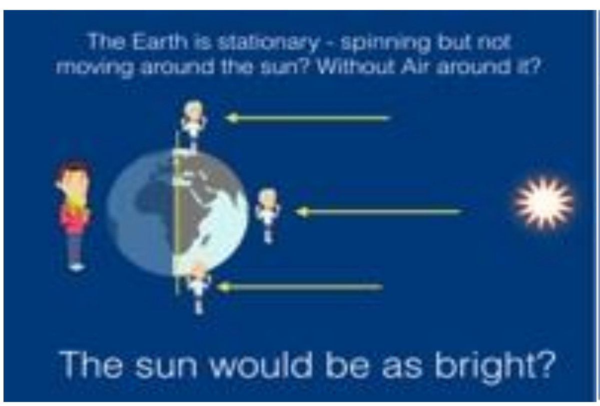
Earlier in terms of heat we had also discussed it absorption, since no air and assuming no clouds. Would the sun appear as bright at the poles as the equator? The question is another in the chain of earlier question and constitutes a methodology which in constructive terms is known as multiple perspectives – approaching the problem from various different angles. Would the child at the southern pole hidden from the sun feeling the cold? Again, we remove the earth from this picture. Would the sun appear as bright from all perspectives? Does this make you question your earlier answer? Before technology, teachers always used to advice, going through an exam paper once after solving it –taking another glance. Never assume an answers validity; without questioning it. Now we tilt the earth, as it is tilted in actuality. If you just Google for reasons for change in the seasons, all websites will include the earth's tilt as factor. This approach of altering one variable while keeping others static will lead to; not answers but further questions. If this was done through an interactive application it would be possible to capture each student's individual confusion and set it right.

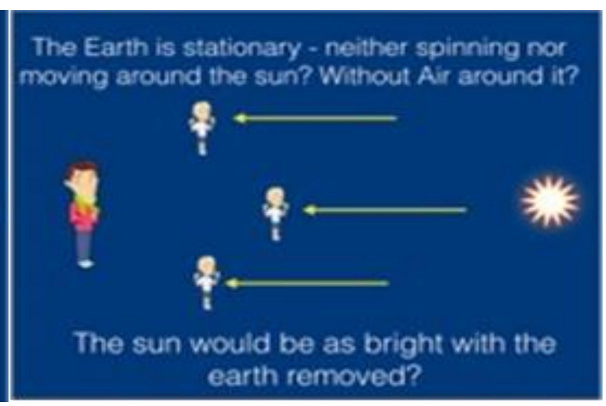

The Earth is stationary - neither
spinning nor moving around the sun?
without Air around it?
Will there be seasons?


The Earth is stationary - neither
spinning nor moving around the sun?
without Air around it?
How the life would look like?


The Earth is stationary - neither spinning nor
moving around the sun?
without Air around it?
Will they feel the same heat?


People would feel the same heat with the
earth removed?


The Earth is stationary - spinning but not
moving around the sun? Without Air around it?
The sun would be as bright?


The Earth is stationary - neither spinning nor
moving around the sun? Without Air around it?
The sun would be as bright with the
earth removed?

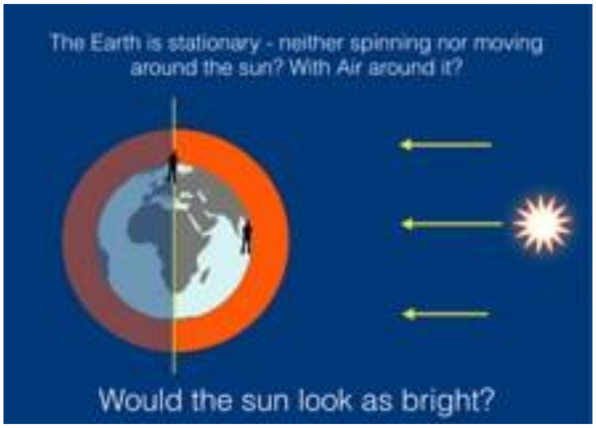
Topic 119

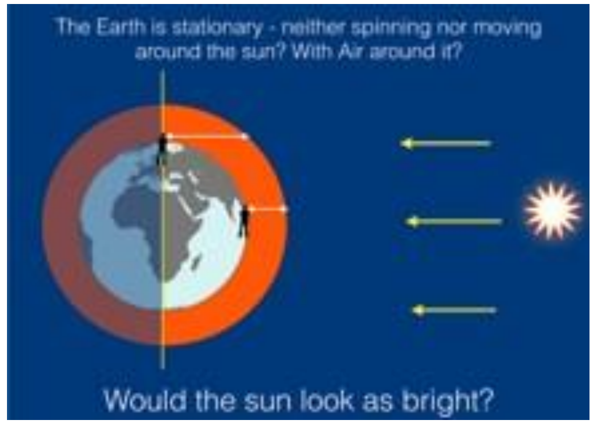
An Educational Game 4

Back to our famous picture, and I say famous since it contains a lot of information which is useful in providing answers to your query. The earth is stationary; neither moving nor orbiting around the sun, without air around it; but this time is it also tilted. Will there be seasons or not? Altering one variable at a time we remove the earth's tilt and include air/atmosphere around it: will there be days and nights or seasons? We do this since most sources, point to some role of air in change of seasons. What would life look like; a multidisciplinary question, which should ignite a student's imagination. What are the basic constituent elements for life: Questions which children usually ask but a faculty which we progressively quash over time? What if there were no seasons? "When a mars size object collided with the earth, 4.5 billion years ago, it knocked off a chunk which would become the moon." I do not know to what extent this is correct. "It also tilted earth sideways a bit, so that our planet now orbits the sun on a slant. Those were two huge changes. Now over the course of the year the amount of sunlight striking the northern and southern hemispheres varies as they wobble back and forth." Here they are trying to provide an explanation for the seasons, which are hard to comprehend. "First the southern hemisphere leaning sunwards and then the northern; this cycle drives earth's seasonal variation." You will find a lot of answers but are they comprehensible? "It is a lucky thing too, without the earth's tilt humanity would be in a sorry state." The problems created, if this was case would include: "Forget modern technology; the steam engine; and sliced bread." "In a world without seasons there would not even be wheat." These facts can only be of added interest to a student. According to Don Atwood, an ecological anthropologist at McGill University in Montreal; "humans would probably never have advanced past living in small - scattered settlements for survival, often dying of horrific insect borne diseases. Scientists think that an earth without a tilt would be stratified into climate band that would get progressively colder as you moved away from the equator. Humans would never survive the continuous winter of high latitude and so we would likely congregate in the planets tropical midsection. In the habital world hermid tropical zone like the rainforest of Congo, unrelenting rainfall would quickly erode soil in any areas cleared for farming and would lean nutrients down below root levels swiftly rendering the tiled land infertile for crops. The result is that humans can only live with a low population densities supported by shifting agriculture or something like it in most of the humid low land tropics. Atwood told, life's little mysteries, low population density and low agricultural productivity results in small - scattered settlements; the amenities of modern civilizations cannot be built on such foundations."

Another thing which he addresses: "people in Britain and Western Europe need heat during the winter; with a growing population in the 18th century Britain was running low on forestland for wood first. Coal helped to heat people homes and happened to be abundant in England, the inventors of steam engine soon discovered that coal could be used to power industry machinery. Furthermore many other crucial advances in science, technology and medicine have occurred in places with cold winters: though the correlation between these developments and the climate is not understood.

Getting back to our earlier problems; now we question the fact that if there is air around the earth and no tilt, would the sun still appear as bright? Observe the two people in the picture; you will be able to pick up a lot of clues if you observe it carefully. This question has been asked at all possible forums; conference, seminars, posh and street schools. The lines/arrows pointing towards the pole and the equator are hinting at something. By air, surrounding the earth, we refer a layer which encompasses it. The layer causes some pollution and contains nitrogen, oxygen, carbon dioxide, other gases, water vapor causing humidity. Now why would the sun appear less bright to standing at the North Pole? This is a critical point and milestone in terms of learning; if this is answered correctly the major portion of the answer is discovered.





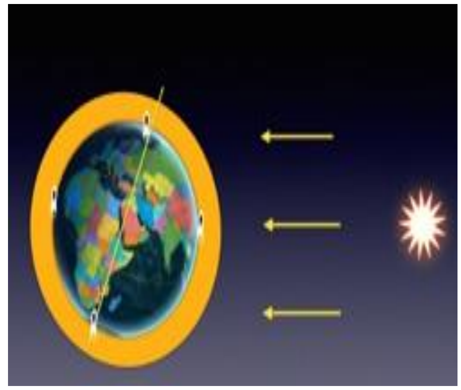
Topic 120

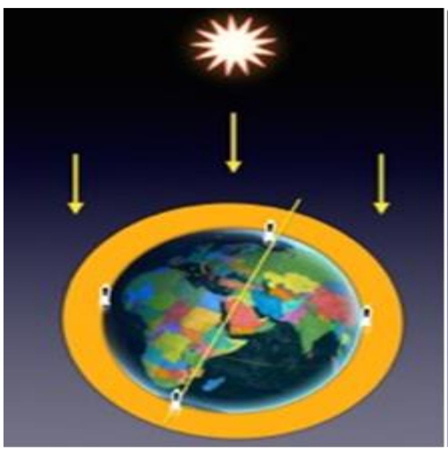
An Educational Game 5

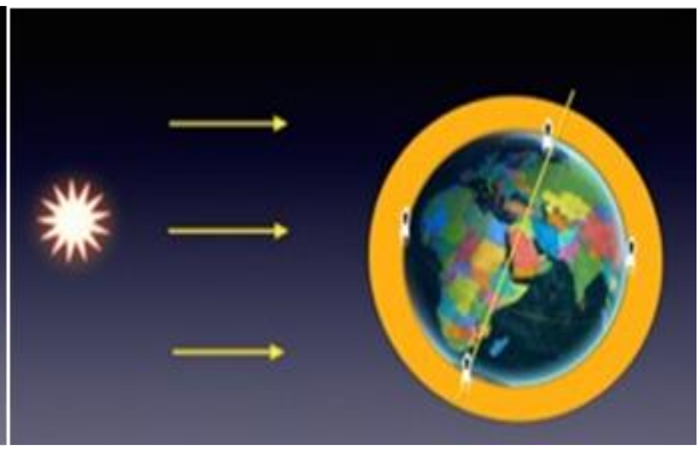
Now the question becomes: that for a person standing on the North Pole, what distance do the sun rays transverse? The longer the distance travelled, less bright the sun appears. Comparatively, what distance would the person experience on the equator in terms of the sun's rays, due to the air? From how bright we turn to the question of how hot? Again, the earth is not spinning on its axis or orbiting the sun and we reintroduce its tilt. Would the sun still appear as bright to a person standing at the North Pole or as hot? We now introduce a major change; the earth is spinning around its axis, with air around it.

Will there be seasons and where? We turn to more meaningful picture dealing with the earth's tilt. Since the sun's ray are falling in parallel and the tilt remains as it is, but the earth is not spinning which areas would be hotter or which colder an important question. Similarly, if the earth was spinning then what areas would be affected; this was another important questions. More importantly we can see the exercise here by rotating a stationary earth interactively. The answer should be quite clear by now. In this state of spinning on its axis, leading to day and night and due to its tilt what area would be comparatively hotter? In comparison to the earlier diagrams there is a major difference in terms of which areas would be affected. If you can logically analyze the four scenarios which we have presented in totality you should be close to an answer. We compound these four scenarios onto one slide. Perhaps you can now place each individual season is relation to its location on the earth based upon the scenarios?

We now turn to a picture from the internet, which attempts to describe the seasons. While this is compounded we have taken manipulated each individual variable to lead to this. The difference in progression is what leads to disconnect in the learning process.








میں نے تمہارا گھر کا کام دیکھا ہے تم
کو تو جیومیٹری کا تیسرا قانون بھی خود
ہی سے آتا ہے


میں نے تمہارا گھر کا کام دیکھا ہے تم
کو تو جیومیٹری کا تیسرا قانون بھی خود
ہی سے آتا ہے

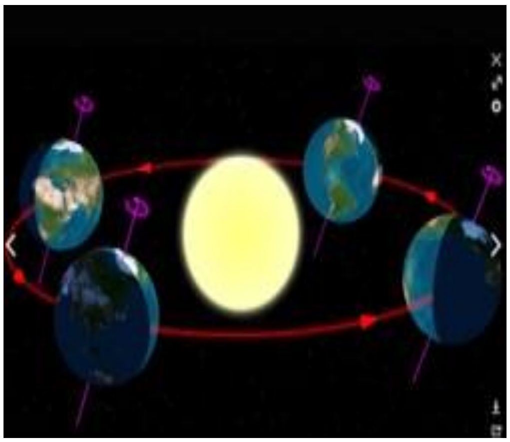

میں نے تمہارا گھر کا کام دیکھا ہے تم
کو تو جیومیٹری کا تیسرا قانون بھی خود
ہی سے آتا ہے

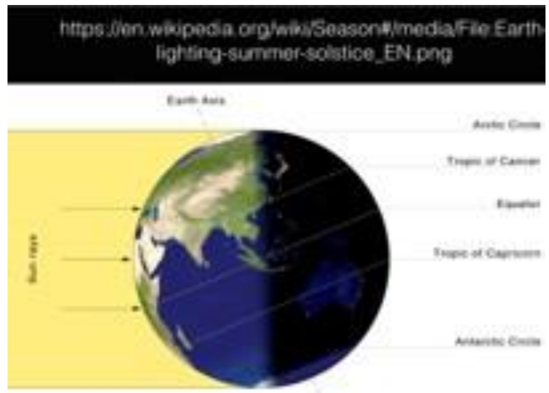
Topic 121

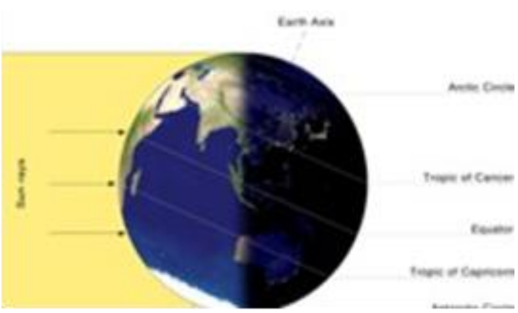
An Educational Game 6

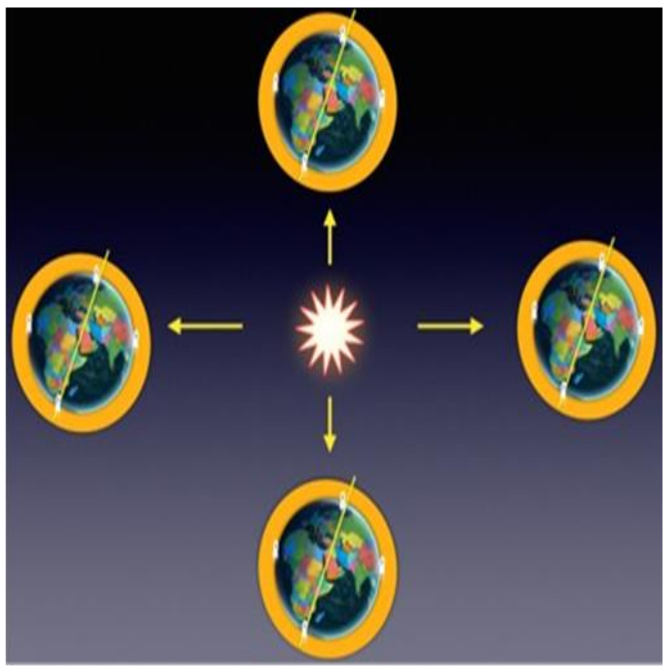
This picture is taken from the Wikipedia, along with its reference. In this you would observe what part of the earth faces the sun during summers. Here difficult labels for various latitudes are provided which further complicates things, something which we have not done. We have an atlas here which presents the sun in relation to the earth at various times in the day (Diagrams of Lahore). With the help of technology we can also make the earth rotate instead of keeping it static. We can now answer related questions. Assume we alter the earth's tilt and it is turning in a different direction; will there be seasons? In another scenario we further alter the tilt of the earth; will there be seasons and what areas would be affected? Would this straightened axis make a difference? Through this process we have tried to converge a lot of divergent ideas. We can now indulge in little divergent thinking; not too much since this can also lead to difficulties. Some observation can be noted by just stepping outside. These observations can provide further clues and helpful in reinforcing our understanding. In some cases curiosity and a seemingly unrelated observation can lead to a great understanding. This is how most intricate mysteries are solved practically in life. Since this story is about the relationship between the sun and earth we should try observing the sun. Naturally, this should not be attempted through the naked eye and appropriate protection is required. Through this we can observe the sun at various times. Around 7 pm in the evening, driving on a road, you can see the see the setting sun. It is not that bright and can be seen with the naked eye. Comparatively, you could not observe the sun at 12 pm in the afternoon with your naked eye. Why is this? Is it somehow related to the changes between summer and winter? The answer is not that the distance increases in the evenings.

Around that time you must have also observed the moon, which at times can be simultaneously and appears as bright. Why is the sunlight?







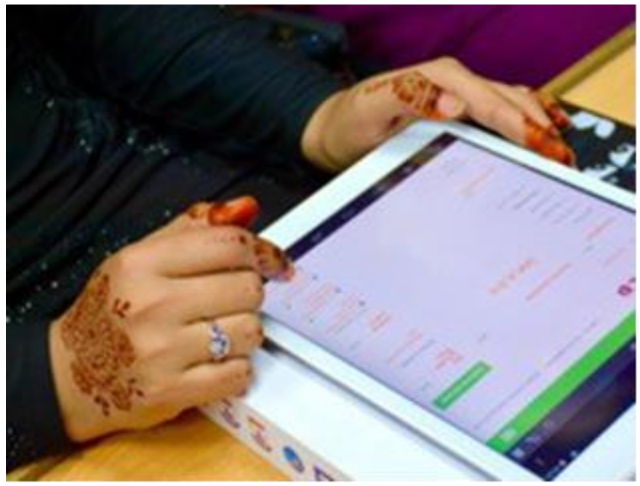


Topic 122

Prior Knowledge

In the previous modules we were discussing the cause of change in seasons and how across from university level downwards to primary school, most students' inability to answer this phenomenon correctly. An appropriate example of a learning problem, which we can now address through the right pedagogy supported by technology. The picture in front of you is about a new course we have recently introduced on thinking; what is thinking and how we think. The faculty to think is critical, unfortunately something our learning process effects adversely. As Einstein said the only impediment to his progress was education.

Here you will observe a concept map of why summers and winters occur. Please, observe the smile on the student's face, as it her first attempt at this. This smile, a reflection of enjoyment of the process of learning, is required in the educational process. In terms of technology we had earlier discussed the concept of instant feedback. When a teacher presents a lecture in class; the assumption is that there is some prior knowledge on which this new knowledge will be added. Take an example of a new builder who comes to erect a building on earlier foundations. If these foundations are weak or missing, you can imagine the building constructed. A teacher's task is to detect any inherent weaknesses in these foundations. A word of caution, and based upon my long experience with teaching, there are no assumptions for prior knowledge. Many a times the simplest assumptions will prove to be wrong; there are numerous misconceptions in a students' mind. It is then the job of a teacher that upon entering classroom to understand individual knowledge gaps for each student. Naturally, without technology this is an impossible task and if this attempted no new learning would take place. In actuality what is required is a 'Classroom Response system'. This is not an expensive proposition and requires smart phones, which most students already possess, or inexpensive tablets. No internet connection is required; all the teacher has to do is to open is laptop and provide intranet connectivity to the student. A small pop quiz can then be taken, consisting of four to five questions, and the answers transmitted back to the teacher. This provides the teacher with a fairly good grasp of the knowledge level of the students and the whole process takes no more than five minutes.



Topic 123

Classroom Response System

Here we see a picture of this classroom response system. Concerning our earlier problem of change in seasons the students are given a few related questions such as: what happens in summer and winters; why is the sun brighter at midday in comparison to the evening? You see them answering these questions, but observe their happiness and excitement. This is a direct outcome of them being part of an interesting activity and the students not just passive listeners. The students come to the forefront, while the teacher recedes to the background. A junior instructor provides them with two minutes instructions for the first time after which the process becomes automated. The computer marks the answers and the results are instantaneously uploaded to the teacher; providing a mechanism to gauge their prior understanding/knowledge.

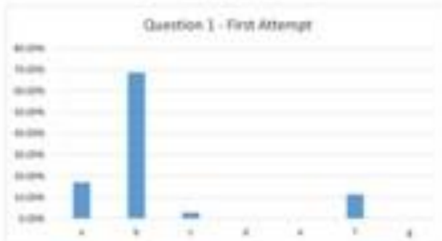
As you see in the picture, each child, at first, attempts these questions on their own, without consulting others. Later they are allowed to consult with each other; another interesting and exciting learning experience for the students. The students are allowed to walkabout, argue, at times use the internet and even make calls. More importantly, the underlying commonality among the students is that they are thinking; analyzing and critiquing their own answers and not being lectured. This is the beginning of the learning process. You should also observe that no student is gossiping or wasting their time. People repeatedly point out that classroom discipline is essential. Yet having attempted this collaborative arrangement numerous times, I can attest that nothing happens. The students are there to learn. Turning to an actual example of this the first question the students are asked is why the sun is not as bright at 7 pm in the evening in June, if there is no pollution in the air. After their initial answer, the students are allowed to consult and you see a clear convergence towards one answer based upon argumentation, analysis and collaboration, collective convergence. We asked another question and you can see that the computer immediately generates a list of all questions for each student. This technology costs little. Infact, in a couple of years the only cell phone available in the market will be smart-phones. So the solution will require little intensive technology.

Class Room Response System Testing - Thursday, March 10, 2016, 11:20am in R006 - Course: OOP (A)

Question 1 - First Attempt

Question: While driving on a bridge at about 630pm in the summer of lahore in a cloud less and almost dust free environment you can see the sun which is not as bright as at the time of noon? Why?

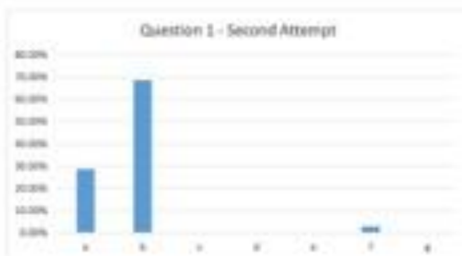
Key	Model response	Credit	Count	%age
a	the distance of the sun has become larger at 630pm than at noon?	0.00%	6	17.14%
b	because the sun rays are coming at an angle at 630pm while they are coming straight at your head at noon? This is the only reason.	0.00%	24	68.57%
c	because there are air particles and more dust at 630pm?	0.00%	1	2.86%
d	because the pollution has increased at 630pm	0.00%	0	0.00%
e	because of the magnetic properties?	0.00%	0	0.00%
f	none of the options	100.00%	4	11.43%
g	[No response]	0.00%	0	0.00%



Question 1 - Second Attempt

Question: While driving on a bridge at about 630pm in the summer of lahore in a cloud less and almost dust free environment you can see the sun which is not as bright as at the time of noon? Why?

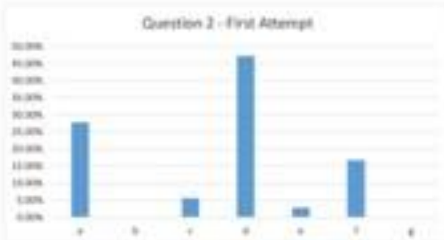
Key	Model response	Credit	Count	%age
a	the distance of the sun has become larger at 630pm than at noon?	0.00%	10	28.57%
b	because the sun rays are coming at an angle at 630pm while they are coming straight at your head at noon? This is the only reason.	0.00%	24	68.57%
c	because there are air particles and more dust at 630pm?	0.00%	0	0.00%
d	because the pollution has increased at 630pm	0.00%	0	0.00%
e	because of the magnetic properties?	0.00%	0	0.00%
f	none of the options	100.00%	1	2.86%
g	[No response]	0.00%	0	0.00%



Question 2 - First Attempt

Question: Why there are seasons in lahore - we have summer in June and winter in January - now the spring is coming? Why?

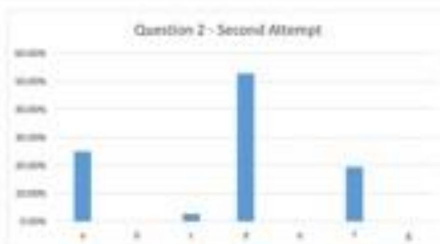
Key	Model response	Credit	Count	%age
a	because in winter the earth goes farther away while in summer it comes closer to the sun?	0.00%	10	27.78%
b	because there is the earth magnetic field?	0.00%	0	0.00%
c	because the earth is surrounded by air and pollution and they increase in winter as compared to summer?	0.00%	2	5.56%
d	because the rays of light hit the earth with an angle in winter and this is the only reason?	0.00%	17	47.22%
e	because the sun becomes brighter in summer?	0.00%	1	2.78%
f	none of the options	100.00%	6	16.67%
g	[No response]	0.00%	0	0.00%



Question 2 - Second Attempt

Question: Why there are seasons in lahore - we have summer in June and winter in January - now the spring is coming? Why?

Key	Model response	Credit	Count	%age
a	because in winter the earth goes farther away while in summer it comes closer to the sun?	0.00%	9	25.00%
b	because there is the earth magnetic field?	0.00%	0	0.00%
c	because the earth is surrounded by air and pollution and they increase in winter as compared to summer?	0.00%	1	2.78%
d	because the rays of light hit the earth with an angle in winter and this is the only reason?	0.00%	19	52.78%
e	because the sun becomes brighter in summer?	0.00%	0	0.00%
f	none of the options	100.00%	7	19.44%
g	[No response]	0.00%	0	0.00%



		Question 1 (10 marks)		Question 2 (10 marks)		Question 3 (10 marks)		Total
First name	Surname	First Attempt	Second Attempt	First Attempt	Second Attempt	First Attempt	Second Attempt	Marks
L1F14BCME0011	HASSAN TARIQ	0	0	0	0	0	10	10
L1F14BCME0013	ZULQARNAIN HAIDER	0	0	0	0	10	10	10
L1F15BCME0001	MAHAM SAEED	0	10	10	10	10	10	30
L1F15BCME0002	IQRA MUSTAFA	10	10	0	10	0	0	20
L1F15BCME0004	NOSHEEN QADEER	0	10	0	10	0	0	20
L1F15BCME0005	ABDUL FAHAD FAHEEM	0	0	0	0	10	10	10
L1F15BCME0008	SHAHID MAQSOOD	10	10	10	0	0	10	20
L1F15BCME0009	SHAHERYAR ASIF	0	10	0	10	0	10	30
L1F15BCME0010	WAFA JUNAID JALAL	10	10	10	10	0	10	30
L1F15BCME0011	BILAL SHAH	0	0	0	10	0	0	10
L1F15BCME0014	ABDULLAH MUTAHIR	0	0	0	0	0	10	10
L1F15BCME0016	ADNAN ARSHAD	10	10	10	10	0	10	30
L1F15BCME0017	MOHAMMAD ABDUL MOEED	0	10	0	10	0	10	30
L1F15BCME0018	SHAHRYAR NASEEM	10	10	0	10	10	10	30
L1F15BCME0019	AWAIS MALIK	0	10	0	0	10	10	20
L1F15BCME0020	AWAD KHALID	0	0	0	10	0	10	20
L1F15BCME0021	MOHAMMAD MAROOF SUBHANI KHAN	10	10	10	10	10	10	30
L1F15BCME0022	KHADIJA ARIF	0	10	0	10	10	10	30
L1F15BCME0023	UME AMMARA	0	10	10	10	10	10	30
L1F15BCME0024	IBRAHIM BILAL	10	10	0	10	0	10	30
L1F15BCME0025	FARGHAM AHSAN	0	0	0	0	10	10	10
L1F15BCME0026	FAHAM AHMED KHAN	10	10	0	0	10	10	20
L1F15BCME0027	ALI AHMED	10	10	0	0	10	10	20
L1F15BCME0028	FARIA FAWAD	0	0	0	0	0	10	10
	Average	3.75	6.67	2.5	5.83	4.58	8.75	21.25

Topic 124

Outside the Classroom

Now that we have discussed the inside of the classroom, we attempt at taking this technology outside the classroom. We took a class excursion to a remote rural area away from the university. The purpose was to determine if we could provide quality education in this setting. By quality, world class education, we refer to these constitute elements: the availability of instant feedback; awareness of a student's foundation knowledge; their misconceptions, individualized learning; and quality teacher-student communications – all elements which can be addressed through technology. It was decided to commence the classroom in the bus. This entailed setting up of an intranet connection between the teacher's laptop and student android tablets, no electricity or an internet connection is required. Compare the cost of acquiring land and building for constructing a school to a bus, which can be rented at a cost of Rs.25, 000 to Rs.20, 000 for a day. Other factors which need to be considered are; the inordinate amount of time students spent on commuting; endless homework and academies. Could not this time be used more productively?

In comparison look at the class conducted in a field; the student's happiness at being out of the restricting environment of a formal classroom needs to be noted. Here a proper teaching with the inclusion of instant feedback is transpiring; a thing which unfortunately not present in most elite institutions in the country. Despite the fact that each child in all probability posses a smart-phone and have access to the latest computer labs. Throughout the bus journey the learning process is not interrupted; leads us to the conclusion that a classroom can be developed anywhere in the wilderness or on a bus.

Extending this logic can we not have a fleet of bus which can target underprivileged segments of the society? The buses can go to the specified localities and park there. Students, most of whom also work, depending upon the time available can go to the bus, where a tablet is mounted on each seat, log in with their own account, provided to them earlier and upload their homework and download their new assignment. Through technology they will be provided what mistakes and misconceptions they faced also their individualized speed and ability taken into consideration. Naturally, we are assuming that these students do not possess a smart-phone. Those that do can come into the vicinity of the bus and repeat the same process. Here we are talking about a revolutionary concept: a child not going to school.

When a child attends school there are numerous difficulties arise: commuting and associated costs; fixed timing, copies and books and similar requirements. Instead of children going to schools; the school comes to the child. This mitigates the costs and difficulties associated with going to school. A child's daily progress report is also sent (sms-ed) to their parents or guardians. An entirely new paradigm for that can also be applied to existing schools. Also, helpful in assessing if actual learning is transpiring in schools; innovation, knowledge and understanding of new concepts and not confined to just rot learning. There are issues with our paradigm.

Topic 125

A Multiple Choice Quiz

In context of earlier question of why there is a change in seasons in Lahore; most students who had some prior knowledge of the problem, answered that in the winters the sun rays fell at an angle on the earth and in the summers directly. Before moving on we have to understand the flaw with a multiple choice format if we want to utilize it. In the second attempt by students, where they were allowed the use of the internet, there was greater convergence towards the same answer. Incidentally, this was also the answer given on the internet. There were still some outliner but the majority agreed with the answer. Is the cause of concern or celebration? But what is the right answer? Is the fact that the sun falls at an angle sufficient? Technically, this is the correct answer as provided in books and the internet. But this is only the answer the What – what about the Why, How and Where. Perhaps those students, who did not answer correctly, did not feel this was intuitively the correct answer. “Conventional wisdom tells us that the learners are converging at the right answer, and here lies the root cause of this very serious misconception.”

It is precisely due to this that our question appears so abstruse. At times students provide answers which are available in textbooks but do not relay know the why part. “Multiple choice questions create and reinforce misconceptions sometimes. They may pick the right choice and it may propagate in class during discussion but they may not know why, how, when and where. They may simply seem to know what the correct answer is according to books, internet, etc.” What we did in case of our class was invite groups of two who had answered correctly to the faculty office and asked them to explain their answer. They replied they had read it somewhere but were unable to explain. We also brought up the earlier concept of a person observing the sun at midday and evening and the difference in brightness. The common answer to which was also that the sun was striking at a different angles. We employed this as counter argument through asking them to remove the earth from the picture. The pertinent point is that despite the convergence upon the right answer the learning misconception persisted.

Topic 126

Elementary Probability 1

We tried another example in class; an elementary mathematical problem of probability. Unfortunately, this is subject which has been traditionally based upon undue formulation. I remember this was how it was taught to us too and this leads to the absence of its real essence and no real intuitive understanding. We asked the students a very basic question; if a coin was tossed what would be probability of heads or tail. The unanimous response was 50%, i.e.1/2. But upon being asked what this implied, there was no response. This was surprising since one was not expecting this misconception. The point that probabilities would vary towards one outcome and with greater coin tosses approach towards the defined probability was not clear. On asking; what is the probability of the sun rising tomorrow, the answer was an unequivocal 100%. Technically the probability is closer to 99.99%.

We now commence with our example. There are three boxes, two containing pigeons and one a precious statue. The graphical presentation is to provide visual stimuli in grasping the problem. Next the three boxes are shuffled and we longer know which box contains what. Students are now provided with a single attempt to try locating the statue. For this example we had tried to create an appropriate classroom environment. Outside the classroom the sign say, "Come and discover." Inside the classroom the problem statement is defined as, "probability of finding the statue." In the picture you will see the girl enquiring as to what is the probability. The man's reply is; if you try a 100 times you will be able to locate the statue approximately 33 times. What does this imply? Random selection will yield you the statue 33 times from a 100 attempts and pigeons the remaining 66 times. This appears to quite in line with commonsense. Now how can we increase the probability of finding the statue? Assume the earlier man in the picture is a magician and will lead you towards this, but which to you may appear counter intuitive.

One box is selected which cannot be opened and is put aside. The selected middle box is set aside. Of the remaining two boxes the magician opens one and a pigeon flies out. Now we are left with two boxes, one containing a pigeon and the other the statue. A choice is given at this stage, to remain with the earlier choice of the box or switching to other remaining box. The story is provided to illustrate the problem more clearly. Now what would be the probability of finding the statue if you remained with your choice or switched? Which would be higher? Intuitively the answer seems to be 50%; think about this.

Topic 127

Elementary Probability 2

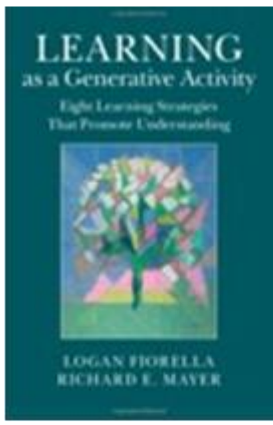
When this experiment was conducted in the classroom 70%of students on an individualized basis replied 50%. When the students were allowed discussion between them, the answer converged to 90%. Please, note here the use of the intuitive thinking process and non-reliance upon formulas. Anyway, once the students were allowed access to the internet, they discovered that their answer was incorrect. Again, we need to be careful when employing a multiple choice format for a classroom response system: there is a tendency in converging towards a misconception. The What may be understood and but not the Why. This precludes the application of this knowledge to problems of a similar nature. Suppose that we now have four boxes and one is selected and set aside. Out of the three remaining boxes, one is opened and the pigeon set free. Now what would the probability of finding the statue between the three remaining boxes?

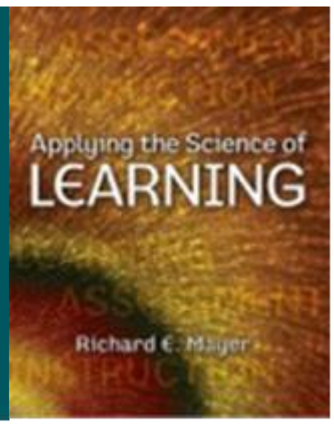
This is a serious flaw with multiple choice format, that the answer may be correct but its understanding absent. Technology is not the cause of it; the problem was there in this format's pedagogy prior to induction of technology. What technology allows us to do is to introduce efficiency in the assessment part, which otherwise a tedious and physically impossible task. "We started using technology to get an idea of severity of student misconceptions. Technology provided instant feedback, which is essential for learning but sometimes flawed. The critics of technology would again promote the role of the instructor; but the instructor can also design and check multiple choice problems and fall in the same trap. The answer lies not in abandoning technology but by using more of it."

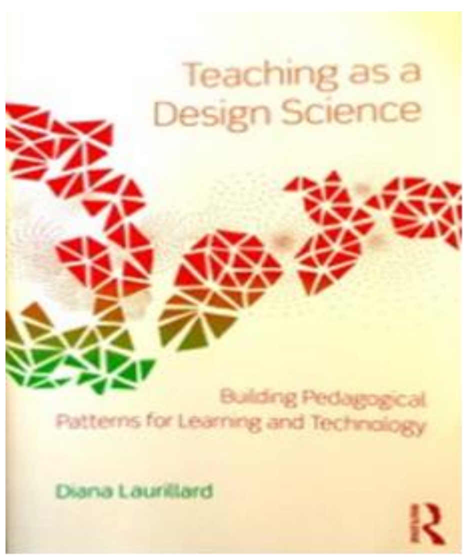
“What we require is more intelligent technology.” This is our challenge for the future. “Sometimes an answer converges towards positive results but with no justification, sometimes an answer converges towards negative results but with no justification. Why learning is not taking place and what should be done.” This leads us again in the role information technology in education. A teacher upon entering a class should be aware of the foundation knowledge of the class; upon which he/she can then build upon, according to a constructivist approach. In actuality this not only needs to be done at the beginning of the class but in the middle and its end. The wrong impression acquired by a teacher, that the majority is correct or wrong needs to be dispelled. What kind of technology is required? How can we get into the mind of a student to generate an understanding of what, why, how and where? We need to revert back to pedagogy. Two books by Richard Mayer: Learning as a generative activity; and Applying the science of learning are useful. Another book, Teaching as a design science is also important. This book is a first of its kind in terms of addressing education as a design science. Some disciplines are by necessity based upon design, i.e. civil engineering and architect. Biology was traditionally an analysis based discipline, prior to us being able to manipulate DNA and create new forms of life, but now is veering towards design. Similarly, chemistry too was a analysis science but now with creation of new composite materials and even elements this is no longer valid. Like these sciences the discipline of Teaching was traditionally looked upon through analysis: what are its problems; how learning takes place; when does it occur; when it doesn’t. From amyls we are now turning towards the actual design of education, an interesting and revolutionary change.


What is the probability of getting the statue if you keep?
Come and Discover !


Now find the probability when you keep and when you switch your choice
The probability of finding the statue!
Come and Discover !


LEARNING
as a Generative Activity
Eight Learning Strategies That Promote Understanding
LOGAN FIORELLA
RICHARD E. MAYER


Applying the Science of
LEARNING
Richard E. Mayer


Teaching as a
Design Science
Building Pedagogical
Patterns for Learning and Technology
Diana Laurillard

Topic 128

Measuring Learning

We begin with a small recap. In the previous module we had discussed a class response system. This was a low cost, technological, solution for gauging targeted student progress. For instance, their foundation knowledge; understanding of a particular concept, after it has been taught to them; and as they finish with a class. The limitations of a classroom response system were also discussed; in relation to the multiple choice format and the tendency of students to converge towards an answer, whether right or wrong. This convergence takes place when students are allowed to discuss a problem in attempting to solve it based on rational logic and innovative thinking. The answer lies not in eliminating technology but the induction of more technology, intelligent technology.

If students are provided with open ended questions, as done previously; why are their days and night? Also the students are allowed to use whatever source they consider appropriate; internet, discussions with friends, their cell phones, etc., what impedes the learning process in their arriving at the right conclusion. We need to understand this process, for deployment of effective and efficient technology in education. The resources book we will utilize, development of the classroom response system, and peer instruction will follow in the next module.

Topic 129

Peer Instruction 1

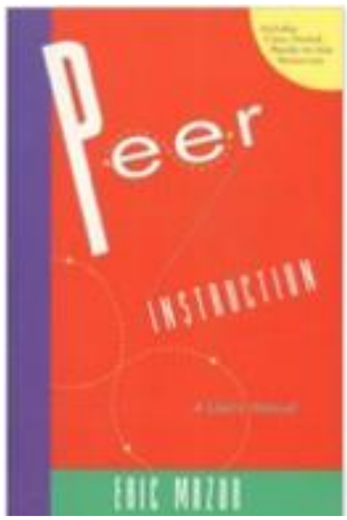
On the screen you can see an image of a book; Peer Instruction by Eric Mazur, a professor of physics at Harvard. Comments on the book at Amazon are also displayed. “If you have a class of 30, 40 or 50, you have problems in terms of participation of your students. “ A crucial obstacle in the learning process is, “If your students are not participating in your class or your lessons or if you would like to create useful discussions in class.” Another important point in terms of learning is; the teachers encouraging students in thinking through problems in class. This creates a fun environment which is conducive to learning and discovery. “By which your students can develop their conceptual understanding of physics. This book will serve as a great resource for teacher.”

Similarly, the publisher note states: “Peer Instruction is an interactive teaching style that actively involves students in the learning process by focusing attention on underlying concepts through interactive “Concept Tests", reading quizzes, and conceptual exam questions. Results, assessed through scores on the Force Concept Inventory and final exams, show that students better understand concepts and perform better on conventional problems in this environment. It can be easily adapted to fit individual lecture styles and used with any textbook. Eric Mazur's Peer Instruction approach has been successfully field-tested in a variety of settings.” The interactivity is critical, since teaching should not be in the form of a monologue. For every ten minutes spent on teaching ten minutes should be set aside for discussion between the students and the teacher.

Topic 130

Peer Instruction 2

Eriz Mazur in his autobiography, in which he had the conviction to address his weaknesses, had this to say: “I have been teaching an introductory physics course to science majors in Harvard since 1984.” “Until 1990, I taught a conventional course consisting of lectures and classroom demonstrations. I was generally satisfied by my teaching. My students did well on what I considered difficult problems. All seemed right and the students evaluations received were positive.” From a normal perspective, this was Harvard, and learning seemed to be taking place in a rational manner based upon critical thinking. “As far as I knew, there were not many problems in my class. In 1990 however I came across a series of articles by Hestenus and Hallom? That really opened my eyes. A strange thing that these famous professor’s eyes are opened: sadly a fact which doesn’t happen in our case. “As is well known students enter their first physics course, possessing strong beliefs and intuitions, about common physics and common physical phenomena. The notions are derived from personal experience and color student’s interpretation of material presented in the introductory course.” Based on the paper by the two students; instruction does little to change these commonsense beliefs. A popular Harvard professor was challenged by two students. “For example after a couple of months of physics instructions all students can recite Newton’s Law, and most can apply this is in numerical problems.” Again an example of formula based thinking. “A little probing, however quickly shows that many students do not understand the basic law.” The basic essence of the law! The two students provided many examples, in which students asked to compare forces exerted by different objects on one another. “For instance when asked to compare forces in a collision between a heavy truck and a light car; many students firmly believe that the heavy truck exerts a larger force." "On reading this my reaction was not my students", professor Mazur stated. But the seeds of doubt were planted in his head.



Topic 131

Peer Instruction 3

I am quoting an interesting story here, “Intrigued, I decided to test my student’s conceptual understanding, as well as that of physics majors at Harvard.” He met with the two students. At the time he was teaching engineering students about circuits. This was rather complex since it entailed nodes, batteries, loops and load for which simultaneous equations needed to be derived. The questions at the back of the text book were all related to this. Setting this aside a simpler question was devised; a battery was connected to two bulbs, with two switches and a two lop circuit. No resistance values, which were the bulbs infact, were provided; also no value for the battery was provided. On seeing this; the professor enquired if giving them an engineering problem or a simple circuit analysis, which could be handled by an electrician? The problem was now that if one of the switches was closed and other turned on; what impact would this have on the intensity of the bulbs, if lit and what bulb would be lit and other turned off? Eric Mazur was amused and thought this was probably a child’s play. On the question being put to class; a majority failed comprehend the problem. One students said that while being taught circuit analysis, their training entailed solving equations where resistance values were provided, here only bulbs, voltages given and determination of the flow of current was required, not if the bulb was lit or not. How do we start?

Mazur’s eyes were opened and he realized a serious issue existed. The students were just being made into calculating automations. Their thinking process stopped. After this he wrote this book, started experimenting and researching into the problem. The intuitive understanding that teachers cannot explain a lot things, which may appear simple and commonsensical to them, despite repeating themselves was evident.

In the development of classroom response systems it was discovered that inter-peer exchange was entirely different from how the professor communicated with students. It was easier for students to explain the problem to each other. In comparison the teacher just repeated himself/her.

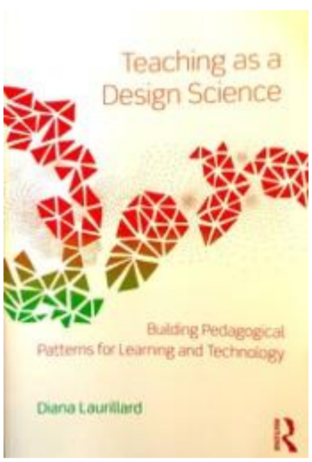
Topic 132

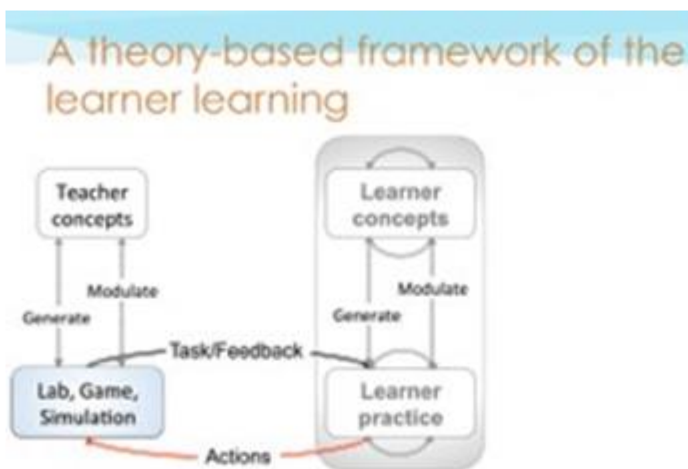
Back to the Basics

The only way out is to go back to basics – in terms of learning. Despite the fact that this course is about technology we go back to the basic question of learning: why people learn and why they do not. A new addition to the earlier discussed books, from which you see a model here: on one side of the equation is a student/learner, on the other a teacher/automated learning system. “Information/learning occurs through acquisition or instructional learning though enquiry.” This can be done through various mediums; lectures, videos, demonstrations, etc. In this interaction there is transference of knowledge. But knowledge is not sufficient. Students have to do something actively to understand, as propounded in constructivist theory. It could be in the form of a thought experiment, an experiment or some activity by hand. This lead to a modification in thinking processes (assimilation); generation of new connections, disassociating from earlier associations (integration) and the formulation of new questions. Based on these questions the student revisits the original problem. This forms a closed loop/cycle. This is an internal and individual process. Ultimately through this rational and intuitive basis he arrives at a conclusion, which may be wrong or right.

Moving ahead in the next scenario the teacher, whether a human being or intelligent technological program, is interacting with the student – the feedback loop is completed. The teacher is aware of how the student arrived at a conclusion, wrong or right. On this basis the conceptual understanding can be modified. This is entirely the function of this course, i.e. how technology can alleviate the misunderstanding in learning. Earlier we had tackled questions of difference in day and night, summer and winters as examples. Through technology a simulation can be presented, which actually illustrates the problem. From this the earlier knowledge, based upon preconceived notions, can be altered. Here we do not say that a person is wrong. Rather new evidence can be presented which provides new insights and challenges our earlier assumptions: sending us in new directions which were earlier closed. Through this simulation, which is also fun, you can interactively play and change various variables to see the actual effects upon the results, i.e. the tilt of the earth, its orbit, etc. This allows for the integration of knowledge intuitively upon which both hemispheres of your brains agree. This innovation through which new knowledge is acquired is essential for learning. Rote learning is not done as in the past. Technology allow for the realization of the objective: one student one teacher.

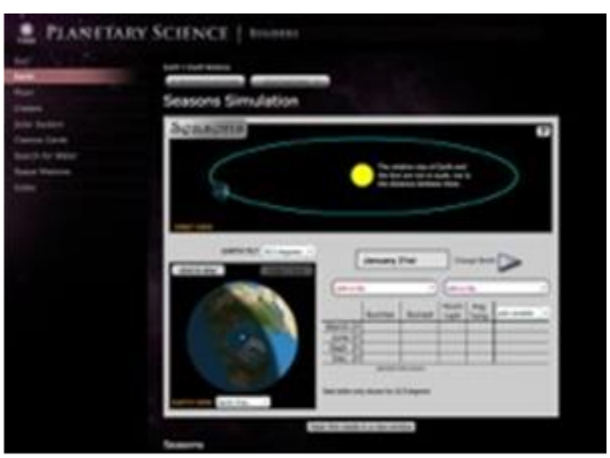
How the teacher enters the students mind and gaining an understanding of what prevents a student from learning and its rectification is critical. As with any individual no two students are alike. Each has an own unique learning style; visual, auditory, verbal, etc. These needs to be understood: the task is not daunting as appears, since for a 1,000 students there would only be 10 to 12 learning obstacles/styles. The greatest defect with conventional schooling is the assumption that one size fits all. Teachers due to the paucity of time cannot pay individualized attention to each student- whatever the institution.






Organizing
Sensory memory
Working memory
Design
Long term Memory Prior Knowledge
A body moving at constant speed in a circle?


Multi Media Instruction
Sensory Memory
All Action Taking place here
Working Memory
Long Term Memory
Words
Video
Pictures
Ears
Eyes
Selecting words
Selecting images
Sounds
Images
Organizing words
Organizing pictures
Verbal
Pictorial
Integrate
Prior Knowledge
Design
Organizing
Feedback
Compare
Learning Outcomes
Learning Objectives


PLANETARY SCIENCE
Seasons Simulation


ASTRONOMY
Seasons Interactive

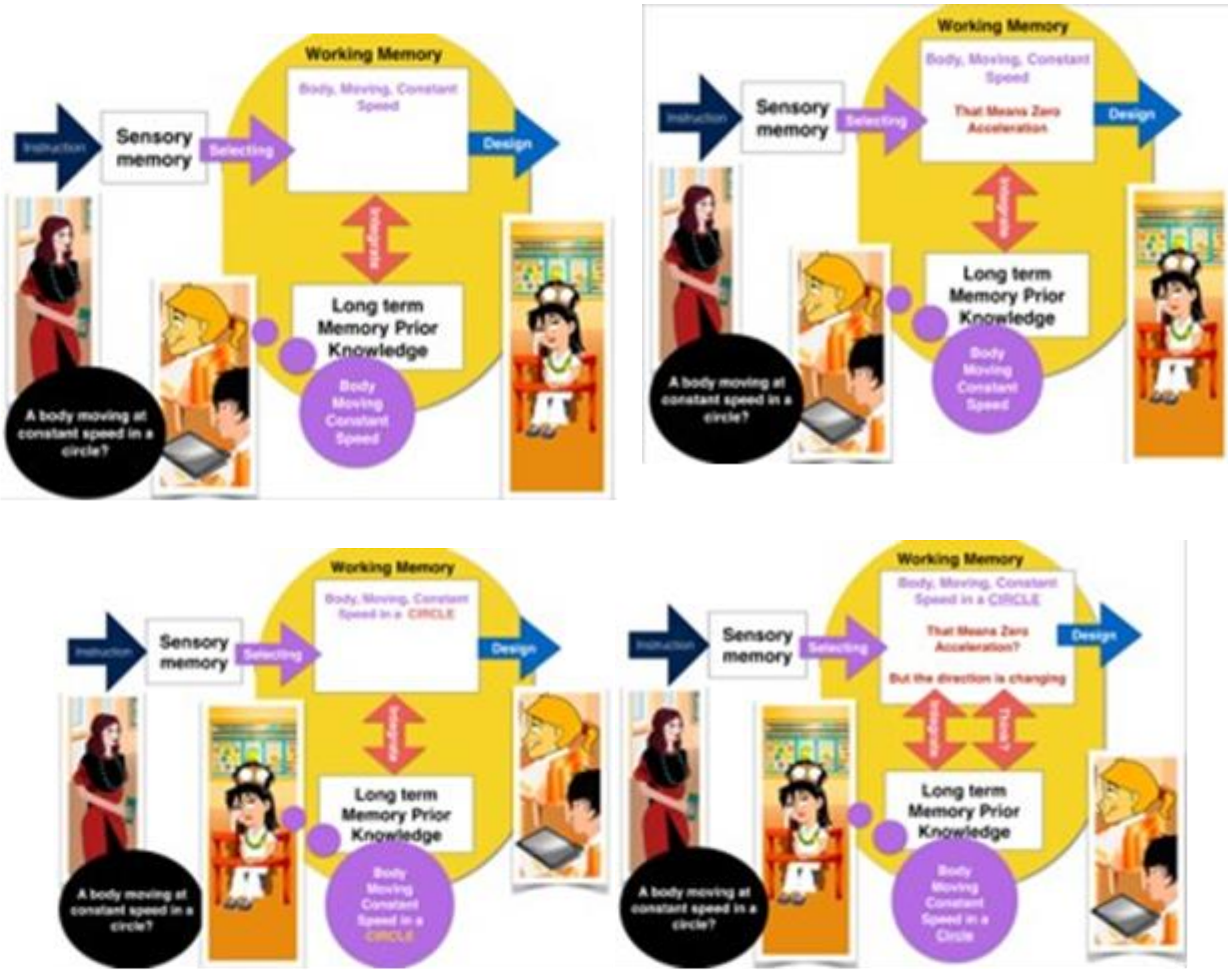

Sensory memory
Organizing
Working memory
Design
Long term Memory Prior Knowledge
A body moving at constant speed in a circle?
Sensory memory
Organizing
Working memory
Design
Long term Memory Prior Knowledge
A body moving at constant speed in a circle?

Topic 133

Learning Styles 1

In the earlier picture, shown here; a student attempts to discover, question, sort out his contradictions and confusion on his own. Whether it is through books, web or simulations: in this he might be successful or not. The second model, in comparison, involved the use of an intelligent learning application, which is compatible with his unique learning style. The onus of learning is not on the student, it is the teacher's duty through the use of technology to understand a student's learning roadblocks. Importantly, the student is not contradicted rather guided and led to modify his thinking processes.

Here we present four different models from four different book; that illustrate how we can affect a child's thinking. In the first scenario a fashionable teachers poses a problem on the blackboard, concerning a body moving in a circle at constant speed. While the student's sensory memory absorbs this input, his working memory starts arriving at conclusion, in the background. The new picture painted, if based upon a rational and logical process passes to the long term memory. But this leaves large gaps and loopholes in the newly acquired knowledge. In the second model, Eric Mazur, inter-peer discussion occurs. Even in this model the teacher or a learning application; still not aware of what is transpiring in a student's mind. For instance when a girl hears the problem, what comes to her mind? The girl only picks up on the words; body, moving, and constant speed. An activity occurs in her mind in an attempt to organize this information. The conclusion reinforced and arrived at; that is subsequently passed to the long term memory is that of zero acceleration. Is this what the teacher was trying to communicate? This is a common occurrence; students during lectures miss out on numerous minor details which result in major misunderstandings. Even illustrating a problem is better than pure verbal communication.

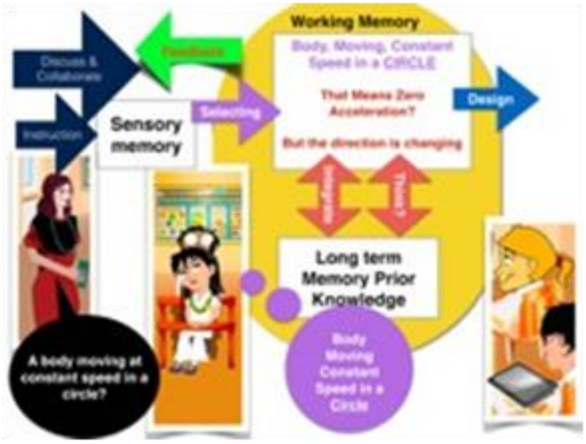


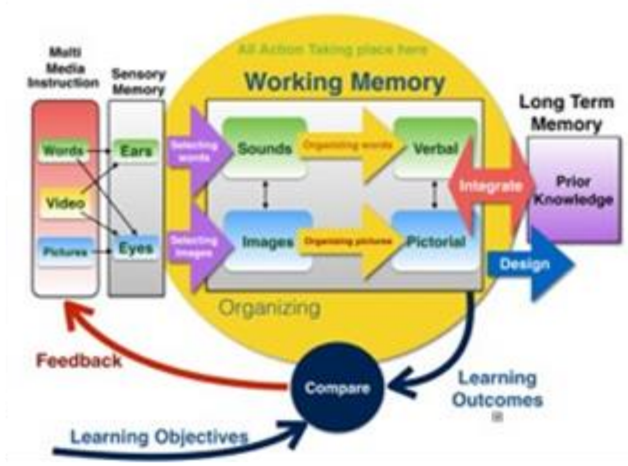
Topic 134

Learning Styles 2

Another student upon hearing the same problem also incorporates the word circle in his short terms memory. Here based upon his earlier experiences his thinking is modulated and a new picture painted. He too arrives at conclusion of zero acceleration, upon attempting to integrate this into his long term memory a conflict arises. His earlier knowledge, that the body is changing directions continually, creates this conflict. A learning, that a teacher or a learning application needs to highlight, i.e. remembers the body is moving in a circle. Due to this conflict in the students mind, arrives at a different conclusion. Here the answer lies in not providing an answer but repeatedly addressing the factors which create this misunderstanding. Perhaps it might be shown by an illustrative drawings or a concept map.

Moving to the next model, the internal processes within a student's mind, short term memory, are described in details in the boxes seen. Naturally, this has greater utility in designing a learning application. In terms of presentation sequentially a multimedia presentation would be preferred. If solely listening to a lecture some information missed. If a picture or diagram is presented it is better and finally the form of a movie would be more effective. Through these media all this sensory information; sound converted to verbal data and images, would be integrated through linkages to prior knowledge. An important consideration that in this system there is a built in feedback loop, which allows you to gauge student misunderstandings, through the use of technology. Is there a discrepancy between, learning objectives and outcomes? Once the information is passed to the long terms memory, a student's behavior would change, when tackling new problems. If the desired outcome is still not achieved, feedback is gathered and the mode of presentation of the problem altered.


Working Memory
Discuss & Collaborate
Instruction
Sensory memory
Selecting
Body, Moving, Constant Speed in a CIRCLE
That Means Zero Acceleration?
But the direction is changing
Design
Integrate
Long term Memory Prior Knowledge
A body moving at constant speed in a circle?
Body Moving Constant Speed in a Circle


Multi Media Instruction
Sensory Memory
All Action Taking place here
Working Memory
Long Term Memory
Words
Video
Pictures
Ears
Eyes
Selecting words
Selecting images
Sounds
Images
Organizing words
Organizing pictures
Verbal
Pictorial
Integrate
Prior Knowledge
Design
Organizing
Feedback
Compare
Learning Outcomes
Learning Objectives

Topic 135

Another Quiz

Now we share a quiz, which was recently taken for computer science university students. The questions asked were rather simple. The answers, while not wrong - a separate debate, were really eye opening. The entire exercise learning was experience for me. The objective of the exercise was to understand limitation and strengths of thinking, classroom response systems and peer- discussion. As mentioned earlier the Harvard Gazette, under the headline which stated: Teaching teachers what kids are not learning, it goes on to mention: “that if you graduated from Harvard do you think you would know why it is warmer in the summer than in the winter? Educators who surveyed Harvard students, on their graduation day in 1986, discovered that most of them could not answer this question correctly.” Not because the students were not intelligent or their professors. Rather it was a case of how students think. Our initial and common assumption that students do not want to learn, is totally wrong. The failure is on our part in not assisting them in learning. When you arrive at a conclusion in your mind there are repercussions, are you ready to deal with these. For instance of our earlier example; a body moving in a circle at constant speed and acceleration is zero. If the repercussion negates your understanding, it needs to be reconciled and your hypothesis rethought. We have never attempted this, to see if there is a flaw in their thinking. The process and voyage of thought not undertaken. Initially they need to be guided through this process, much like a child learns to walk holding a parents hand. Later he can walk, run and jump on his own.

The following quiz problems were given, which were conceptual in nature and linked to Newton’s laws, quite commonly known – or so assumed by people. But the litmus test is of the ability to apply these laws.

1. A car is moving in a straight line on the motorway, with the speedometer reading a constant 40km/h. No mention of velocity. Will there be any force needed or fuel consumed to keep the car moving?

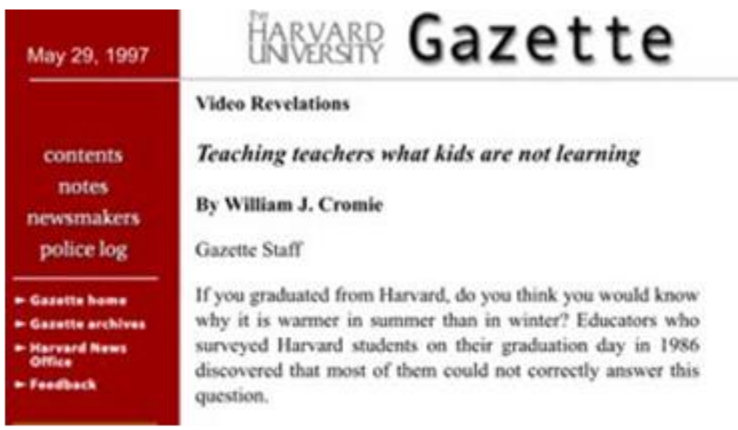
    Now Newton's laws contain no mention of fuel consumption also its applicability in real life is not that simple. If the speed is constant is velocity also constant? Straight line, constant speed and other variables are all churning a person's mind – working memory. An assumption would be that if the speed on the speedometer is constant than speed should also be constant. If moving in one direction than velocity should also be constant; would this imply acceleration also constant? No fuel being consumed? Would acceleration be constant or zero? if zero than no fuel consumed. It would appear so but in reality fuel is being consumed. Can these contradictions be resolved: these needs to be checked?

2. A car is turning with the speedo meter reading a constant 40km/h. Would there be any fuel consumption? A situation which happens when you take an exit from the motorway, which are quite circuitous. Again the question is whether there will be acceleration or not.

    If you observe these problems are descriptive in nature and no calculations are required.

Now if we introduce two new variables that the road is frictionless and there is no resistance for the two earlier problems; will there be acceleration and fuel consumption? Are Newton's laws applicable for all or none; or apply in a particular case? This type of questioning generates a lot of turmoil in a student's mind. This curiosity leads him to revisit the earlier problem and compare his earlier assumptions and answers. Generation of this curiosity needs to be part of any learning applications we design.

The last question involved equations. All these university students had handled equations, very complex ones, earlier. First they were shown this equation $a^2+b^2=c^2$. What picture came to their minds? Next they were shown $x^2+y^2=r^2$ and finally $a^2-b^2=-c^2$. Again the question was asked, as to what came to their minds? What was their long term memory communicating to their working memory? These problems are also posted on my Facebook page. As you would realize these types of problems cannot be used for classroom response systems; which is based upon a multiple choice format. The advantage of descriptive problems is that, since you have to provide a rational, you begin to see a picture of what is in a student's mind. This can be followed up with detail meetings. The results which we will share with you were very interesting. After forty years of doing this, I can still be surprised. The requirement of technology, for determining individual thinking styles: become apparent and an imperative. The journey of these students to where they now stand needs to be analyzed.


May 29, 1997

The HARVARD UNIVERSITY Gazette

contents
notes
newsmakers
police log

► Gazette home
► Gazette archives
► Harvard News Office
► Feedback

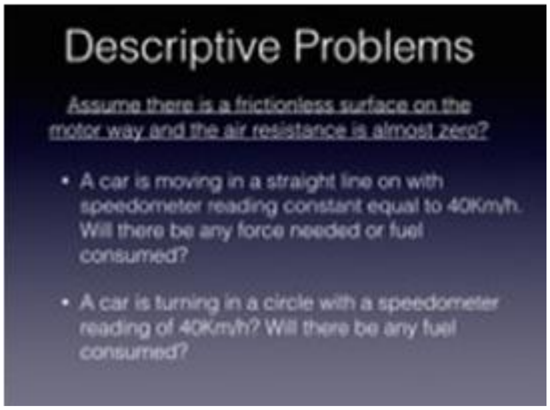
Video Revelations

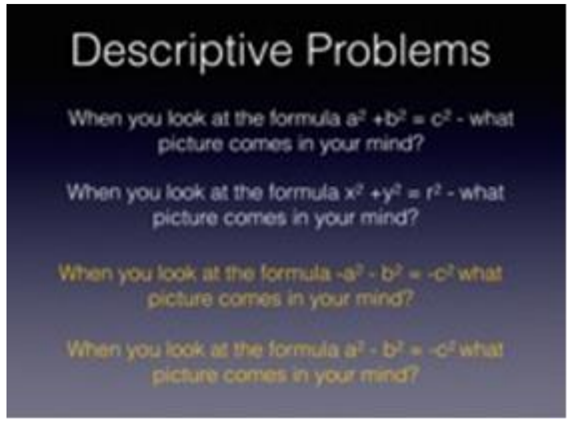
Teaching teachers what kids are not learning

By William J. Cromie

Gazette Staff

If you graduated from Harvard, do you think you would know why it is warmer in summer than in winter? Educators who surveyed Harvard students on their graduation day in 1986 discovered that most of them could not correctly answer this question.

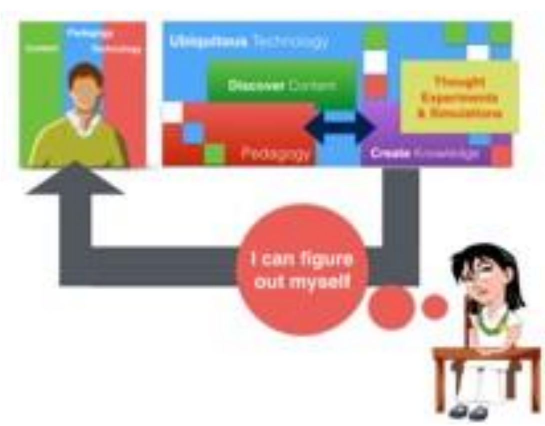

Descriptive Problems
Assume there is a frictionless surface on the motor way and the air resistance is almost zero?
• A car is moving in a straight line on with speedometer reading constant equal to 40Km/h. Will there be any force needed or fuel consumed?
• A car is turning in a circle with a speedometer reading of 40Km/h? Will there be any fuel consumed?

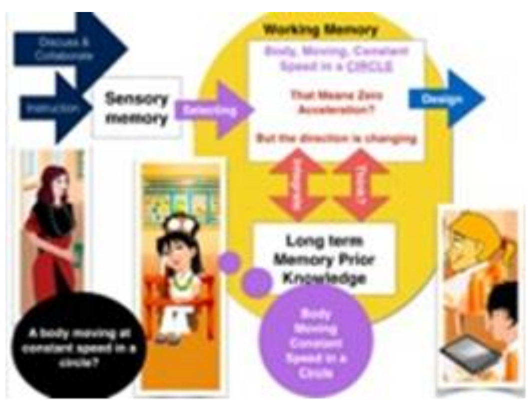

Descriptive Problems
When you look at the formula $a^2 + b^2 = c^2$ - what picture comes in your mind?
When you look at the formula $x^2 + y^2 = r^2$ - what picture comes in your mind?
When you look at the formula $-a^2 - b^2 = -c^2$ what picture comes in your mind?
When you look at the formula $a^2 - b^2 = -c^2$ what picture comes in your mind?

Topic 136

Teaching Teachers 1

Last time we had discussed a current course which I am teaching on thinking. We had given certain descriptive questions to university students. The results were surprising to say the least. Any weaknesses were entirely due to the system and not a personal failing. We will look at each answer, to the earlier questions posed, to diagnose where learning breakdown was occurring. This analysis is essential for any educational design; whether a lecture or a learning application. The basic answers were in a yes or no format and the students allowed to discuss the problem with their peers, use the web, book, or whatever resource required. The answers not only to what but critically why is essential. These descriptive answers are useful in developing any learning application. The task is not as taxing since, as mentioned earlier, from a sample of a 1000 students the standard learning styles or common mistakes would fall under 10 to 12 categories.





Topic 137

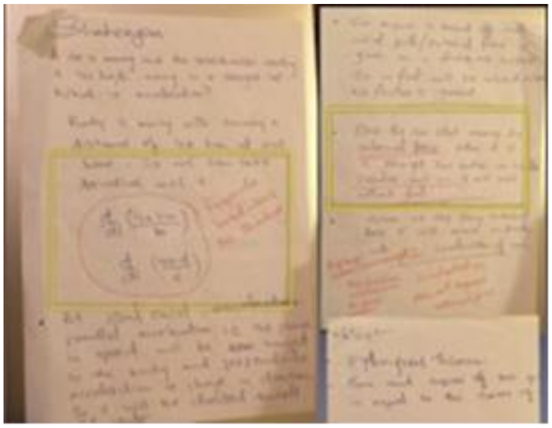
Teaching Teachers 2

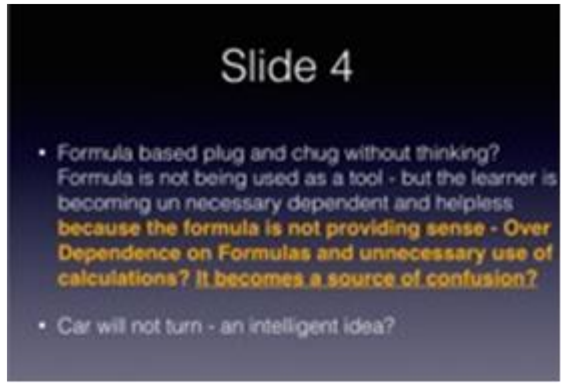
You have seen this picture earlier. On being given the quiz and have gone through it, selective verbal cues/words came to the student's mind: a car; 40 km/h; constant speed. With these words a picture is formed in their working memory. Will fuel be used and force applied? Linkages are created in the student's mind based upon prior knowledge. The creation of this feedback loop is essential; without which learning cannot take place. This point needs to be retained and will greatly assist in educational design.

In the first slide a student's response is as follows: utilizing conventional wisdom arrives at the conclusion; no acceleration and consequently no fuel consumed. This appears to be contrary to conventional wisdom, i.e. fuel consumed. Also there seems to be confusion in terms of constant velocity and speed as shown by the speedometer. If no acceleration than F=ma and force exerted is zero. The belief, that if no acceleration no force, is a common part of physics conventional wisdom. This point needs to be put across to the students repeatedly. In reality while driving on the motorway at a constant speed, fuel is consumed. This creates a conflict in terms of observation compared to what science taught; cognitive disequilibrium occurs. A desirable state, in terms of learning, and if it does not occur has to be induced artificially.

The student also links acceleration to the application of car brakes, i.e. no brakes are applied. Extending this logic he states that no acceleration while the car turns: turning at a constant speed hence no acceleration. This is a worrying thought for the teacher. The picture in the student's minds shows he equates acceleration with the screeching of tires and the use of brakes.

There is another issue with problem formulation; one is not able to think of certain things, that student's come up with: a fact by which their intelligence can be gauged. A point in case; when a car is turning or traveling in a straight line on a frictionless surface, it wheels should not be moving. Without friction and air resistance this is technically correct; the car would be sliding/gliding. Also, in the scenario if you tried turning the car, using the steering wheel, it would not turn. Despite the fact that the students made some basic mistakes, this point was one which personally one could not think of. From this quiz it was evident that there were flaws in how they were taught, but they are still using their brains. The fault lies with us and not them.




Slide 4
Formula based plug and chug without thinking? Formula is not being used as a tool - but the learner is becoming un necessary dependent and helpless because the formula is not providing sense - Over Dependence on Formulas and unnecessary use of calculations? It becomes a source of confusion?
Car will not turn - an intelligent idea?

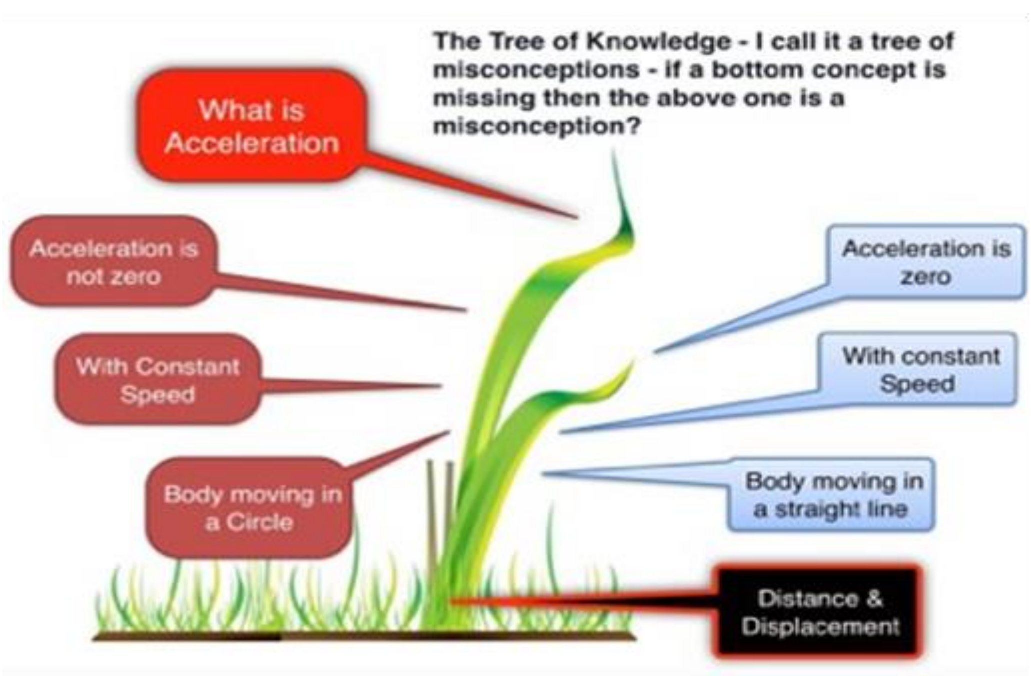
Topic 138

Teaching Teachers 3

In the second slide acceleration is zero because velocity is constant. This answer was apparently based on intuition, since no applicable formula used. This illustrates the lack of cognitive disequilibrium, no conflict apparent, something which might have to be induced artificially. In the case where the car was turning, the acceleration was assumed to be zero, since constant velocity. The same mistake is done as for the earlier example; perhaps confusion between speed and velocity. Here velocity is not constant, which varies, rather speed is constant. Another background factor, in his mind, could be that turning does not involve acceleration. Another mistake, in the third problem, where the car is travelling in a straight line and there is no friction or air resistance, is that there would be no opposing forces. This naturally implies no friction, no acceleration and consequently no fuel consumption. The student also states that the car will not turn on a frictionless surface, an intelligent observation. Based on the answer, we presume, that the student is thinking; on a frictionless surface where there is no air resistance, a car can travel in a straight line but cannot turn.

The point, that there are no opposing forces, as in space where a vehicle can travel in a straight line but would require force to turn, is quite startling. Discussing this with other professors they were equally surprised. Conventional wisdom dictates that upon turning, force comes into play. But what is the opposing force in turning which we need to overcome, and which cannot be seen? While friction can be seen, and requires force to overcome it.

In the third slide we find a demonstration of conventional wisdom, where a formula based interpretation is attempted without the requisite thought process. A formula only helps when a model based on rational thought is developed earlier. No formulas are required for understanding the basic problem; here an inverse approach was taken. Naturally, this approach leads to confusion at a later stage. The differential arrived at, 40km/h, for calculating acceleration apparently derives from this approach. Assuming velocity at 40km/ hr, differentiating for acceleration, they arrive at 40*d/t, which is entirely meaningless. A significant majority took this approach of hiding behind a formula. Once the car starts moving, by external forces, either in a straight line or circular it will move without consuming fuel. Even if there is a frictionless environment we need to differentiate between straight line motion and circular – a serious misconception. When a car is moving due to external force, in a straight line or a circular motion, it will not consume any fuel, since no resistant opposing force. As the earth orbits the sun, does it require any force? In space there is a vacuum and no friction or air, so no force required. Similarly, for the earth to spin on its axis, is any external force required?



Topic 139

Teaching Teachers 4

With slide four, diagrams pertaining to how learning occurs are also shown and need to be remembered as reference. Here the student again resorts to formulaic learning, but in this instance could not apply the formula correctly. He states that acceleration will be constant in a straight line, while when turning acceleration decreases. Here the formula provides his with the wrong conclusion. From his answer it also apparent that there is no internal conflict in his mind – formula versus logic. The student was called in for an interview. He explained that he wanted to write speed instead of acceleration. His logic was based on his parents continually telling him to slow down while driving and taking turns. A fact which was ingrained in his mind and when he was noting the problem had difficulty in understanding – mental training.

A car is turning at 40km/h, without air or friction, the assumption that car can only go in a straight line and not turn, since wheels not moving: much like space where an object will continue in a straight line at constant speed and can only turn if force applied – a technically correct and an intelligent observation. This is an example of formula based, plug and chug thinking; where the formula is not being used as a tool but the learner is becoming unnecessarily dependent and helpless because of over-reliance on its use. An over- dependence upon formulas and unnecessary use of calculations becomes a source of confusion. That the car will not turn is an intelligent insight. Not sure if the thought process behind this valid since the student applies this even when a force is present.

In this new slide a case of inability to solve a contradiction. What problem of learning does this imply? Do we train them to resolve contradictions? The use of the formula $\Delta V/\Delta T$ is right, but since not aware of definition of acceleration, states that it is decreasing. But if the formula had been used correctly he would have derived a value of zero for acceleration, which would be correct. Instead he based his answer on car turning upon intuition. Since the quiz was based on open textbook format, he could have gotten this information. Or for that matter from other students since discussion was allowed. In this case he the educational system had equipped him with the right tools but his application, a small step, was lacking.

Pedagogically he should have gotten a hint when employing the two methodologies; some dichotomy since two different answers. It is critical to try solving a problem through a multipronged approach. If there is a conflict, in terms of answers, a red flag should be raised and revisiting of the problem required in determining where the problem lies. This is a great flaw in our educational system. If we want to create learning designs, applications, lectures or blended form; training in utilizing a multipronged approach is required. Finding a contradiction is a step forward, in fact the first step in learning.

Topic 140

Teaching Teachers 5

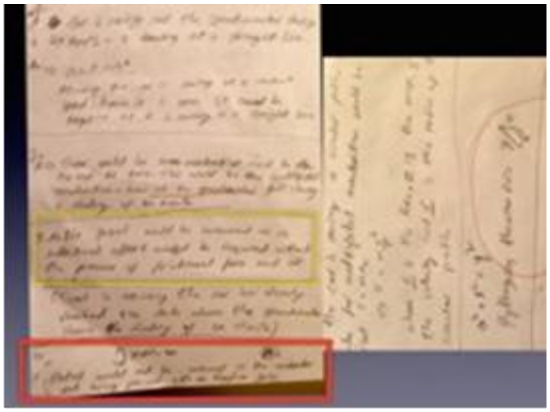
Contradiction, friction, conflict, cognitive disequilibrium all lead to meaningful learning. Resolving a contradiction is ultimate means to learn. It is important for us to allow students to explore several paths towards the same problem – rote learning has no place. If this is the case then the students' needs to be provoked in finding or towards a new path, that intuitively appears correct but is in reality not. The underlying point is to force a student to appreciate and understand the rationale behind his answer.

Earlier we had discussed the case of students whose mind was so conditioned, decreasing acceleration when turning, that his working memory fails to register what is being asked. Similarly, in this another case the student assumes, if velocity is constant then acceleration too is constant. A common mistake, most students assumes that when dealing with linear values, applicable across the board. Also if constant then all values constant; based on this his assumption that while turning a car must slow down. Prior experience of actual driving overrides his understanding of the problem statement.

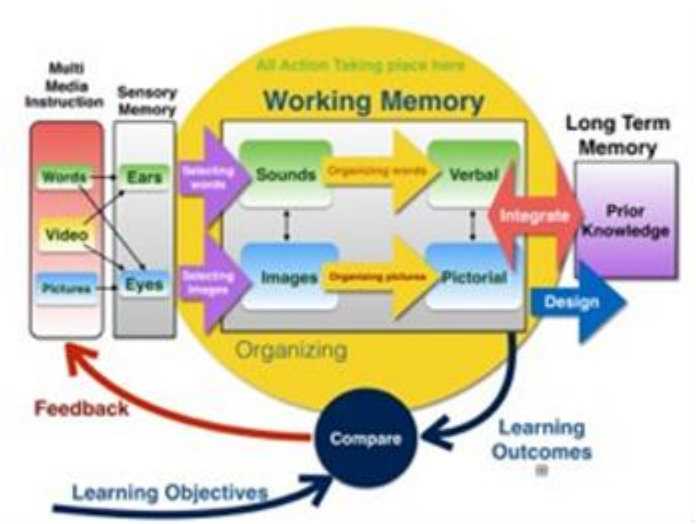
In the next slide we again see a case of formula plug and chug, without thinking: leading to results which are absurd. The student does not understand differentiation of a constant value. He might be aware of differentiation and can probably solve complex problems, but fails to understand what differentiating a constant implies; an approach reflective of overdependence upon formulas. In the second part concerning frictionless surface: again hindered by the use of a formula. For acceleration a formula based on Newton's law, F=MA is used. The other conclusion, intuition based, derived is that no fuel would be consumed since, no opposing force. Both approaches are contradictory since if force acceleration can be calculated – a slave to formula. As Einstein said, the greatest hindrance to his discoveries was his education. This is one of the major flaws in our education system, which impedes the thinking and understanding faculty of the students. On a personal level I have found that one has to make students de-learn for further progress.

In the next example, the student uses the formula $s=1/2at^2$. Since distance is not known assumes 40 km and time as one hour. This is another common mistake where the applicability of the formula is not understood. Under what conditions and case does this formula apply? Another interesting approach, which is quite prevalent, used by students, entails use of Pythagoras. The formula $a^2+b^2=c^2$ is used. Where a is assumed to be the base, b the height and c the hypotenuse, for a right angled triangle. The c is then replaced by r (radius) to derive an equation of the circle, concerning circular motion. The variable utilized is different, but the same approach that is utilized by many students. What they fail to understand is r constant, a cause of conern????

Moving to the next slide, eight, we see a case of using the wrong the formula but arriving at the right answer. The formula in question is $a=v/t$, i.e. of velocity is constant so is acceleration. The student fails to comprehend differential over time. An error: arising out of earlier faulty understanding in mathematics or calculus. The contradiction in his answers is apparent. The derivation of acceleration as zero is based on intuition and not the formula used. If the formulaic approach had been carried out to its conclusion, acceleration would have been finite. The anomaly between the formula and answer should have caused a red flag in his mind. A common misconception is that no fuel is used since frictionless surface. Why is that we require force to overcome friction but not for the car to turn?




Slide 14
If there is no friction then there is no acceleration?
A Serious Misconception? Implies that turning without friction is possible without force?


Multi Media Instruction
Sensory Memory
All Action Taking place here
Working Memory
Long Term Memory
Words
Video
Pictures
Ears
Eyes
Selecting words
Selecting images
Sounds
Images
Organizing words
Organizing pictures
Verbal
Pictorial
Integrate
Prior Knowledge
Design
Organizing
Feedback
Compare
Learning Outcomes
Learning Objectives

Topic 141

Teaching Teachers 6

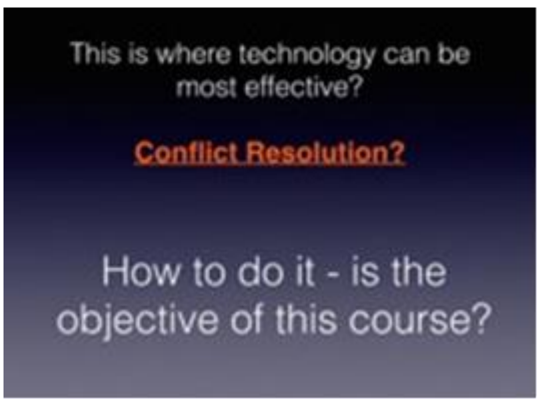
The assumption is understandable since if a car travelling in straight line and no friction or air resistance and hence no opposing force, why should it be different while turning. A similar problem to why earth orbits around the sun. Gravity needs to be taken into account. For students the inherent ability to think about consequence of their statements is missing. This common and prevalent misconception needs to be addressed when designing interactive learning applications. The assumption of constant velocity and hence no acceleration by the student in comparison to his real life observation to the existence of friction and air resistance shows that he is not entirely relying on what is taught. Unfortunately, whether teaching Newton’s laws, kinesics, the periodic table or cell structure, no effort is made to connect this new learning to everyday experiences.

This linkage to compare and apply needs to be encouraged. If a contradiction occurs the thinking process starts. The conclusion is derived that force is applied yet no acceleration is a failure of not understanding Newton’s laws. The student is not to blame and in the fact that if force, acceleration also present, he is partially correct. Fuel will be consumed at a constant velocity of 40km/hr. The fact that Newton’s laws are so counterintuitive, demonstrates Newton’s insight in arriving at them. In a laboratory environment it is impossible to create a frictionless surface and to negate air resistance a vacuum is required.

Topic 142

Teaching Teachers 7

A most serious pedagogical problem remains the ability of conflict resolution among students. Based on the previous examples we have seen that despite the availability of several methodologies, personal intuition and real life experiences; in using these and arriving at different conclusion the students are still unable to resolve this conflict. In any learning design and applications we need to introduce this conflict, provide student with various approaches, show how these are resolved and what were the wrong answers and why. Having undergone this process the student is not only aware of the right answer but the rationale behind it.



Topic 143

Analyzing the Learning Process

A small interlude before today's lecture: One way in which the East differs from the West is the strength of our relationships. A popular song, the link of which is provided, is as follows:

Jidhar bhi yae dekhaye,

jidhar bhi yae jaye

Tujhe hi dhonti hai yae pagal nighanye.

Tu jo nahi hai, kuch bhi nahi hai,

Ye mana kay mehfil jawan hai, haseen hai.

Main zinda hon lakin, kahan zindagi hai

Meri zindagi to kahan kho gayi hai.

Whatever they see, wherever they turn

These troubled eyes search only for you

If you aren't present nothing is

Agreed the gathering yet young and beauteous.

That I am alive, yet what life

Wonder where my life lost

We will discuss how this linked to our lecture later. In the earlier lectures we had discussed a quiz which was given to students to assess their learning. A car is travelling in a straight line and later turning at a constant 40km/hr. There is no friction or air resistance. The question then became; would there be any fuel consumption. Earlier we looked at some of the results. The purpose of this in-depth analysis was to diagnosis the breakdown in the learning process. In terms of our course and the use of technology, it is imperative that before its deployment, we have to understand a child's learning process. How they learn and how they fail to learn. We begin with a brief overview of the earlier results.

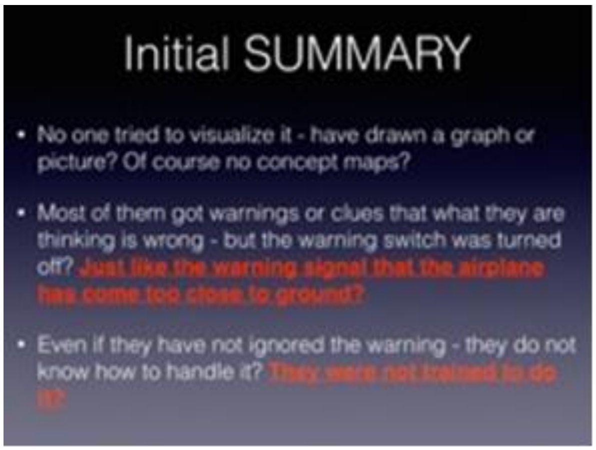
I. No one tried to visualize the problem and failed to grasp the bigger picture. No one attempted to depict the problem through a graph or a concept map.

II. Most of the student faced warning signals that their thinking was flawed. A single most common problem; yet these signals were unheeded. As is the case with aircrafts there is a warning alarm when they get too close to the ground, warning them to pull up. Failing which they plane could potentially crash. Similarly, failing to heed their internal warnings students' crash out of the educational system.

III. If they are able to register these warning signals, their inability to resolve these flaws is absent. A good example of this relationships, linked to our earlier rendition of a popular song: That I am alive, yet what life – wonder where my life lost.

We now turn to an excerpt from Zia Mohiuddin, a famous orator. On hearing the passage, if you pay attention, you will observe numerous warning signals. A lot it you will find hard to swallow and improbable. A doctor to the insane:

"The doctor for the insane asylum was examining new inmates. One of the patients appeared to well and in his senses." Upto this point there is nothing in the narrative which challenges your mind or creates a contradiction. "The doctor asked the patient, what the reason was for him being admitted since he appeared well. The patient replied he was healthy but recently got married." At this point you might think this might have been the cause, but marriage can only drive you half insane. "The woman I married had an eighteen year old daughter and she too started living with us." At this point some eyebrows maybe raised. "My father took a liking to this girl and got married.” Things appear to be clear to this point but the next part of the story is guaranteed to create incredulity in your minds. The startled neurons firing will point to something being wrong. The same applies to studies where mostly these signals are by students, leading to breakdown in learning.



پاگلوں کا ڈاکٹر

پاگل خانے کا ڈاکٹر نئے داخل ہونے والے مریضوں کا معائنہ کر رہا تھا۔ ایک پاگل اُسے سنجیدہ اور ہوش مند نظر آیا ۔ ڈاکٹر نے اسے پوچھا تمہیں یہاں کیوں لایا گیا ہے؟ تُم تو اچھے خاصے ہو۔ پاگل نے جواب دیا جناب میں صحت مند ہوں، ٹھیک ہوں ۔ دراصل ہوا یہ کہ میں نے ایک عورت سے شادی کر لی جس کی ایک اٹھارہ سال کی جوان لڑکی تھی، وہ بھی اپنی ماں کے ساتھ میرے گھر میں رہنے لگی۔ اتفاق سے وہ لڑکی میرے باپ کو پسند آ گئی اور اُس نے اُس سے نکاح کر لیا ۔ اُس دن سے میری بیوی میرے باپ کی ساس بن گئی ۔ کُچھ عرصے کے بعد میری بیوی کی لڑکی جو میرے باپ کی بیوی تھی کے ہاں اولاد ہوئی، یہ کہ رشتے کے لحاظ سے میرا بھائی ہوا کیوں کہ وہ میرے باپ کا لڑکا ہے۔ مگر اُدھر میری بیوی کا نواسہ بھی ہوا۔ گویا میں نے اپنے بھائی کا نانا بن گیا۔ کُچھ دنوں بعد میری بیوی کے ہاں بھی بچہ ہوا اُس دن سے میرے باپ کی بیوی سوتیلے بھائی کی بہن ہو گئی مگر وہ اُس کی دادی بھی ہو گئی، کیوں کہ وہ اُس کے شوہر یعنی میرے باپ کا پوتا تھا اسی طرح میرا بچہ اپنی دادی کا بھائی بن گیا ۔ اب ذرا سوچئے ! ڈاکٹر صاحب میری سوتیلی ماں یعنی میری بیوی کی لڑکی میرے بیٹے کی بہن بھی ہو گئی تو میرا بیٹا میرا ماموں بن گیا اور میں اُس کا بھانجا ۔ جبکہ میں خود اُس کا نانا بھی ہوں اور میرے باپ کا لڑکا جو میری بیوی کی لڑکی کا بیٹا ہے وہ میرا بھائی بھی ہے اور میرا نواسہ بھی۔

ڈاکٹر نے کہا خُدا کے واسطے بند کرو ورنہ میں پاگل ہو جاؤں گا۔

Topic 144

Family Ties

Since that day my wife became my father’s mother in-law” – surprising since not a normal relationship. “After sometime my wife’s daughter, who was also my father’s daughter had a child. According to relations my brother, since my father’s child but it is also my wife’s grandson. This was confusing since also my brother’s maternal uncle.” Try to understand this strand difficult without the help of a pedagogical aid is impossible. So here it gets even more complex. “In a few days my wife too had a son. From that day my father’s wife became a sister to step-bother, but also a paternal grandmother – confusing. Because of her husband, my father’s grandson, my son, became a brother to his parental grandmother. Now understand doctors, my stepmother, my wife’s daughter became my son’s sister; my son became my uncle and I his nephew. Wouldn’t this drive you crazy too? Since I am also his maternal grandfather, my father’s son, my wife’s son, is my brother and grandson. The doctor exclaimed I too will go crazy.”

This story should provide a parallel how a teacher teaches in class. The students if not taught through learning applications or a video have difficulty in matching the lecturers speed, in terms of assimilation of knowledge. The story also provides many warning signals signifying conflict. For example to understand a maternal uncle’s relationship; the sister has to be married and have a child. But a relationship like my wife my father’s in-law, seems hard to fathom. Despite its complexity a visual aid, graphical representation can perhaps simplify things to an extent. The complexity of the subject otherwise would lead to great agitation, friction and conflict in the mind which cannot be resolved.

Topic 145

Doctor to the Mad

Here we attempt to capture the complexity of "the doctor to the mad," through a graphical representation. Initially the relationships are quite simple. On one side is the picture of the father and the son, a natural relationship, on the other side a mother and her daughter; again a natural relationship. The man marries the divorced woman, as indicated by the arrow and who also has an eighteen year daughter from the previous marriage. The father of the man takes a liking to the daughter and they too get married. Things seem quite clear upto this point. That I and my wife become my father's in-laws: things start becoming confusing. When the man's father has a son, who now the man's brother and his wife's grandson, things become murkier. I also became a maternal grandfather to my brother. How is this possible? At this point there is friction and confusion in your mind. Continuing the man too has a son; now my father's wife becomes a stepsister to my son and also his parental grandmother. The brain tends to start losing grip; yet the graphical representation/pictures still provide a modicum of understanding.

We now turn toward our earlier dissection of student quizzes; concerning common misconceptions, problems of learning and why these occur. The assumption that acceleration is zero while turning, with friction or without, i.e. force is not required is a common misconception. For this to be resolved there need to be conflict artificially induced in the students mind. The problem is that the students fails to observe the holistic picture and does not ask the right questions.

In another answer, acceleration is still zero, since brakes are not used. At constant speed there is no acceleration: again a widespread confusion that turning requires no force. Technology can be utilized to artificially create a conflict in an attempt to surmount this misunderstanding.

With the aid of technology we will develop scenarios which would help in this. Why is this problem widespread; having diagnosed the problem we now need to look at its cure. Through many animations we can provide a signal to their brain that there is something inherently wrong with the answer.

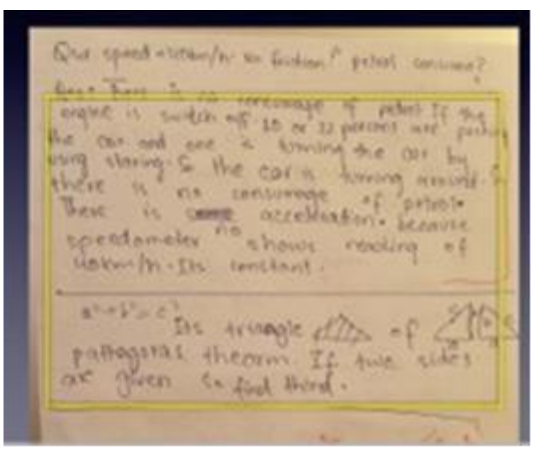
In another slide the plug and chug approach is seen; the wrong formula is used despite being and open textbook exam and discussions allowed. The remaining, more difficult problems are correct despite of not knowing the correct formula for acceleration. If enough educational research was done and these problems identified, these problems would not be so prevalent. The most widespread misconceptions are: circular motion without friction requires no acceleration; association of frictionless surface with no acceleration; and linked to this, no friction no opposing force, even in circular motion. Pedagogical theories tell us that if 10,000 children undergo an exam, there will be around ten or so common mistakes. If we are able to capture these mistakes and create the requisite conflict and have students resolve it, we can tackle the problems of learning. The students are not that far off since they cannot visualize force or intuitively justify it. Especially, relevant in case where turning, since there is no opposing force. There confusion is genuine, for example if a body is moving in space at constant speed no force is required since no gravity. Only if you try to stop or provide acceleration to the body will force be required. “You have not seen it or experienced it, especially in power steered cars: although the car has a tendency to come out of the circle and move in a tangent to it.”

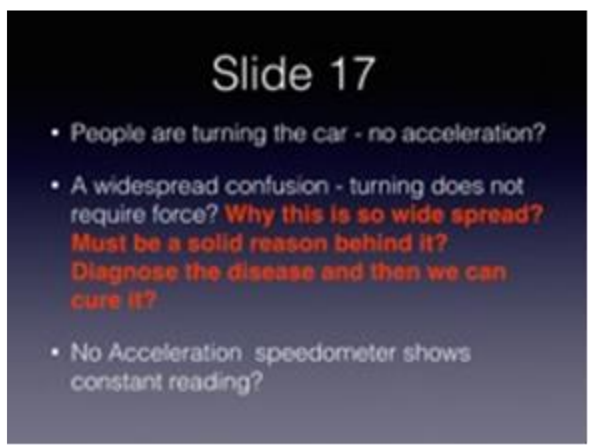
From the descriptive problems provided in the earlier discussed quiz; most people aware of formulas and also possess common sense, yet they fail to understand the problem or try to visualize the big picture. In terms of technology we have to ensure understanding: what inputs and outputs; appropriate methodologies from different angles and intuitive understanding.

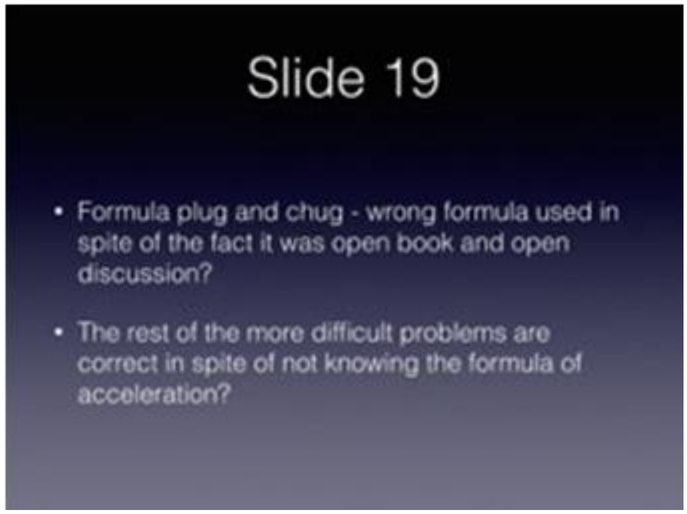

میری بیوی
میں
میرے باپ کی ساس

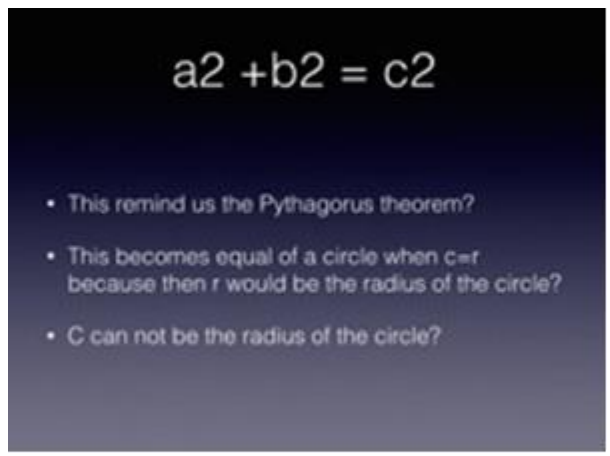

میری بیوی
میں
باپ کی بیوی سوتیلی بھائی کی بہن
سوتیلی بھائی کی دادی
سوتیلی بھائی


میری بیوی
میں
میری بیوی کا نواسا -میں اپنے بھائی کا نانا بن گیا


engine is switch off 10 or 12 persons are pushing the car and one is turning the car by using staring. So the car is turning around.
there is no consumption of petrol.
There is no acceleration. because speedometer shows reading of 120km/h. Its constant.
Its triangle of pathagoras theorem. If two sides are given so find third.


Slide 17
• People are turning the car - no acceleration?
• A widespread confusion - turning does not require force? Why this is so wide spread? Must be a solid reason behind it? Diagnose the disease and then we can cure it?
• No Acceleration speedometer shows constant reading?


Slide 19
Formula plug and chug - wrong formula used in spite of the fact it was open book and open discussion?
The rest of the more difficult problems are correct in spite of not knowing the formula of acceleration?


a2 +b2 = c2
This remind us the Pythagorus theorem?
This becomes equal of a circle when c=r because then r would be the radius of the circle?
C can not be the radius of the circle?

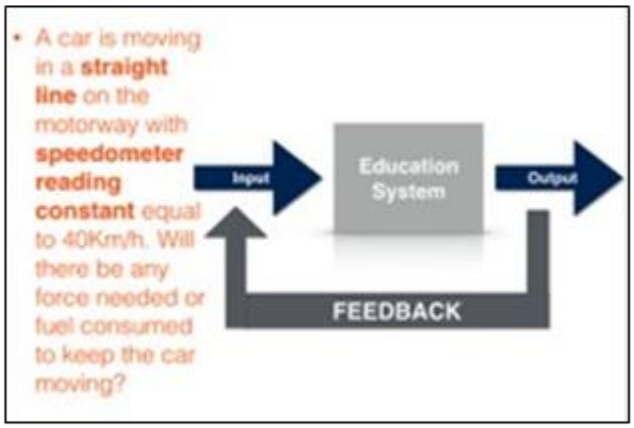
Topic 146

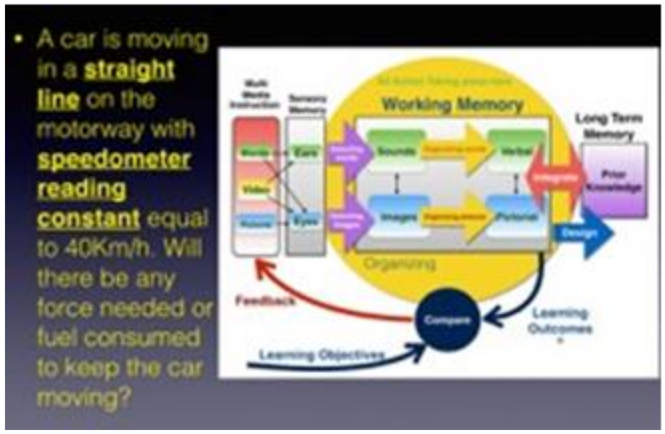
Considering Feedback

We again start with the same statement; a car moving in a straight line at a constant speed with the speedometer showing 40km/hr. This time we highlight the constant speed part. What picture now comes to your mind? Turning towards another book, we see a comprehensive model with the addition of feedback. By feedback here we refer to a result, which you have arrived and seeing if it fits in with picture you have developed. Does it make any sense? Here is another picture containing feedback. Either the feedback loop is distorted in the students, switched off to not account for conflicting warning signals or not taught in terms of conflict resolution. The harmonizing of intuition, observation and formulas is a key necessity and which needs to be taught. Another picture and another example of the feedback being blocked; in any organization there are measures of efficiency. Feedback from consumers is taken for each product and modifications made. Without this consumers would stop purchasing the product and the organization would go out of business.

Summarizing our earlier quiz findings; we see failure of visualizing the bigger picture and warning signals not heeded. If in terms of technology, if we are able to capture the common mistakes and the reasoning behind them understood we would be optimally placed to design the right learning aid. Also, these categorized mistakes needs to be discerned from a large sample to cover the maximum possible misconceptions. A golden rule for initial homework for learning application design, blended learning design or in a teacher centric classroom: if we know the mistakes we can deliberately design to provoke the students in making these mistakes. This allows them to discover on their own, where they went wrong. Once having undergone this process they will never repeat these mistakes again.

Agreed that you would to design these applications separately to cater to various disparate disciplines; but once done you would not have to update them on a daily basis. Perhaps an annual revision may be required to cater to the possibility of a new mistake arising, for which the application should have provision to incorporate the new mistake, i.e. self-correcting. With technology this is all possible.





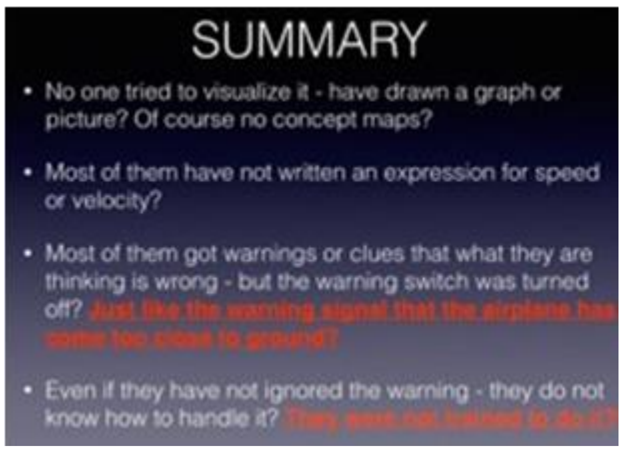
• A car is moving in a **straight line** on the motorway with **speedometer reading constant** equal to 40Km/h. Will there be any force needed or fuel consumed to keep the car moving?
Multi Media Instruction
Sensory Memory
Working Memory
Long Term Memory
Words
Video
Pictures
Ears
Eyes
Sounds
Verbal
Images
Pictorial
Integrate
Prior Knowledge
Design
Organizing
Feedback
Compare
Learning Outcomes
Learning Objectives

Topic 147

Why, When & Where

In the last module we had discussed the collection of large sample data to cover all types of mistakes. This information provides us with the basic tools required for learning. There is more; despite the fact that we may understand a misconception, i.e. force and turning in Physics, do we know why? This is the basic requirement; what, why, when and where. “If the number of mistakes committed by a 1000 students is less than a dozen, then why they commit these mistakes would perhaps be even less.” If we know this our job of designing learning applications becomes simplified. “If somehow we know why they committed these mistakes or how they would have corrected these mistakes by themselves or avoided these mistakes: a more effective use of technology can be made. Knowing the correct answer is one thing, this could be by chance, luck or rote learning.” For real learning to transpire we require a definition, a major milestone in our course: Real learning is not only knowing the correct answer but also the why, how, when and where and what would be the formal, intuitive or formula driven answers and why they are the wrong answers. Can we derive a general strategy to find the right answers, and avoid the wrong ones? If we could do this we would be home. Even if our learner goes astray we should be able to guide him back. “It would also be great if the strategy is problem and content driven addresses all disciplines.”

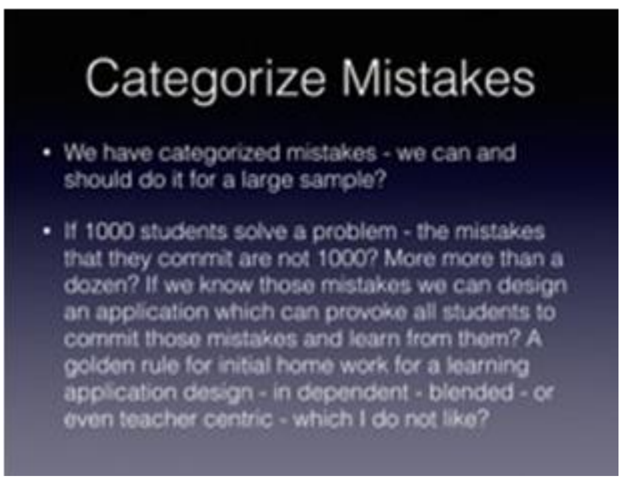
The investigation of the slide tells us what the mistakes are, but also something more subtle. The students were not dumb but intelligent, they knew the subject but despite this they made serious mistakes. They were fully equipped to avoid these mistakes or correct them but they did not know how the use or resolve the conflict which was arising in their minds. It is also not the fault of the system. The system provided them with tools, to heed the clues, warning signals which should have made them correct these mistakes. Their training was missing; the ability to approach a problem from various angles, visualization of the big picture, intuitive feel and the ability to not follow formulas blindly. These signals need to be heeded; for example while driving if you see a truck in the middle of the road, it needs to be avoided, otherwise result in a serious accident. Sometimes the disequilibrium if too strong and we do not know how to arrive at equilibrium. This is a serious flaw in our educational system and is not content specific – applies across the board.



Topic 148

Incorporating Error into Interactivity

An interesting thing about this flaw; if we remove teacher-centric learning with interactive discovery based applications, addressing this flaw becomes simpler. We need to teach the students how to think; where the feedback loop is strong that whenever a conflict arises, alarms go off. This missing element is perhaps one of the greatest mistakes of which I too was a part in my 40 years of teaching. If we can impart this conflict resolution training or build it into our learning applications, we can bring fresh impetus to learning. The system should not only be applicable but also recordable to cover any new misconceptions. Naturally, this does not apply non-conceptual subjects and where only memorization is required. Next we turn to past examples, earlier lectures, where the conflict arose either explicitly or implicitly.



Topic 149

Back to School

If you remember when a student in Muslim High School in Multan; a student in a mathematics quiz, instead of proving a theorem disproved it. To be honest I was not intelligent enough to make such an intelligent mistake. But making mistakes can be beneficial. The subtle mistake by the student created a strong conflict in my mind; the reconciliation of which required great intellectual effort and engagement on my part. Through this process my understanding of that particular theorem and others became absolute. This is also a basic principle of science; you develop a theory, test it and if any contradiction go back and modify it until validated. Another vital point in conflict resolution is using collaboration to artificially induce conflict. If class has ten students and they share their mistakes the final clarity for all students much clearer. Not the correct answers but what mistakes. As it is collaboration is usually associated with problem solving, i.e. at the workplace. Creating conflict which some might refer to as confusion is quite correct. Once this is reconciled and integrated with prior knowledge the repetition of the mistake becomes unlikely. If you have never faced conflict you have not really understood.

Another example from our high school: our teacher was explaining evaporation to us. In those days water was kept in earthen jars. When water evaporates from the porous surface of these clay vessels the water is cooled through evaporation; a natural method of cooling and one that does not utilize electricity. The professor was repeating the fact that if there was more evaporation there would be more cooling. An intelligent student created a conflict at this point based upon the flaw in the statement of the professor. He said that heating the container would create more evaporation and consequently more cooling. A unique conflict; that if we place the vessels on a cooker the water would be cooled. Based on this the realization that the professor’s statement needed modification, a conflict arose. The modification needed should have stated that the heat generated should be within the vessel. This type of statement is known as conditional. If you would have picked up only part of the information, your answer would have wrong.

Topic 150

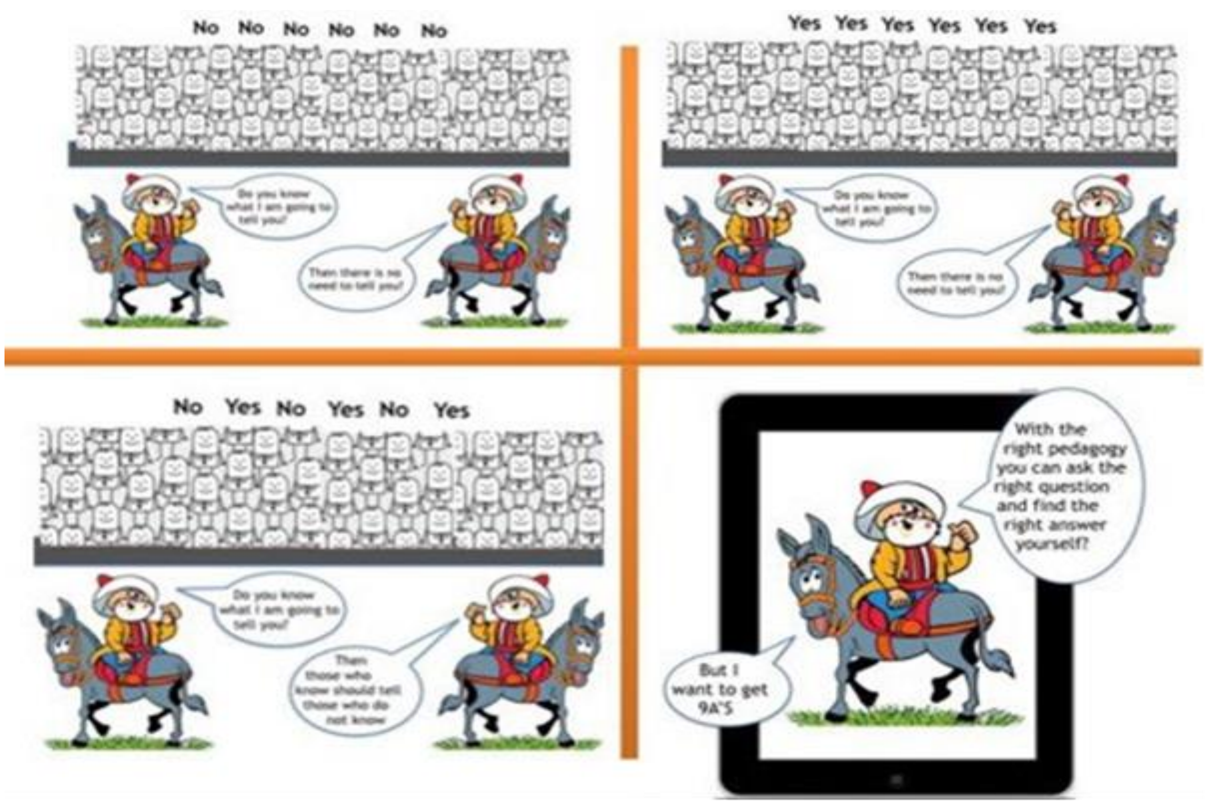
Conflict Resolution

The study of ‘Role of Information Technology in Education,’ is currently the most popular and in-demand fields in Pakistan and globally. In Pakistan it is critical since lack of resources for construction of typical brick and mortar schools in comparison to the West. Technology allows us to create a parallel system where world class education can be provided to anyone, anytime and anywhere. The level of education which can be delivered would be far superior to existing standards. We begin today with Mullah Nasaruddin, a hugely popular Turkish and central Asian character, whose stories, humor and tales, containing great wisdom, are known to all. In this series of cartoons; in the first depiction the Mullah is arriving at a mosque, after a rather prolonged absence. The people are startled and excited: thinking what the special occasion is. The Mullah addresses the gathered crowd and enquires, if they know what he is going to narrate? The crowd expresses it ignorance: to which Mullah replies if you don’t know this then there is no point in telling you.

Turning to the second cartoon, the people appear quite despondent, believing they had disappointed the Mullah. Again after a long absence he comes back and enquires of the crowd what he wants to convey. This time they all respond in the affirmative. The mullah responds if you already know the answer what use of my asking? Think about this since it is simply not a witticism. In terms of education if you do not know what you want to learn, i.e. there is no prior knowledge, nothing can be taught. Similarly, if you know it all, you cannot be taught. After a more protracted absence the Mullah returned. This time the people prepared. Upon Mullah’s enquiry, half said that they knew, while the other half that they did not. So Mullah told those that knew to tell those did not. He also said that you can solve your own problems, why do you need me? He also illustrated the point that with the right pedagogy you can ask the right question and arrive at the right answer.

In terms of conflict resolution, when danger signals are observed and if a collaborative consensus can be arrived at; leading to further insights, that can only be arrived at through collective wisdom. A fact illustrated by the Mullah. These days this is referred to ‘crowd sourcing;’ something known by the Mullah hundreds of years ago.

Moving ahead with collaborative conflict resolution, we will look at some more examples. If we are able to incorporate this system, solving all the problems that arise, we arrive at true knowledge. With the right mix of pedagogy and technology the teacher becomes redundant.



Topic 151

Student Politics

A few days earlier, I met up with a colleague from the University of Engineering and Technology, after a about 20 years or so. Our talk turned to the past when we were teaching there. In those days politics was rife on campus. Student political organizations were supported by main stream political parties and some even provided arms. Complete lawlessness prevailed. Students would at time make their own and exams and conduct them. My attitude was rather strict: my stance that we should not yield to student pressure under any circumstances. Having said that if the student is wielding a Kalashnikov, one is left with little choice. I was advised by other teachers to desist since I had been warned by the students and had little children. One was torn between concern for my children and student's injustice. Human beings are built by the creator with an inherent mechanism which signals between right and wrong. Similarly, in education while solving a problem through a formula, despite the answer, your intuition at times signals that there is something wrong with the answer. These warnings should never be ignored. I too paid heed to my conciseness and disregarded student threats. These internal conflicts exist in everyone's life.

These days I am associated with a university where the inverse is true. Students are completely subjugated to the faculty. While reminiscing about old times, with my friend, and my strict stance against the student body in UET; he enquired if it had changed at all. I told him it had undergone a 360 degree turn. Now I always sided with the students, whenever there is an attempt to throttle their demands. The prevailing consensus, in the university is that, if students are leeway they will take undue advantage. My position is that they are intelligent people who are there to acquire education and their opinions should be considered. Observe how circumstances and conflict resolution changes. Life too, in a large part, constitutes of conflict resolution. Here a poetical interlude: what do we mean by life?

Zindagi ka jawaz kiya hai	what justification for life?
Is bandage ka hisab kiya hai	what account of this devotion?
Hamaray dil may khalish hai kis ki	what agitation exists in the heart?
Hamaray dil me malal kiya hai	what regrets present in the heart?

This captures the discontent when one not at peace with oneself. Life continues in tandem with learning. One does not exist without the other. From the day a person is born to the day he dies, learning continues and with it conflict resolution.

In February 1986, I was with NASA at their research center in Langley. It was snowing, which was rare, and I was trying to get my car out to get to work. While attempting this I turned on the radio and heard the tragic news of the space shuttle Columbia exploding. Since I could not take out the car, I went inside and tried calling the office. It was the first time in my stay in the States that I did not get a dial tone. The lines were overloaded by people calling to enquire of the tragedy. Another aspect to this tragedy was that a female school teacher was also part of the crew and the launch was being broadcasted live in all schools. To investigate the incident a commission was formed and according to their findings NASA was entirely responsible. The space shuttle contained rings which distorted in the winters. There were clear instructions that the shuttle should not be launched in the winter. Junior engineers had warned the administration about this, yet their warnings were disregarded. There are many stories as to why this was done. One states that the President was conducting his state of the union address and wanted to mention the launch. But the relevant things here is that despite warning signals being present and which were ultimately disregarded, the tragedy occurred. The young school children witnessing the tragedy required counseling. An apt lesson in not heeding warning signals. Here you see a picture of those brave astronauts.


Nation Mourns Again
As NASA Seeks Answers

LAST MOMENTS: A Somersault In Space And A Blizzard Of Checklist Entries

SHUTTLE: Crew Of Seven Lost; Wing Damage Suspected

Topic 152

Kinesthesis

Turning to another example from Kinesthesis, which was presented in various schools and colleges, a car about to move on a road is stationary. This implies a starting time of zero, distance covered zero, speed zero and consequently zero acceleration. As the distance covered is zero, differentiating for speed (speed differentiated to find distance) we get zero. What mistake am I making? With speed zero we also get zero acceleration, which implies the car cannot move. In this problem we are not provided with any numbers, rather it needs to be solved through logical thought. Any car is stationary prior to moving, but this does not imply that it will not move, since it takes you from point to another. How do we reconcile this conflict? If we are able to successfully do this we would achieve a higher level of learning.

Another conflict developed by a philosopher. A common methodology in which paradoxes provided, that can be solved with the tools available. They are designed to make you think and not used a formula based approach, which does not lead to deep and meaningful learning. Those were the days of philosophers and arrows, not bullets. In a related paradox the question was: "if you have an arrow and in order to make it cover a distance of 100 yards, what is required?" For it to cover the 100 yards, first it must cover the initial 50 yards. If covering of the first 50 essential; prior to that it should cover 25 yards, 12 and ½ yards and so on – this leads to infinite numbers. Since you cannot cover infinite numbers in infinite time, the arrow cannot cover the 100 yards. This does not tally with our observation, which leads to generation of warning signals forcing you to think. Learning, technology, education all have their biggest and singular purpose to make you think; an objective which can only be achieved by creating a dichotomy between results and observation. This is known as a triggering event: an event which causes you to be startled and your mind to be agitated. A triggering event creates warning signals, plays a critical role in learning. With technology, through animation we can use this very effectively.

Topic 153

Multltan & My High School

Back to Muslim High School, Multan; it must seem that I cannot forget my school. But this place shaped me and my beliefs. If you remember there were a few examples of conflict in my school. The incident of our teacher telling us that evaporations causes water to cool in an earthen container; the faster the evaporation the greater the cooling. Extending this logic one of the student said that if we heat the container the water would get even cooler. This goes against common sense and experience. The conflict between logic and observation needs resolution for learning.

Another example was of an intelligent class fellow of mine, who managed to disapprove a theorem, through a subtle mistake rather than proving it. I was asked to check for his mistake. The exercise in conflict resolution, trying to find his mistake, provided me with mastery over the subject.

Perhaps you have noticed that collaboration is usually used in conjunction with conflict resolution and problem solving. Creating a conflict, which some people label as ‘creating confusion,’ is an essential part of learning. In a collaborative setting you encourage each individual child create unique, fun mistakes. When you come out of so many unique confusions, real learning takes place and you become a real learner.

Another example was when my mother’s pretty neighbor glanced and smiled at me while leaving her house. My wife was rather jealous and had assumed the worst. This only lasted by the time we closed the car door. The triggering event was the damage done to my car by the pretty lady. The bubble of confusion in my wife’s head burst and her mental conflict resolved.

Concept maps help in charting where confusion arising from. We will talk about them in detail later on.

Topic 154

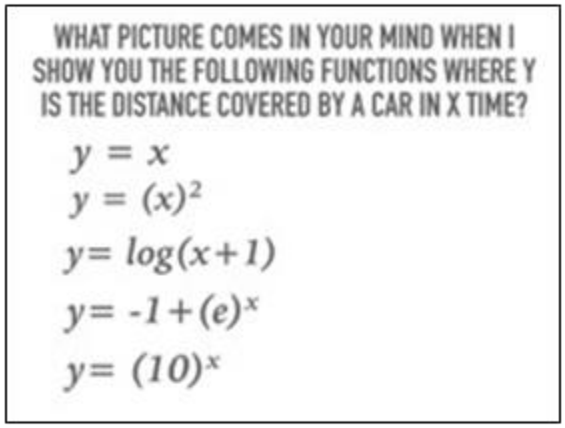
Introductory Functions

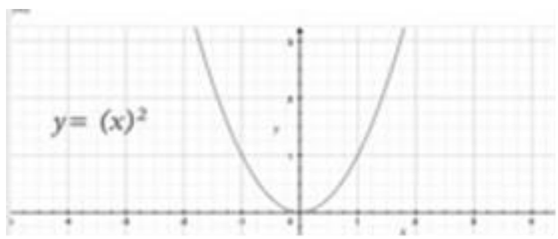
We now look at introductory functions, which constitute the basics of calculus. What these are; what is required to understand them; and what conflict needs to be generated in the student's mind. In the slide in front of you five different functions –y as a function of x – are presented. If no questions arise in your mind, or emotional response evoked you do not really know functions. If no passion exists in your learning and not aware of its pitfalls no warnings will exists when attempting to solve. What pictures arise in your mind if we now we define function y as distance which a car covers in time x? With the addition of this descriptive element, do any questions, conflicts, and agitation arise in your mind? If there is no reaction you have not studied functions properly. Today we look at how these should be taught to create a passionate association. First we shift the y value to kilometers and the x to hours? Does this make a difference? When being taught functions did your teachers, just jot them down on the board or tried to create stories around them? If you create a story the associations are tagged in your mind. When I should you the functions, if any linkage existed, these stories would come back to you. Storytelling is an effective tool in teaching, with or without technology. With technology now it is possible to create the ultimate stories through animations and movies. For their utility as essential linkages x and y should not just be symbols, instead characters of a story.

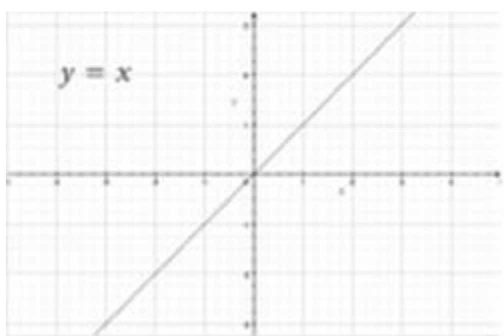
Secondly, did the teacher allow you a visualization of the problem; trough drawings and graphs? Without this the pictures associated with the story would not be available to you. Our minds are structured visually to effectively and efficiently manipulate images and not equations. Easier for us to understand and analyze images. Computers are much more effective in manipulating and analyzing equations. Even when primitive human beings dwelled in caves and relied on hunting for food, they were painting images and not developing equations. Steeping out of their caves, even the slightest rustle of leaves would point to a danger signal against which they could take defensive measures. From this example it should be apparent that how life and learning were always closely intertwined. Also how critical a role warning signals play.

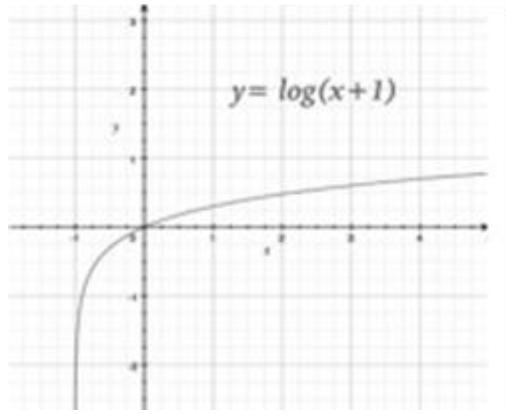
An interesting dilemma with computer science students; when designing an algorithm – which entails y steps in solving a problem: when a student is confronted with y=10 power x, where y number of steps and x is the size of the problem, which due to its exponential nature relationship is very large. Conversely if y=x squared he would be quite satisfied. And if y=log to power x+1, he would be overjoyed. Please, note how emotional linkages are created in relation to these problems. If these exist, future problem solving would have inherent generation of warning signals capability. A story needs to be associated with the problem. The actual impact of y=10 power x will be looked at later in detail. Why does it cause so much anxiety; why are PhD's made and break on this premises?

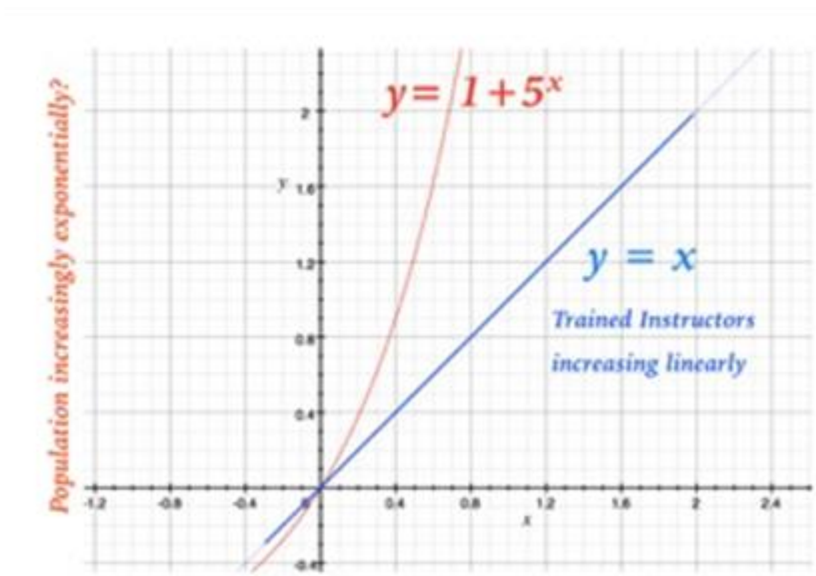
Let us try to visualize these to understand this emotional response. A small example, also available on Wikipedia, involves the number of school going population. The function y= 10 power x or x power e (exponential) define how this population increases – exponentially. Comparatively, the population of trained instructors does not even grow linearly, let alone through a square function. This is because most governments face budgetary constraints and do not allocate this quantum of funding to education. This creates a significant gap between school going population and the availability of qualified teachers. A trend which extrapolated will lead to the demise of conventional teaching. With this you can understand how the importance of our course would increase over time. The brick and mortar schools will no longer exist and technology would be solely utilized in the delivery of education - perhaps not in our lifetimes but soon. With this example you can see the utility of function, linear or polynomial and how an example/story can create emotional affinity with teaching.








y= log(x+1)


y= 1+5^x
y = x
Trained Instructors
increasing linearly
Population increasingly exponentially?

Topic 155

Describing Equations 1

Here you a see a face; faces are easier to remember than names and for that matter equations. These linear polynomial functions are graphically plotted. What is so critical with these polynomial factors that makes PhD students quake, when confronted with this time complexity in their algorithms? Compare the rise of these exponentials in comparison to log functions. Population growth is also exponential and can be captured quite dramatically through animation. A good question to ask students would be if they can narrate any underlying stories behind these functions. If these linkages do not work; no intuitive or real understanding would be present. In terms of layman the concept of power usually denotes strength;; the ability to do anything one wishes. How does this compare with 10 power x? To understand its magnitude we turn towards an example.

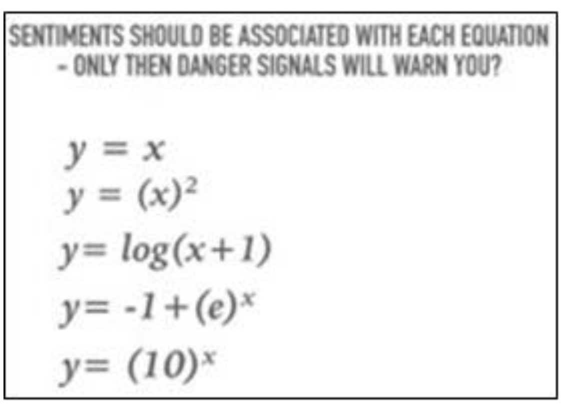
Chicago is usually cold and during summers people take full advantage of the weather. Here we see a couple with their child picnicking. The family is photographed from 1 meter up, i.e. 10 to power 0. We move to 10 power 1 and the picnic cloth appears to be small patch. Moving up sequentially you can see the edges of Lake Michigan. In another step you see the entire lake. By the time you reach 10 power 7 you are in space and can see the entire globe. Moving up to 10 to power 15 you are out in the solar system by power 19 near the Milky Way and by 20 beyond. With this you realize the immensity of this exponential growth. Most movies only go up to power 35, where you are dealing with the universes. If this seen in a movie form you would never forget exponentials and also understand the dilemma of computer science students confronting this in their algorithms. Next the movie goes in reserve and at 10 cm you can see the details of their skins. 10 power -5, we get blood cells, at power DNA, our basic building block. At -8, DNA strands start opening up; by -9 molecules and at -13 atoms and electrons. These number 35 and -20 are small number but here sufficient to define existence. This underlines the importance of stories and how they assist learning. Turning back to comparative graph, it hopefully makes much more sense now, in context of how school going population (exponential growth) will quickly outstrip trained teachers (linear growth).

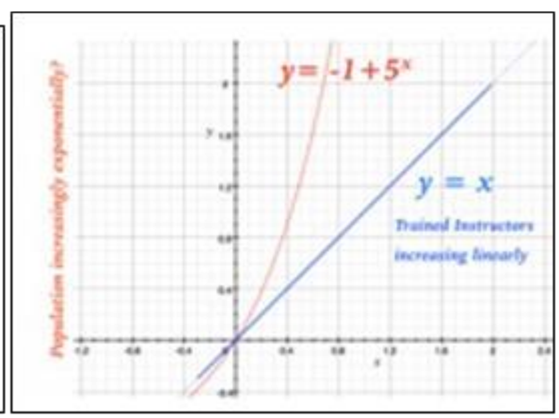
Topic 156

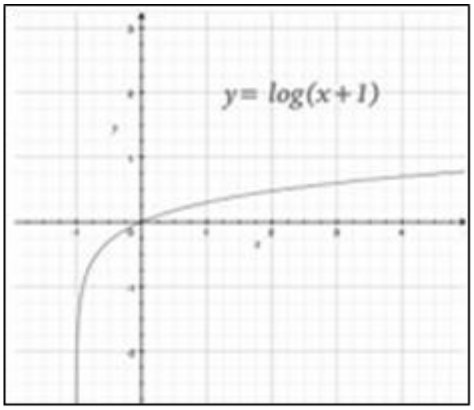
Describing Equations 2

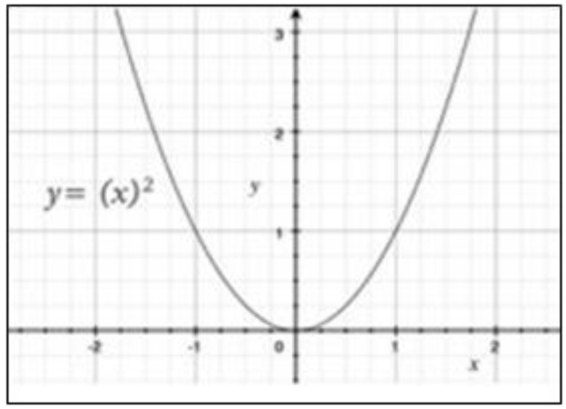
Earlier we were discussing functions, and this slide containing five functions. The pertinent point was to see if these function elicited any emotional response. We also tried to demonstrate visualization through a problem of involving population of school going children, which was growing exponentially, in comparison to the availability of trained teacher which was growing linearly. When we observe a scene of torture or conversely a flower blooming, both evoke strong emotional responses. We need to create these linkages in education. We now turn to a game designed by us. The key elements in game should be its ability to first create conflict and surprises for the user and then maintain the level of excitement and immersion. In the light of strong emotions, a linkage is created, which leads to retention. This is the function of all games, immersive and interactive; to focus your attention in entirety and to challenge you so you are completely immersed in the experience. This needs to be replicated for learning. The reason children play with these games for hours in comparison to passive toys, is challenge involved. This game was designed in collaboration with one of my students, Sajid. The thought process, if not equally critical, is more important than implementation of the game. By this we imply all the elements within the game which constitute its challenge.

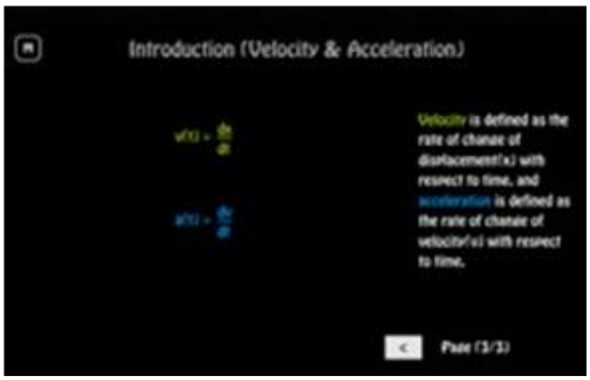
In the game, ‘educational drive,’ (created by one of my students with my light provokation) again graphs of functions; linear, log and exponential are shown; the point here is to refresh your prior knowledge. Squares and polynomial l functions are also shown, these are for reference and we will discuss them later, since part of the surprising element in the game. Next there are slides which contain definitions for displacement vectors, vectors and acceleration, vectors and velocity, etc. Now the underlying problem in the game involves a new car, moving on a road, with the odometer showing 30km, which you have driven out of the showroom. On a straight road you increase in a manner that speed becomes 30km/h. The displacement and speed are equal. Observe that here we have not discussed any specific mathematical formulation rather we create an actual example which will be later linked to mathematics – this lead to understanding. The fact that displacement and speed are equal is mathematically interesting. As I had told you earlier understanding the question is critical, if you are able to do this you have solved 60% of the problem. In terms of the problem 30km on the odometer and 30km/h on the speedometer; if speed remains constant your odometer reading remains constant but displacement increases. If speed too increases, speed and distance increases. If speed gradually decreases and direction remains constant; speed decline but odometer value increases. Now in the problem is how we accelerate to ensure that both values, of the odometer and speedometer, remain the same? For example if speedometer value goes to 40km/h, odometer reading should also increase to 40km. The second question is that if we think in terms of function, displacement increase and is equal to speed; what does this imply? Finally, if this is done for a period of ten hours, how far would you get from say Lahore?

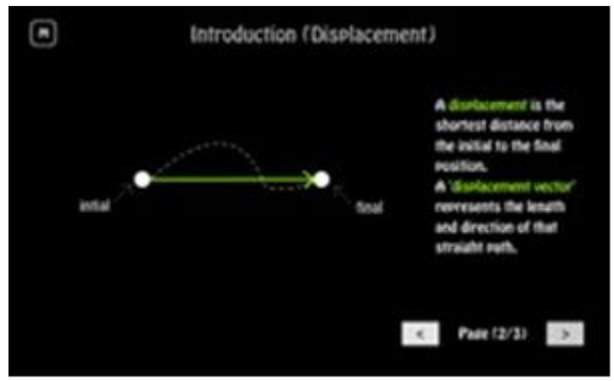


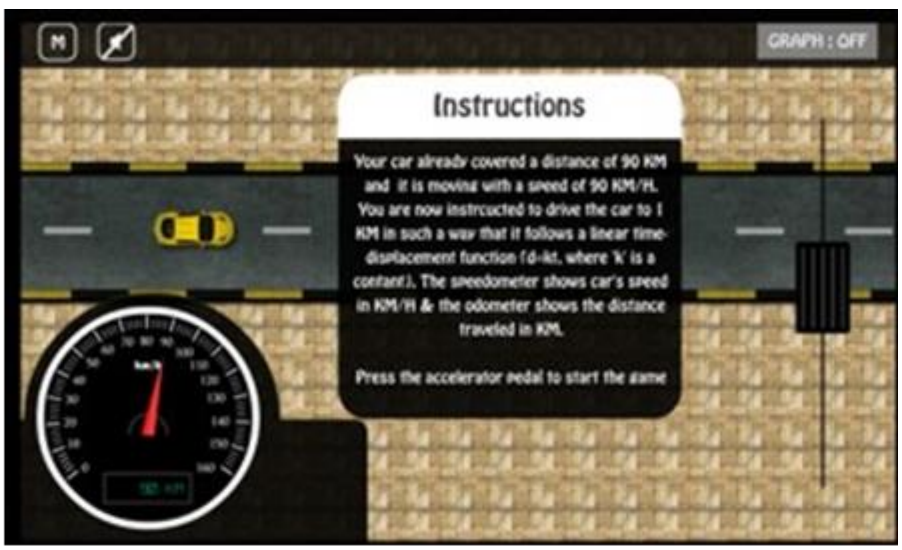



$y = log(x+1)$


$y = (x)^2$


Introduction (Velocity & Acceleration)
Velocity is defined as the rate of change of displacement(x) with respect to time, and acceleration is defined as the rate of change of velocity(v) with respect to time.
Page (3/3)

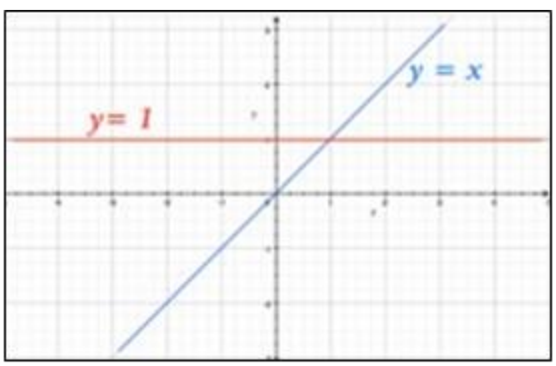

Introduction (Displacement)
initial
final
A displacement is the shortest distance from the initial to the final position.
A 'displacement vector' represents the length and direction of that straight path.
Page (2/3)

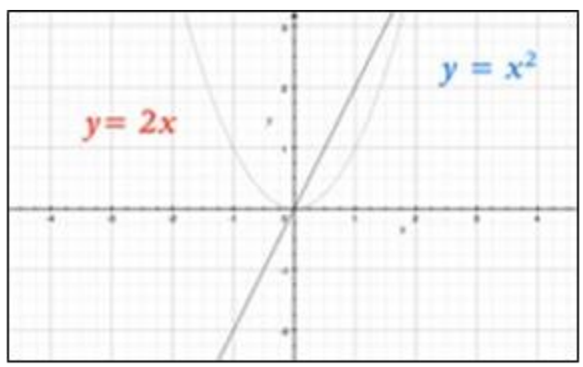

GRAPH : OFF
Instructions
Your car already covered a distance of 90 KM and it is moving with a speed of 90 KM/H. You are now instrcucted to drive the car to 1 KM in such a way that it follows a linear time-displacement function (d=kt, where 'k' is a contant). The speedometer shows car's speed in KM/H & the odometer shows the distance traveled in KM.
Press the accelerator pedal to start the game

Topic 157

Describing Equations 3

Now that the problem is in front of us, i.e. odometer and speedometer reading should be the same; implying that speed and displacement to be equal. What is the relationship between speed and displacement? Here your prior knowledge is needed. If we differentiate displacement, we should arrive at the function of speed. We are now transforming the problem into mathematical formulation: a y function is required, which differentiated with respect to time, provide the same y function. A real life problem has now been turned into a mathematical one. We need to remember which function reflective of this relationship. If this is not remembered, we will arrive at the right function.



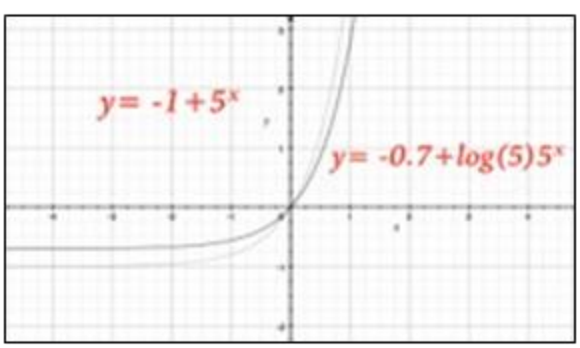


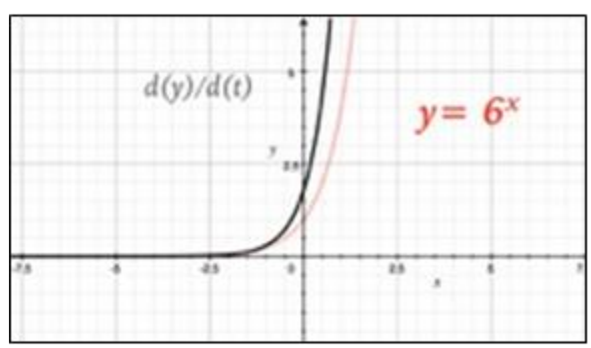
Topic 158

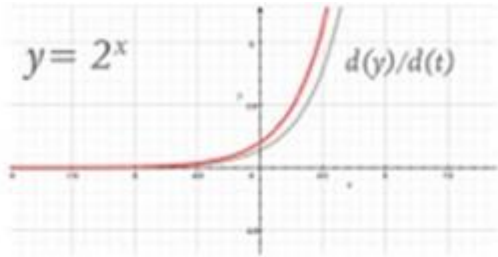
Describing Equations 4

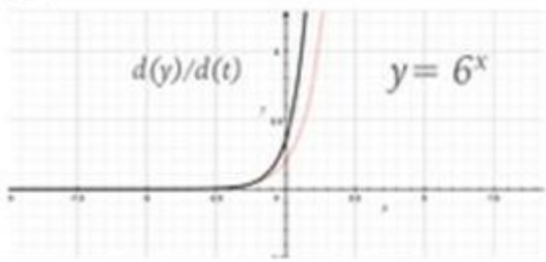
We need to try different functions to arrive at the appropriate relationship. The first function, which was previously shown, is linear. Differentiating y=x (x=time), we can see that displacement rises with time. If we differentiate for speed we arrive at the value of 1, which is constant. As with all linear relationships the two values will never be the same. An important mathematical concept associated with functions, which you have learned.

If y=x squared, with respect to time; differentiating we arrive at y=2x, which is shown on the graph in front of you. The two values seem to approximate, yet are not equal. You can try the value of x cubed, on your own, and you will see that it is even a closer approximation but still not equal. We now turn to t y=6x, an exponential function. As in earlier graphs the distance is plotted in black, while the function in red. Again, you see that the two are quite close, but not equal. Speed, in red, is increasing faster than the displacement in black. Time would be e to power x. E is a special number and the only one possessing property for allowing speed and displacement to be equal. Here we have introduced this special relationship, in mathematical terms, through a real life example of a car.

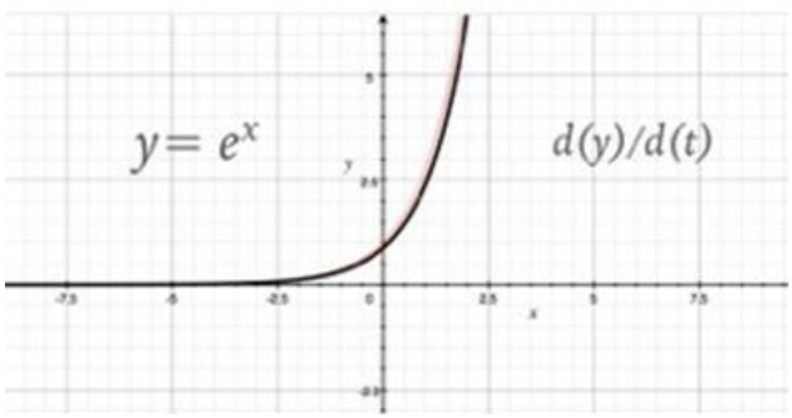








There is only One Such Function?



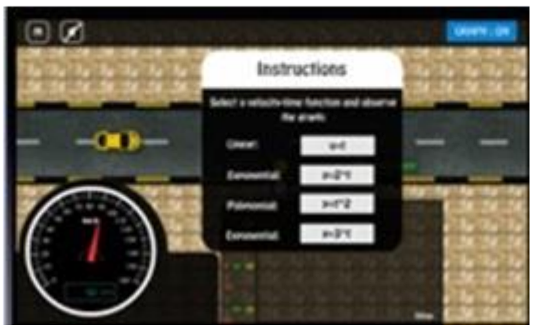
Topic 159

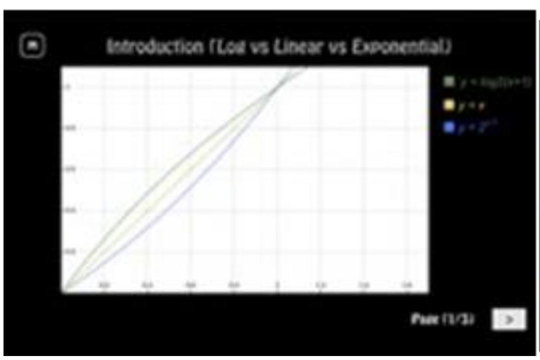
Describing Equations 5

Now, we are turning to game, a truly interesting one, you see three cars racing. You instructions tell you that the yellow car represents linear relationship, blue exponential and green log. You can specify how they will be plotted, i.e. displacement with respect to time. At this stage you should have acquired some familiarity with exponential, linear and log growths. In the game you now have an option to bet upon a particular car in the race, i.e. select one. If the game animation was available, you could visualize it better. Yet, here I will try to explain how it works. In the opening screen you can see two buttons. One is for turning on/off the graph plotting function. While other is of 'luck.' What does this imply?

Suppose your friend bets on an exponential functional. Most people with a background in working with algorithms would choose this option. Unfortunately, they forget a certain condition applies for this rapid growth. One the race commences you see you see your car lose. You have an option to begin again. Seeing that the green car (log function) won in the last race, you select that particular car. Again you lose. This continues to transpire, due to which your attention is drawn to the luck button. What variable does this control? As you turn the luck switch to on, your car starts winning. You are convinced by now that something is being manipulated. This is not actually so rather, a linkage and an introduction to a critical property developed through the luck function. Exponential growth is large, but only if the x value is great. Similarly, log function increases slowly if the value of x is great. In a linear relationship both variable grow linearly.

Thus, if time is reduced or distance shortened, a variable which is being manipulated. Much like a marathon runner in comparison to short distance sprinter. In the earlier instance, i.e. when luck was off, this is what was taking place. One the button is turned on, time and distance/displacement would be increased, leading to converse results. The point of the game is to clarify many misconceptions which arise due to functions in terms of time and distance. Based on this the answer to the question of how far you would be from Lahore if speed and displacement were kept constant over ten hours: this is an exponential function and you would probably end up well outside in the Earth in space. Another point in terms of graphs, if we magnify the image we can see that the small difference which are hardly noticeable, acquire a significant magnitude. We hope this game proved useful in terms of functions.





Topic 160

Describing Equations 6

As mentioned earlier, learning entails heeding any danger signals which arise and how this conflict is resolved; leading to new thinking patterns and new neural configuration through processing of new concept/data. As promised we will now look at problem which was presented as a midterm question to first year students of computer sciences and electrical engineering at a university. The problem was designed with artificially introduced warning signals, at multiple stages, to see if students would heed them and manage conflict resolution. The inability to do so a major hurdle in terms of learning. Also the ability to think logically and critically, very important on its own, in no way undermines this leading to good grades. If thinking is not translated into good grades, there is something lacking in the learning process. Some advice which needs to be incorporated and disseminated between students to allow them to design interactive learning applications, is the necessity of incorporating warning signals, artificially, to keep students on the right path. Much like warning signs on a dangerous road.

Incidentally, the problem which we will dissect was also given to LUMS student during their PhD entrance interviews. Here we are talking about students with sixteen years of schooling and significant number with mathematical backgrounds. We will compare the two. It has to be understood that this learning process begins in school, if not integrated at that level, would imply it not being present in college. In a certain sense it is quite simplistic, when you meet a person for the first time, how do you interpret signals from the other person, which allow you to trust him. So from that perspective it is common sense.

Now to the problem a car which is traveling in one direction in a straight line from Lahore (no vectors required). The displacement/distance is plotted against time graphically as presented here. Assuming starting time to be 0 hours; in the first hour there is no change in displacement, i.e. car is stationary. From one to two hours linear speed; at 2 hours displacement is 200; a fact which can also be used to calculate speed. In the second and third hour, displacement remains at 200. What does it mean? In the third and fourth hour; same displacement remains as second hour. From the graph of a function equations for each stage of the journey can be derived. At y value 0, time 0; a straight line equation can be derived. Similarly, equations for 2 to 4 hours constant and displacement equal to 200. What does this mean? From fourth to fifth hour distance decreases. What does this mean? At the fifth hour 100; what story is being told here? As discussed earlier in context of the "Harvard Calculus,' a hidden story in every graph; linguistic, descriptive, visual aspect. If equations were solely provided, an analytical expression, it would be probably hard for significant majority. People think differently and require an appropriate representation which fits with their style – these needs to be accounted for. For instance this information could also be provided in a tabular format. There are basically five or six main methodologies for presentation of data. The important point is the story they are telling, which can be captured in a analytical, tabular and other frameworks.

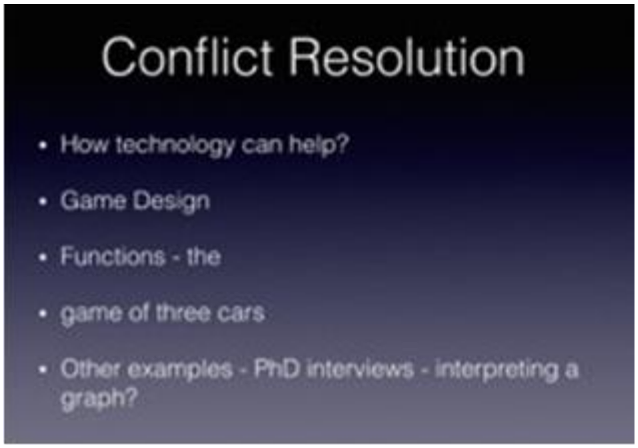
Meeting with a group of school principals, discussed the same problem, i.e. what distances they were covering. The response was that this question was out of course. They were only teaching them how to draw graphs, not interpret or read them or understand what story they were telling. This is not learning. A student should be able to one form of expression, presentation of data, to another, even if not all: if they understand the underlying descriptive aspect.

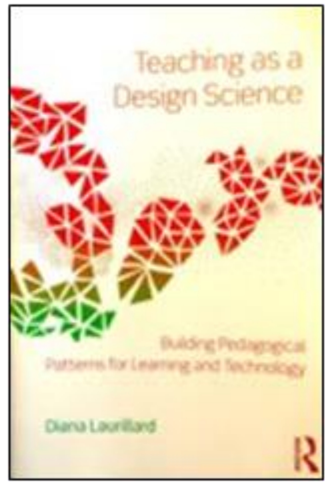
Finally to the actual question, which is also seen here, a car leaves Lahore for Islamabad through the motorway, starting at time 0. The magnitude of displacement or distance is plotted on a graph. Before turning to the questions, try to really listen to them; which are the real questions, which designed to induce warning signals.

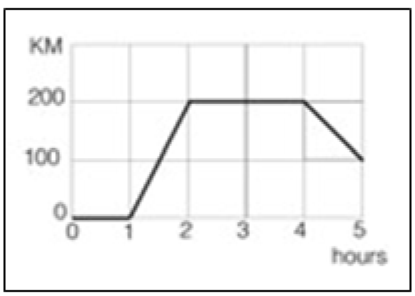
Find the distance of the car from Lahore in half an hour? This only entails reading the graph, starting from time 0. This illustrates the importance of reading the question. Also find the distance at two hours. A question to which, as mentioned earlier, the principals had replied that they did not know how to read the graph. Most of you must have visited a hospital, where nurses, who are not well educated, plot your temperature graphs. Upon query by the doctor they can tell particular reading and any observable patterns. Again, distance from Lahore at four hours? These answers are already provided in the graph.

In the next questions find the distance of the speedometer at 1.5 hours and 3 hours, some manipulation is required; function needs to be differentiated. This is followed by a yes and no question; did the car reach Islamabad within four hours? The next questions is that if someone is drinking coffee at 1.5 hours, is there a possibility of them spilling it due to high speed. You might have realized that this question is designed to generate a warning signal. Similarly, if coffee being drunk at three hours, spillage due to high speeds? Finally, how far is the car away from Lahore after five hours? These constituted the basic questions which were asked.

The initial questions were solely designed to see if students understood how to read a graph. No formulas were required and all that was required was commonsense counting. At 1.5 hours and three hours some manipulation was required but if one knew one answer no manipulation was required for the second. Reading of speedometer and coffee question together you would realize that since there was no displacement; how can coffee be spilled? The car was stationary at that point, which you can see from the graph. We next turn to actual mistakes committed by student with these problems.







Problem No. 4: A car was supposed to start from Lahore on the motor way and move towards Islamabad. It was supposed to start at 0 hour? A graph of the magnitude of displacement of the car from Lahore is plotted in the diagram as shown?

(a) Find the distance of the car after half an hour from Lahore - half an hour starting from 0 hour?
(b) Find the distance of the car from Lahore at 2 hours?
(c) Find the distance of the car from Lahore at 4 hours?
(d) Find the reading of the speedometer at 1.5 hours?
(e) Find the reading of the speedometer at 3 hours?
(f) Did the car reach Islamabad within 5 hours?
(g) If some one drinking coffee at 1.5 hours is there a possibility of the coffee spilling over because of high speed of the car?
(h) If some one drinking coffee at 3 hours is there a possibility of the coffee spilling over because of high speed of the car?
(i) How far away the car is from Lahore at 5 hours?

Topic 161

Educational Technology

The technology, focal area of our course, is continually evolving. Keeping up with new developments is imperative. Coming across a new book, I immediately ordered it since one felt it would have utility for you, in terms of this course. The book by J. M. Spector, Foundations of Educational Technology: Integrative Approaches and Interdisciplinary Perspectives, published in 2016; is one book captures these changes. In terms of educational technology, while underlying foundation definition remains the same, yet practical definitions change.

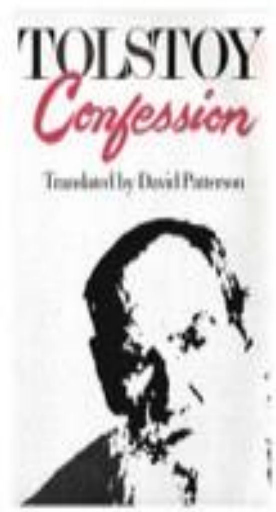
Phillip Harris, Ed.D., Executive Director of AECT, has this to say about the book: "For serious scholars, researchers, and practitioners in the field of educational technology, this is the book to own. It makes reading about the field exciting as well as informative and provides the reader with insights and understandings by one of the field's leading authorities. This may be the first book of its kind that is a true page-turner."

Similarly, Dr. Monica Tracey, Wayne State University says: "J. M. Spector's book, Foundations of Educational Technology: Integrative Approaches and Interdisciplinary Perspectives, alleviates the fear that teaching novices the basics in the field of educational technology must be reduced to simplified models and procedures. This textbook manages to embrace the breadth and depth of educational technology while providing understandable definitions, examples and exercises."

Despite its cost the book is well worth it. Immediately, upon opening it you notice fresh insights into education, its definitions, technology and educational technology. As you are probably aware I rely immensely upon social media, particularly Facebook. Having purchased the book, I took no time in declaring its utility to friends and associates. My only fear was that they would ask for a photocopy of the book. In ten minutes, I was told that a copy of book had been acquired; not from Amazon but downloaded from somewhere. A good example of how technology has progressed. While it took me a week to acquire the book, others took only ten minutes – how's that for technology? It is another thing that they would not access to reader reviews and rating, if not purchased through Amazon.

The book commences with a quote; "that we shape our tools and afterwards our tools shape us" - Marshall McLuhan from Understanding Media. The same holds true for technology, which we initially create and later it defines our lives; an unending cycle. The book's new insights and perspective into education will be appreciated by the layman; but particularly by you who by now have greater familiarity with the subject.

Another quotation which I want to narrate to you from chapter nine of the book; Theories of Information Communications: "When I use a word,' Humpty Dumpty said in rather a scornful tone, 'it means just what I choose it to mean — neither more nor less.'" - Lewis Carroll, Through the Looking Glass. The book is as interesting, from an educational perspective, as Alice in Wonderland. Before discussing the book in detail we look at an analysis of the midterm, as promised earlier. The purpose of the exam was to see if students can heed their intuition, warning signals and the ability to engage in effective conflict resolution. We will focus on one question and its interesting outcomes.



INTRODUCTION

IN THE FALL of 1879 the fifty-one-year-old author of *War and Peace* (1869) and *Anna Karenina* (1877) came to believe that he had accomplished nothing in life and that his life was meaningless. Either of these works would have assured him a permanent place in the annals of world literature; both testified to the depth of his genius and creativity. If artistic achievement of this magnitude cannot instill life with meaning, then where is meaning to be found? Such is the "question of life" that Tolstoy addresses in his *Confession*, a question as timeless as the spirit.

Ernest J. Simmons has described the *Confession* as "one of the noblest and most courageous utterances of man, the outpourings of a soul perplexed in the extreme by life's great problem—the relation of man to the infinite—yet executed with complete sincerity and high art."* It is a tale of midlife spiritual crisis, the ingredients of which had been fermenting in the man since his youth. As such, the *Confession* marks a turning point in Tolstoy's concern as an author, and after 1880 his attention was concentrated quite explicitly and almost exclusively on the religious life that he believed to be idealized in the peasant.

Although there are parallels between the torments of Levin in *Anna Karenina* and Tolstoy's own conflicts in the *Confession*,

Topic 162

War & Peace 1

From the book we will discuss an interesting story. In front of you is a picture of an immensely famous author, philosopher – Leo Tolstoy. Much has been written about him, his books have been adapted for movies and among his famous works is Anna Karenina. In terms of education, the heeding of warning signals and their reconciliation, which in some cases not possible, an insight can be found in the works of Tolstoy. He understood this pedagogical phenomenon and underwent a change through it. “The story is taken from Leo Tolstoy’s Confessions, which is based on his journal and personal reflections. Confession was written in 1879, when Tolstoy was 51 after he was well known and highly respected for War and Peace and Anna Karenina; it was first published in Russia in 1882.” I remember watching War and Peace, with my mother and aunts in Multan. At that time I was in the sixth standard in Muslim High School Multan, a reference to my alma mater is necessary. Multan was covered in movie poster and we saw the movie either at Starlight or Zenith. “Tolstoy already had all the fame and fortune, and was enjoying the benefits of his success when he happened to visit Paris, France, around the year 1865, when these events occurred.

At that time, Paris was regarded by Tolstoy and others as the intellectual center of the universe and a showcase for progress in civilized society. Tolstoy was regarded as one of the leading lights of modern civilization.” In the background you can see some pictures from War and Peace. “He had gone to Paris to meet friends and have a good time. While cavorting in Paris, he chanced upon a public execution. At the time, France applied the death penalty for serious crimes and the form of execution was the guillotine. Executions were public, perhaps based on the belief that the horror of such executions would deter crime." As you know we have repeatedly discussed danger signals, conflict resolution and triggering events.

Imagine the event which mentally shook the great author. "Tolstoy records in his journal something like the following (loosely translated): 'When I saw the heads divided from the bodies and heard the sounds with which they fell separately into a box, I knew with my whole being that this was a bad thing.' Tolstoy was shattered. 'This unexpected and unplanned event marked a turning point in Tolstoy's life. It is marked by the following words recorded in his journal (again the same rough translation): When I saw the heads divided from the bodies and heard the sounds with which they fell separately into a box, I knew with my whole being that this was a bad thing. (The repetition is intentional.) He goes onto reflect about his prior belief with regards to civilized, with regard to Paris as the cradle of civilization, with regard to progress proceeding from Paris throughout the rest of the world, and so on. He writes that his belief in progress included a faith that society was moving in a positive direction and that Paris was leading this movement.' Consider here the earlier discussed prior beliefs put across by Paget in terms of pedagogical learning.

'Then he recalls the: "When I saw the heads divided from the bodies and heard the sounds with which they fell separately into a box, I knew with my whole being that this was a bad thing. (The repetition is intentional.)' He could not shake off the event and it kept turning in his mind. 'He knew with whole being – he was fully engaged in this moment.' Despite the fact this is a gruesome example you will notice many parallels with pedagogy. Here he saw, heard and thought; observed, absorbed and integrated. 'He saw, he heard and he thought. As a result, he could no longer hold onto his prior belief in progress and faith that Paris was the cradle of civilization. He could no longer regard himself as one of the leaders of civilized society if this is what civilized society represented.' Again implications in terms of design of education, which need to account for prior knowledge and how it needs to be reshaped. In this instance, stark example, the entire foundation (belief system) shattered. The inhumanity displayed collapses the belief in civilization.

This story is taken from Leo Tolstoy's *Confession*, which is based on his journal and personal reflections. *Confession* was written in 1879 when Tolstoy was 51—after he was already well known and highly respected for *War and Peace* and *Anna Karenina*; it was first published in Russian in 1882. Tolstoy already had fame and fortune, and was enjoying the benefits of his success when he happened to visit Paris, France, around the year 1865, when these events occurred. At the time, Paris was regarded by Tolstoy and others as the intellectual center of the universe and a showcase for progress in a civilized society. Tolstoy was regarded as one of the leading lights of modern civilization.

In any case, Tolstoy records in his journal something like the following (loosely translated): "When I saw the heads divided from the bodies and heard the sound with which they fell separately into the box, I knew with my whole being that this was a bad thing."

This unplanned and unexpected event marked a turning point in Tolstoy's life. It is marked by the following words recorded in his journal (again the same rough translation):" When I saw the heads divided from the bodies and heard the sound with which they fell separately into the box, I knew with my whole being that this was a bad thing." (The repetition is intentional.) He goes on to reflect about his prior beliefs with regard to civilized society, with regard to Paris as the cradle of civilization, with regard to progress proceeding from Paris throughout the rest of the world, and so on. He writes that his belief in progress included a faith that society was moving in a positive direction and that Paris was leading this movement.

Then he recalls the event: "When I saw the heads divided from the bodies and heard the sound with which they fell separately into the box, I knew with my whole being that this was a bad thing." (The repetition is intentional.) He knew with his whole being— he was fully engaged in this moment. **He saw, he heard, he thought.** As a result, he could no longer hold on to his prior belief in progress and faith that Paris was the cradle of civilization. He could no longer regard himself as one of the leaders of civilized society if this was what civilized society represented.

Topic 163

War & Peace 2

Continuing with the story of Tolstoy: "His faith in progress was shattered. He changed his life entirely based on this event. He gave away his fortune. He declared all of his writing public property. He began writing short moral tales for the common people rather than writing for the educated elite. He began advocating for the reform of peasant schools. He changed his life on account of having witnessed by chance a public execution in Paris." This dichotomy between the educated elite in our country and their proclamation of being civilized, merit consideration, in light of this story. Another point which needs to be thought about is the Author's changed focus on schools for the poor. Something we seriously require in this country and one of the purposes of this course; developing technologies which can provide world class education to them.

"He learned something that day in Paris. That he learned something is marked by the fact that change occurred that persisted through other events and for the remainder of his life. These changes included how he thought as well as what he did; the changes are observable in his subsequent writings and in how he lived his life after witnessing the execution. What he learned was not planned. He was not explicitly directed towards a goal nor guided a plan to achieve a goal. What he learned might be characterized as incidental to his having witnessed the execution." This is the learning we have attempted to discuss earlier and what is required, in terms of triggering events.

"By contrast, the kinds of education primarily discussed in this volume involve intentional learning where a particular goal is involved. It is worth noticing that the goals of a learner might not always coincide with that of the instructor. In formal learning environments, which generally involve intentional learning in school settings, it is optimal when the learner's goals and those of the instructor are closely aligned."

What did Tolstoy learn? Do you recall the sentence from his journal that was repeated three times? Why do you think I repeated it three times?) "When I saw the heads divided from the bodies and heard the sounds with which they fell separately into a box, I knew with my whole being that this was a bad thing." Perhaps this is difficult to say without knowing more. He learned that not all social practices in Paris were good. He learned that he could not accept a society that publicly executed criminals as a civilized society – this reflects a value perspective, which is essential in education and in the application of technology to support education, according to the framework presented in this volume. He probably learned a lot more, and that learning event might well be regarded as a process that only began that day in Paris in 1865; perhaps it began earlier.

This story provides a concrete way to think about learning – learning is marked by stable and persistent changes in attitudes, behaviors, beliefs, knowledge, mental models, and skills and so on. Learning may be planned or unintentional. Learning in which an individual is fully engaged is especially effective. Full engagement often involves perception, cognition and emotions. Technology can be especially useful in promoting active engagement.

Did I change? A question we will address in the future. What caused this and how my philosophy and thinking changed? Naturally, I am no Tolstoy, but I believe every person goes through this change, to some extent or other.

What did Tolstoy learn? (Do you recall the sentence from his journal that was repeated three times? Why do you suppose I repeated it three times?) Perhaps this is difficult to say without knowing more. He learned that not all social practices in Paris were good. He learned that he could not accept a society that publicly executed criminals as a civilized society—this reflects a values perspective, which is essential in education and in the application of technology to support education, according to the framework presented in this volume. He probably learned a lot more, and that learning event might well be regarded as a process that only began that day in Paris in 1865; perhaps it began earlier.

This story provides a concrete way to think about learning—learning is marked by stable and persisting changes in attitudes, behaviors, beliefs, knowledge, mental models, skills, and so on. Learning may be planned or unintentional. Learning in which an individual is fully engaged is especially effective. Full engagement often involves perception, cognition, and emotions. Technology can be especially useful in promoting active engagement.

Topic 164

Recognizing Danger Signals

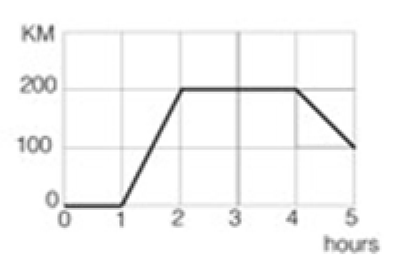
We are turning back to the midterm problem, in which warning signals were artificially induced. To create the requisite conflict to ensure a corrective mechanism in terms of the given questions. The problem was given to both, first year university students, in one college and PhD aspirants, during their interview in another famous university. The underlying rationale for the exercise was to see if the possessed the ability for conflict resolution and if they were trained to do so. If this was not the case, could technology alleviate this situation? First we turn towards the first year students. You are already familiar with the question, i.e. a car is traveling, in a straight line, from Lahore and its displacement/distance is plotted over various hours starting from time 0 on a graph.

The first question was what would be the displacement in half an hour? This was simple question which only entailed reading of data from the graph or from the table. No calculations were required and consequently little marks associated with the question. No special consideration went in the question. Despite this most students resorted to a formulaic approach. Why do they think everything is formula driven? It is commonly observed that they always turn to chug and plug approach and have stopped thinking.

In the results shown in this snapshot; the answer provided is 0 distance. While this is correct its derivation, again through a formula, is entirely wrong. The student assumes velocity to be zero and multiplies this with distance. No value for velocity was provided, still used. Similarly, in snapshots three and four you see the same mistake, velocity in unnecessarily introduced. Looking at it from a student’s perspective this is how they have been trained; to look for velocity (formula) while ignoring the obvious. A fact and prevalent practice of which, earlier, we had no inkling.

Again a correct answers, but cannot read the graph. Another formulaic approach but the wrong formulas used: reflective of either the inability to read graphs or a lack of understanding. The same pattern, was repeated, despite the fact it was an open book problem. Most students knew the formulas, or at least memorized, but did not understand this approach was not required. A problem which was probably acquired in schools and now an inherent part of their thinking process: a fact which makes our task harder since have to make them unlearn this. Currently, in a course on thinking which I am teaching this is what we are trying to teach. Whenever faced with problem in college, job or for that matter real life; first look at the inputs provided and then what outputs required. If these equate there is no need to do anything. If not that we have to understand the relationship between the two.

As teachers we thought, or rather took for granted, that reading of graphs would be trivial. When designing educational technology or pedagogy if we had gone with this assumption, an assumption which most teachers would have agreed with, we would be entirely wrong. We can probably see how critical since if incorporated we would fail bitterly. Although, the results were rather disappointing, tremendous learning was acquired. Useful information for educational design gleaned. This clearly illustrates the importance of assumptions on prior knowledge: teaching teachers what students do not know (Harvard Gazette). Till we address this there is no effective learning.



Problem No. 4: A car was supposed to start from Lahore on the motor way and move towards Islamabad. It was supposed to start at 0 hour? A graph of the magnitude of displacement of the car from Lahore is plotted in the diagram as shown?

(a) Find the distance of the car after half an hour from Lahore - half an hour starting from 0 hour?
(b) Find the distance of the car from Lahore at 2 hours?
(c) Find the distance of the car from Lahore at 4 hours?
(d) Find the reading of the speedometer at 1.5 hours?
(e) Find the reading of the speedometer at 3 hours?
(f) Did the car reach Islamabad within 5 hours?
(g) If some one drinking coffee at 1.5 hours is there a possibility of the coffee spilling over because of high speed of the car?
(h) If some one drinking coffee at 3 hours is there a possibility of the coffee spilling over because of high speed of the car?
(i) How far away the car is from Lahore at 5 hours?

Topic 165

Further Learning's From the Mid Term 1

Earlier we were discussing a customized midterm which we had given to gauge student response in terms of conflict resolution and their thinking processes. The questions contained deliberately designed warning signals. It was observed that most students either ignored these or were unable to resolve the resultant conflict. These signals constitute a critical part of learning. A baby when learning to walk stumbles. The body sends warning signals that, toppling over; immediately the cognitive feedback mechanism re-calibrates balance known as cognitive equilibrium. In this manner a baby learns to walk, an inherent learning process for which it requires no teaching. Similarly, in a murder mystery a detective looks for clues at the crime scene, from which he pieces together and solves the case. Researchers too look at all past research and try to analyze the reasons for previous researcher's inability to progress further. Through this process all new knowledge is created which is also essentially learning. Warning/danger signals form an essential part of this cognitive process – academically or in real life.

In the news you currently see a lot of comparison between democracy and authoritarian rule. Most analysts tell you about the weaknesses of democracy and how decision making is much more effective under a dictatorship. This is entirely wrong. If you look at all major wars, you would notice that; ultimately won by democratic countries in comparison to authoritarian regimes. Why did this happen? The basic reason is that in a democracy all voices are heeded and their perspective incorporated in the decision making process, unlike a dictatorship. The inability in conflict resolution results in wars when nations involved. This conflict exists at all levels; from nations to family and finally at the individual level. Without this ability in conflict resolution no learning or progress. Listening to another perspective essential, the reason democracy more suitable. Consider the examples of Libya and Iraq, two very prosperous nations, where citizen were looked after completely. Free education, healthcare and job were provided for all. Yet due to their toleration structure, the West was able to leverage dissent and ultimately leading to toppling of the regime. The scenario was played out in Iraq. Closer to home, the same applies to education. It is said that in a university the quality of education is inversely proportional to how powerful is the vice-chancellor. If powerful usually the singular perspective applies, conversely collective wisdom prevails. Also, bureaucratic red tape slows down decision making in universities, unlike say a speedometer which immediately indicates your speed and consequently warns you of over speeding. This type of instant feedback is not possible in education without technology as well as conflict resolution.

Topic 166

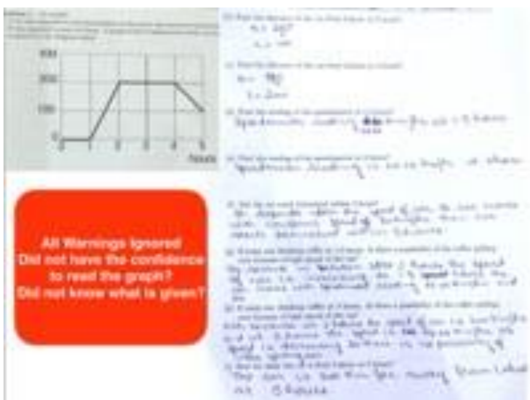
Further Learning's From the Mid Term 2

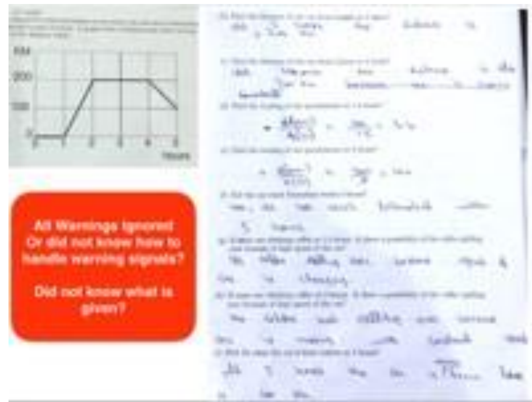
Turning to slides containing midterm answers we can look at an analysis of these. In the first slide, warning signals were ignored as well as the input and required output. The same thing occurred here and problem not understood correctly. It has communicated to these students that in the next exam there were be immobilized for half an hour, so that they can use their minds and not their hands. In the third slide unable to read graph and blind reliance upon formulas. This is not their mistake, since they know no other way .They have not been taught to think; according to teachers out of course. The difficult task of undoing is required. Continuing with the exercise the same mistakes are being repeated. If input is equivalent to output, nothing needs to be done. If not, what approach is required and attempting of multiple approaches to discern what discrepancies – heeding of warning signals. Moving on the pattern continues; greater reliance upon formulas than intuition. For example while driving, mostly rely upon intuitions. In cases of avoiding collisions, scientists have discovered that while braking suddenly, you body responds prior to you mind. If our reliance is so great in real life why not in education or for that matter exams. This is because our educational system has deliberately managed to suppress our intuition. Returning to the problem, some students have no idea what they are doing. What is the problem? This requires a detailed analysis. Looking at further analysis we see that the answer is correct, while the explanation wrong. If the students had tallied the two he would have noticed the discrepancy. Some answers, as you see, are completely correct. These students are the exception and require little help from the teacher, pedagogy or technology. The challenges of our course not for these students, rather those who require help. Other examples follow. From a total of 21 respondents, we see that these exceptions only number four. Those that had failed to heed warning signals, or not having read the problem correctly, i.e. what is provided and what is required, number 16 or slightly over 70%. In our university about 700 students apply for the computer science/engineering course. After the first year two semesters 70%, find the work too hard and dropout. In other universities and other courses the dropout rate is not so high. It is not that these students are not intelligent or that they cannot do it; but their thinking systems are so distorted that they have a terribly hard time. This clearly illustrates the importance of technology required to transform their thinking.

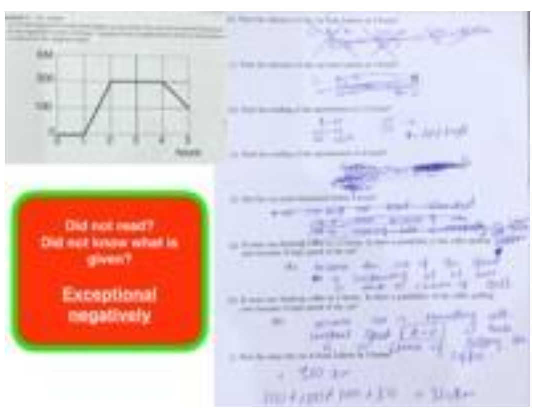
On this graph you see two peaks, usually a bell curve for results. Incidentally, a class fellow of mine in UET, once analyzed the results of final year students in engineering through histograms; this was on an IBM 1103, on which cards were used. He discovered that the results were not in the form of a bell curve. Mathematics, unlike other disciplines, is not propionate the amount of time you study. There is a certain barrier in terms of understanding which only arrived at once you understand a problem, associated warning signals and conflict resolution. Of the two peaks you see one represent the students who have managed to cross this barrier and are conversant in the subject, while the other of careless students. These are not unintelligent people, some of my class fellows who at the time were careless are now business leaders. First twelve years of education critical in this respect.

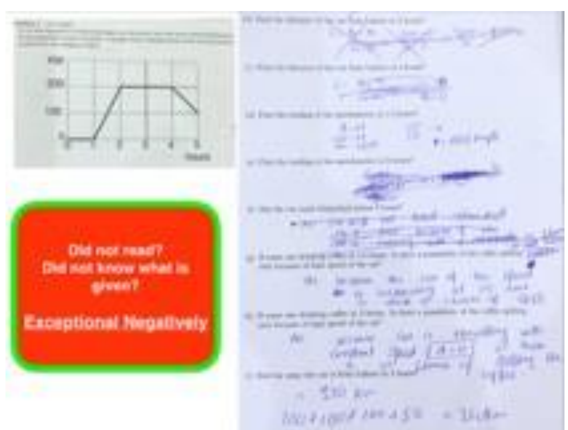

KM
200
100
0
Hours
All Warnings Ignored
Did not read?
Did not know what is given?
Intersting?

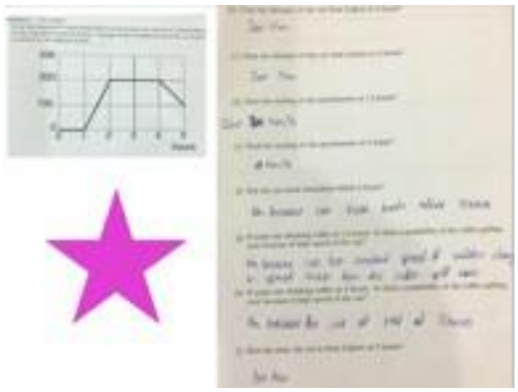

KM
200
100
0
Hours
All Warnings Ignored
Did not read?
Did not know what is given?
Intersting?

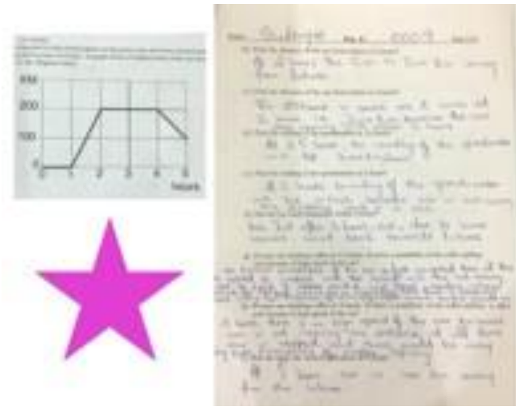

KM
200
100
0
Hours
All Warnings Ignored
Did not have the confidence to read the graph?
Did not know what is given?

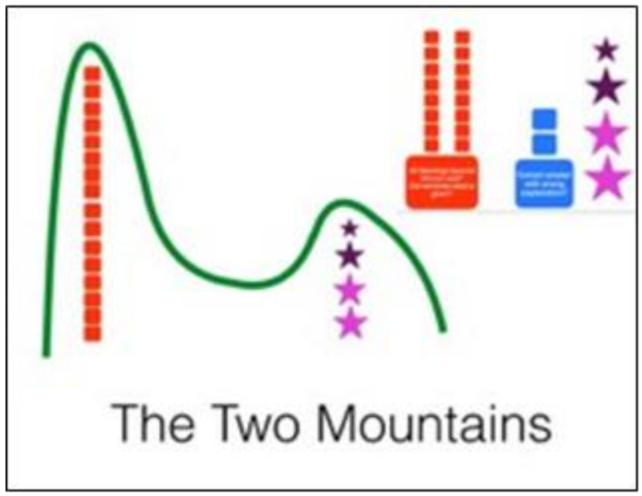

KM
200
100
0
Hours
All Warnings Ignored
Or did not know how to handle warning signals?
Did not know what is given?


KM
200
100
0
Hours
Did not read?
Did not know what is given?
Exceptional negatively


KM
200
100
0
Hours
Did not read?
Did not know what is given?
Exceptional Negatively







The Two Mountains

Topic 167

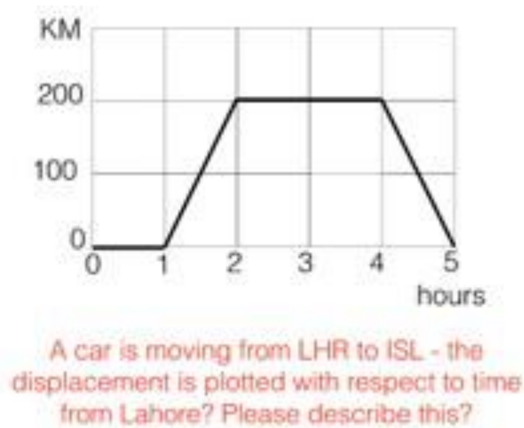
Further Learning's From the Mid Term 3

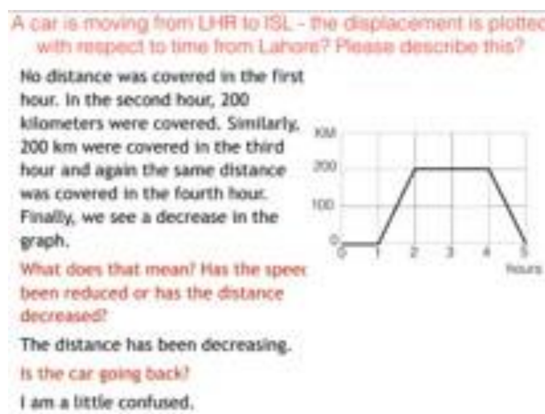
We now look at similar question which were used for PhD applicants for LUMS computer sciences program, which was incepted in 2001. We had numerous applications from varied backgrounds. The main interest was that at the time we were offering HEC scholarships, which paid a stipend of Rs.20, 000 and fees and books were free. The stipend amount in those days was equal to what the industry was offering. Admission interviews were recorded and cross questions put to the students.

The question was something along these lines; a question which should have been easily solvable by O and A level students. A car traveling from Lahore to Islamabad is delayed by one hour. At origin the time is 0. The displacement of the car is plotted with time. The question then becomes; describe the story behind the graph? If you remember from the Harvard calculus, it was discovered that there were many approaches to framing a problem; linguistic, graphical, analytical and tabular. Any teacher or a learning application needs to account for these, to allow students to learn in their own style. The problem with engineering and math's students was that they had never heard a question like this. No stories were told to them while learning and could not narrate any. Most answered that no displacement took place in the first hour; which was correct. The problem arose as the displacement increased, in the first hour 200km, in the second 200. Apparently, they were having difficulties reading the graph. We had plotted the graph of displacement from origin and not hourly displacement. There assumption was wrong. At the end of the graph we see a decline; what does this imply? Has the speed been reduced or distance decreasing, i.e. moving back towards Lahore. The answer was that it was confusing. This was perplexing since graphical interpretation required. The displacement in the fifth hour was asked.

Questions deliberately designed to induce warning signals. There we no time pressure and question repeated in simpler terms for them to grasp the concept. Further still the question was broken down into parts, i.e. what distance covered in two hours. The answer 200km was correct. Yet problems further on. Form this you see that a teacher can never address all students in a one to one situation. This is only possible through technology.

We now move to the written part of question , but before that two quotes might be appropriate: Gorge Polya, a Hungarian mathematician said, “yes the solution seems to work, it appears to be correct; but how is it possible to invent such a solution – how would I invent or discover such things by myself. Another: “In today's Information society, the future of economic well-being rests on the effectiveness of schools and corporations to empower their people to be more effective learners and knowledge creators - Joseph D. Novak.





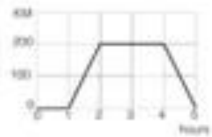
What is the confusion? This is the distance from Lahore to Islamabad.

In the fifth hour, the car did not cover as much distance.

How much distance was covered? This is a graph of distance, not of speed. How much distance was covered in five hours?

I didn't understand.

This is a graph of kilometers. Distance is increasing with time. Study the graph and tell me the total distance.



What is the distance after two hours?

200 kilometers.

How much distance has been covered after three hours?

400 kilometers.

Someone is recording the distance that has been covered after every hour on the motorway while going from Lahore to Islamabad and it has been plotted on this graph. Now tell me how much distance has been covered after two hours.

200 km.

After three hours?

Again 200 km.

After four hours?

Again 200 km.

After five hours?

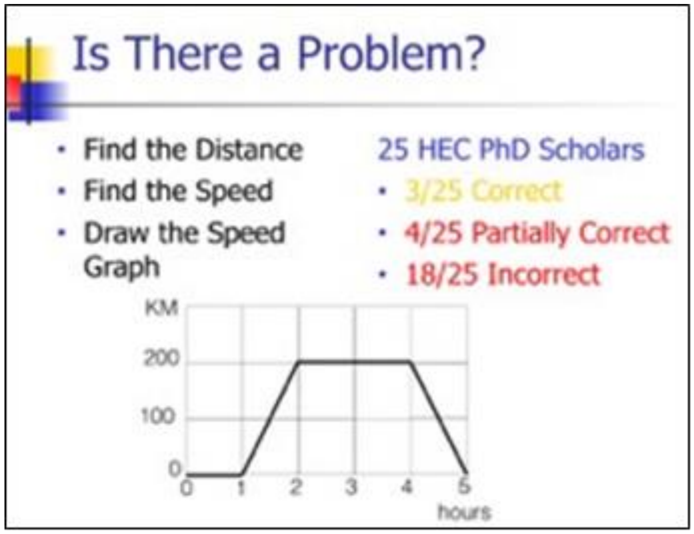
Zero.

Topic 168

Danger Signals &Higher Education

The written question given to PhD students was similar to the earlier question. Displacement of a car traveling to Islamabad from Lahore was measured over time, in graphical form. The questions asked were the measurement of instantaneous speed; this was simplified for clearer understanding, i.e. speedometer reading. Distance at 2.5 hours and various other time intervals. The only different question was the calculation of speed and its graphical representation. 25 HEC scholars were asked to provide distances at various intervals. Only three answered correctly on their first attempt – a cause for concern. Concerning instantaneous speed, four partially correct answers provided. Finally, in drawing of a graph, 18 did this incorrectly. How do we generate, handle and reflect upon this? We will look at this in detail. Yet, we do learn an important lesson in terms of learning and passing exams from these examples. A subject needs to be taught in a manner that it remains memorable. The book shared with you earlier; Foundations of Educational Technology: Integrative Approaches and Interdisciplinary Perspectives by, J. M. Spector, contained one such event in the life of Tolstoy. While what he witnessed was not planned, we deliberately attempt at creating this triggering event.

In the first chapter, defining educational technology, in the book there are some new definitions on education and technology. You must be wondering, why we are looking at these definitions at this stage of the lecture. This course, like its subject, is not static. Technology evolves at every instance and consequently the need for new definitions and the latest in books which I try to acquire for you.


Is There a Problem?
• Find the Distance
• Find the Speed
• Draw the Speed Graph
25 HEC PhD Scholars
• 3/25 Correct
• 4/25 Partially Correct
• 18/25 Incorrect
KM
200
100
0
0 1 2 3 4 5
hours


LOOK AT THIS LATEST BOOK WITH A NEW DEFINITION OF EDUCATION AND TECHNOLOGY PUBLISHED IN 2016
FOUNDATIONS OF EDUCATIONAL TECHNOLOGY
INTEGRATIVE APPROACHES AND INTERDISCIPLINARY PERSPECTIVES

Topic 169

Technology Implies Change

Technology simply is change. Change in this case is considered valid if effects society, otherwise not considered change. How do we cope with this change in terms of its conflicting requirements? I will try to explain through my story.

The story begins in the heart of Multan, At Pul Mauj Daray, where I resided. It was in the 60s and I was around six or seven. At the time we used sleep outside, no other option in the sizzling summers of Multan. In the evening the ground would be sprinkled with water and everyone would move outside. It was the way to cope with the heat in an era, where no air-conditioners, coolers and even at time electricity. It was very pleasant outdoors, since no pollution, vehicle or dense buildings. From this you probably realize that there are positives and negatives to technology. Sleeping outside would mean that we would get up early, due to the sun. Yet, I felt very fresh. I walked to school as did most people. No student came in a car. Our headmistress would come by bicycle. I would pack my books in a cloth sack, since I did not take my school bag. The reason was that I was bought a very nice school bag and when I took it to school all the children, who were rather poor, gathered around to gawk. Things have changed these days it is the rich who gawk if you bring something inexpensive. Even little children have pencil boxes which cost a couple of thousand. Anyway, I felt terribly embarrassed and told my mother that I would not take the bag to school. She enquired if it was not to my liking since I had chosen it. I told her I liked it but would not take it to school.

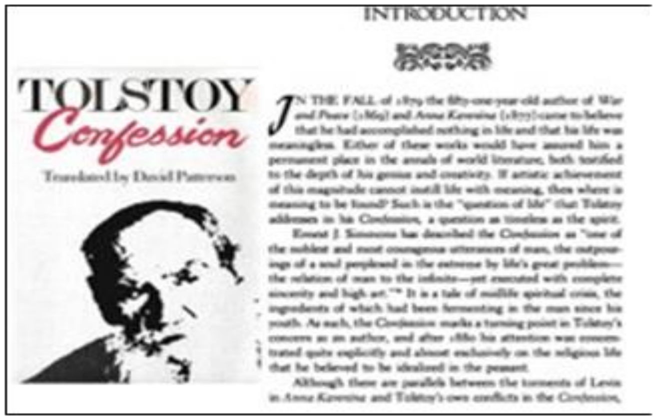
In those days we wrote on tablets (takhtis) to improve our handwriting. An old servant, Babaji, was responsible for shopping; whether vegetables, meat or other grocery items his mode of transport a bicycle. Food and other perishable were stored in a ventilated larder (ganjina).

Cooled water was avialble through clay containers (surahis), ice bought and stored for guests in thermoses. The supervising of cooking of food and maintenance of the household was my grandmother's responsibility, since my mother and aunts all taught. They traveled on a horse drawn buggy (tonga) which was dedicated for their use, a rare things since most were shared. No petrol or gas was used. Compare this to how technology has impacted our lives and society. Not all good. We had fresh milk, butter and lassi (milk beverage). In terms of media our sole technology was a Marconi radio, still with us to this day. From the limited number of newspapers, we subscribed to the Pakistan Times. Incidentally, my grandfather, my aunts and I were regular contributors to this: despite the fact that technology was primitive, greater awareness common.

I remember distinctly my first letter which I contributed. In our college during our FSc, the course for Physics, Chemistry and Mathematics was revised. While there were no issues with the physics and mathematics books, we could not figure out the chemistry textbook. Upon enquiry with the teachers, they told us still coming to grips with the new course. I wrote to the paper, anonymously and pointed out what we could not understand. This started a debate and lots of people wrote to provide the answer. That this was included shows the difference in level, as to what content contained these days. Later we found out that while the physics and mathematics textbook were copied exactly from foreign textbooks, consequently no issues, the chemistry book was a hash of local and foreign content. The issue of pedagogy, a term and concept, of which I was not aware at that time was highlighted by me in the paper. Finally, I asked a friend and was delivered the original textbook, bought from Mirza Book Agency and couriered to me through PIA – the sole courier service in those days.

In those days the use of electricity in schools and home was minimal. In schools we only had a ceiling solitary fan. In the 50 centigrade heat of Multan we studied in the heat. Despite being drenched in sweat we had no issues. Petrol and gas were not used as fuel. For cooking we used deadwood found in our house, which had a large garden. As time lapsed and population grew, a wood vendor (Pathan) established his shop across the road and we used to purchase wood from him. Later this was replaced by wood shavings. Next came coal; a big leap in technology. Coal was specially used for making tea since it was faster. The people living in our quarters would use cow dung in the form of patties, a cheaper form of fuel – technology. When the water bubbled way for tea and the steam caused the rattling of lid, I could envision the technology behind the steam engines. Afternoon was a treat, a time of family gathering after a hard day's work and rest: something which I cherish and will remember forever.

The leap in fuel technology was gas; which we started using indiscriminately. A TV drama on Pakistan Television, Koalaywala (the coal vendor), became very popular. A coal vendor faces customers shifting to gas from coal and how it affects his livelihood. Going house to house most refuse his coal but at one household, of someone thoughtfulness, his coal is purchased despite the fact that they too had shifted to gas. This goes on until after a long time he revisits the house and tells the owner that he can no longer supply coal since he has finished his business and become a gas technician, but he would find him an alternate supplier. The owner tells him he does not require further coal. Upon further enquiry he is shown the house's courtyard which is covered with coal. In his surprise he asks what this is. To which the owner repliers there is something called Consideration.



INTRODUCTION

IN THE FALL of 1879 the fifty-one-year-old author of *War and Peace* (1869) and *Anna Karenina* (1877) came to believe that he had accomplished nothing in life and that his life was meaningless. Either of these works would have assured him a permanent place in the annals of world literature, both testified to the depth of his genius and creativity. If artistic achievement of this magnitude cannot instill life with meaning, then where is meaning to be found? Such is the "question of life" that Tolstoy addresses in his Confession, a question as timeless as the spirit.

Ernest J. Simmons has described the *Confession* as "one of the noblest and most courageous utterances of man, the outpourings of a soul perplexed in the extreme by life's great problem—the relation of man to the infinite—yet executed with complete sincerity and high art."* It is a tale of midlife spiritual crisis, the ingredients of which had been fermenting in the man since his youth. As such, the *Confession* marks a turning point in Tolstoy's concerns as an author, and after 1880 his attention was concentrated quite explicitly and almost exclusively on the religious life that he believed to be idealized in the peasant.

Although there are parallels between the torments of Levin in *Anna Karenina* and Tolstoy's own conflicts in the *Confession*,

CHANGE – EFFECTS ON THE SOCIETY

How to cope with that change as there are conflicting requirements ?

Conflict Resolution?

THEN CAME GAS - AND WE STARTED WASTING IT AS IF IT WILL STAY FOR EVER

پی ٹی وی کا مشہور ڈرامہ

کویلے والا

وضعداری اسکو کہتے ہیں

Topic 170

Studying Abroad

Earlier we were discussing how technology has evolved in context with my younger days in Multan. Those were days when in sizzling summers of Multan, we would study underneath the Neem Tree (Azadirachta indica). There were no air- conditioners or coolers. We had looked at technology in terms of transport, food storage, cooking and other aspects. Now we look at it in terms of communications. During the 60s in Multan the population was around six to seven million and there was only one telephone exchange. These exchanges were mostly manual, i.e. mechanical. We were lucky that we had a phone. Our number was 2427, which implied that there were approximately 10,000 phones in totality. For intercity call, call had to be booked. Direct dialing was introduced much later and considered a luxury. Telegraph was the other medium of communication. Late night telegraphs were a time of anxiety and happiness depending upon what news. Letters were regularly written, and mail did not imply email. Mail travelled through the Khyber Mail in those days, consequently the name, i.e. mail train.

My maternal grandfather Dr. Mohammad Wahid Mirza travelled to London for his PhD, during the early 30's. He traveled from Lahore to London via ship and it took him a couple of months. While in London his sole means of communication was by letter or telegraph. In 1962 my maternal uncle, Dr. Arslan, who went to become vice-chancellor at Quaid-e-Azam University, went for his PhD in biology to Wisconsin, US. We saw him of in a Boeing 707 and took his a few days to get to his destination. His means of communications was still letters and telegraph. During his seven year stay he only called, using the telephone, twice. It took him most of the night to place the call. One instance was when he had acquired his degree and the other at the demise of his sister my aunt. Sarah Fatmi was a English professor at Lahore College for

Women. Perhaps the mothers of some of you watching might have taught by her. Anyway, my son went for his doctorate to University of Central Florida, US in 2013. He travelled in an Airbus 780 and made his destination in a day. Through Skype and regular phone calls we were in touch with him continuously and knew what he was doing at most of the day and see his regularly. In those approximately 80 years, at intervals of 30 or so years, you can see how technology changed communications – from my grandfather to son.

Another grandfather of mine Dr.Abid Ali, also went for his PhD to Oxford, UK. He was the principal for Sargodha College during the 40s. In this picture you see his granddaughter, at VU, where we are figuring out how to teach graph algorithms. Komal completed her degree in TIE (technology innovation education) from Harvard. This program was replicated at NUST in the form of ITE (Innovative Technology in Education). (Picutres).

1935

2014

Topic 171

Evolving Calculations

In 1969, we started university, University of Engineering and Technology (UET). At the time there were only two engineering universities in the country; one in the West wing and one in the East. In those days' personal calculating devices, calculators and computers were nonexistent. In those days the only available option was scientific calculators. These used to consists of two fixed edges with a sliding middle portion. A short orientation course was available and required. Once understood, it was capable of performing quite complex calculations. I distinctly remember my first slide rule, manufactured by Faber-Castell, a German company. It was purchased from the Anarkali Bazzar and it came with a beautiful protective leather case: its use and memories cherished still. There was a certain pedagogy associated with the slide rule. The ruler was operated manually and used a moving/sliding cursor. Some of the calculations carried out were quite involved and involved multiple steps. The step by step process and sequential manual operation allowed lead to numerous chances of error. To counter this we were taught the use of paper and pencil, in arriving at an approximate answer or estimate. This is a good example of warning signals, at least flags the fact that, if your answer even in the ball park. Allowing you to revisit you answer or rely upon your intuition. With calculators this is no longer possible. As in the displacement problems discussed earlier, it was quite apparent, in the post mortem of results, that an immediate resort to a formulaic approach was taken; formulas relied upon even when not required. We need to revert back to an approach where a student thought about a problem prior to attempting to solve it.

A multiple approach allowing a student to countercheck their answers needs to be reintroduced. If the slide rule does not yield anything within the anticipated range, you would probably anticipate user error. This pedagogy needs to be reintroduced through the use of technology. While the slide rule has been replaced by powerful handheld calculators and computers, it reminds us that a powerful affordance of an educational technology is to get one to think about the problem one is attempting to understand. The educational principle here is that reflecting on the nature of the problem being solved is often more effective is providing learning and understanding – a principle well worth remembering. This was the story of the slide rules.

It is strange fact that I have never purchased a calculator in my life. As a professor during the late 70's and early 80's, at UET, my pay was not sufficient to acquire one. In those days calculators were rather expensive. A good friend Zafar Mahmood, my friend since FSc days in Multan, who later became my colleague at UET, went to Japan for MSc. On his return he brought with him a precious gift, a gift if given today you would probably throw away, it was a Casio scientific calculator.

Our university department purchased our first personal computer in 1980. All our department research funds went towards its purchase. It was the first computer which I touched with my own hands. You have heard its story before in detail. It was a RadioShack TRS 80 Model 2. At the time its memory consisted of 64k ram and contained no hard disk. In comparison the Apple watch I am wearing contains much more memory than the computer. From this you can realize how technology has evolved. These days all my children and even grandchildren have their own computing device; whether a laptop, tablet or android devices. All these are enormously powerful than our university microcomputer, which at that time was priced around Rs.100,000. This aside my driver, has an Apple Macbook Pro and an I Phone. He can utilize this to take any university lectures from top class international universities, if he wants.

We next turn to new definitions of technology and how it can be deployed in education more effectively and efficiently.

Topic 172

Technology Changing Society

Now that you have heard my story of three generations: from my grandfather to my grandchildren - approximately, a period of a hundred years. The changes in technology, during that period, and it speed is mind boggling. A change is only construed as such if it is for the betterment of society or if it creates a change in society.

Change is integral, nothing remains constant but the divine. You could possibly question the betterment part of the definition, in terms of technology. Have more benefits accrued in comparison to disadvantages? Yet, you cannot question the fact that there have been tremendous changes. Some critics would point out that some groups have been disproportionately favored, while other left behind. While this may be true, it is only through technology that we will be able create equilibrium.

Technology involves the practical application of knowledge, for a purposeful change; again a point which can be debated. Knowledge is progressing and so are the goals and intentions of people. People's demands and requirements are progressively increasing. In the old days travelling from one city to another was a chore. Now it is easy to travel globally even to the earth to space -the destination of dreams one which will never be arrived at. Technology is all pervasive and changing every aspect of our lives. How you communicate, live, educate and relax. "Technology changes people and people change technology," a famous quote. We are now transferring a treadmill of technology, which perhaps out of our hands. Who affects who, no one quite knows. A thousand years ago or for that matter a hundred years ago, the pattern of living around the globe was quite similar. Starting with the advent of the steam engine the fragmentation caused by technology is quite evident: the fragmentation of empires and the rise of new entities and territories. Change is the imperative word; it has now assumed a life of its won and beyond anyone's control. We need to harness this Frankenstein to play a useful role in education. Technology makes things possible which were not possible in the past. The earlier stories all contain elements which point towards this trend. Similarly, what is impossible today will be tomorrow's possibility.

We now turn towards education and see what new definitions we can derive. Our course, the use of technology in education, raises certain questions. Why is that with all the changes in technology our classrooms, course books and other educational tools are pretty much the same as they were a hundred years ago? This is the main purpose behind this course to tackle this issue of education.

Topic 173

Purpose of Education

Education is defined now, as always, involving a purpose, or goal and a process to achieve this. Knowledge and process of learning are essential for any educational experience. Learning is a change in what a person can do or believe. There should be a marked change, wither in thinking; a change from a geocentric belief to a heliocentric belief of the universe. 35:35 this change in thinking took place over a period of hundreds of years, as did the ideas of Newton and Einstein. There are many things which have been made possible by their discoveries. Using Newton's laws we could predict planetary motion, on which we consequently based our satellite orbits. So learning implies a change in what a person believes or can do. Similarly, new knowledge is a change in what a person can think, do or achieve which was not possible without this knowledge. This sounds very familiar to how we had defined technology earlier. It seems like we are talking about education yet it appears as if we are discussing technology. So learning through new knowledge is a change in what a person can do, to achieve a purpose. Similarly, technology involves the practical application of knowledge for purposeful change. A point which the author is trying to reinforce, that technology and education are similar in terms of objectives. A concept which hs enormous implications for our course since based fundamentally on technology and education. The commonalities are shown in the diagram which follows. On one side you find Learning/Education and the other Technology. The underlying elements under the two are as follows: Learning – Knowledge, Change, Process and Purpose

Technology – Application of Knowledge, Process and Purposeful Change From this diagram distinguishing the two is hard. Now we turn towards aggregating the two, education and technology and defining them. Educational technologies involve the disciplined application of knowledge for the purpose of learning, instruction or performance. The notion of disciplined application of knowledge is included to reflect the view that educational technology is an engineering discipline. The major difference between a science and engineering disciplines is that; science studies existing phenomena. Engineering meanwhile creates new systems and structures. Thus the classification of educational technology as an engineering/design discipline, through which creates something new. All new design solutions based on scientific theories; educational technology based on learning theories. Past experience and empirical evidence guides what professional educational technologists do. This is the reason that in the book teaching is described as a design discipline/science. Its principles derived from basic sciences and empirical research (students teaching methodologies) and rooted in constructivist and behavioral theories and beyond these in; cybernetics, communications, cognitive, design, organizational theory, psychology among other. A truly multidisciplinary based approach. Educational technology is inherently an interdisciplinary enterprise, which makes it rather complex. This is the reason that problems in education in Pakistan. While various departments in isolation are strong, since there is interdepartmental communications education suffers. Very few educationalists are available in comparison to teachers for other disciplines.

The principle of encouraging problem solvers to reflect upon the nature of the problem, can be traced back to cognitive psychology, perhaps it goes back much further. This reliance upon a multidisciplinary approach is based upon the fact that problems in educational technology are complex (wicked problems) and challenging. For these problems, it is especially important one think about what one does and naturally, why and how, in a disciplined and systematic manner. It is of great import that this research commences in Pakistan, for instance the MSc program we had introduced at NUST. In other educational programmes there are separate department for pedagogy, technology, social sciences and basis sciences (Pedagogy-Content – Technology) yet no department talks to another. Till the time they communicate educational technology will not be developed.

Topic 174

Framing Learning Changes

Learning is a holistic concept that involves cognition, cognitive memory, mental constructs, language associations, non- cognitive emotional states and physical conditions, aspects and constraints. All these variables have an effect upon learning. Suppose a student is not motivated to attend class? We have extensive knowledge of human physical development but more limited knowledge with regards to other aspects of human development – cognitive, emotional and social development. My daughter, who is going to for her MSc, in her college Colombia they do not distinguish between the three aspects of development. What students understand in class is not solely a cognitive problem but also of one of emotional and social development and cognition. Much learning is unplanned and incidentally associated with a variety of actions, while much of the learning which occurs in educational programs is planned. This is where the problem lies, why can little children learn on their own but as soon as put into school this ability deserts them. Planned learning activities typically occur in complex environments; classrooms, online education, blended learning and workplace locations, with many things which can enhance or otherwise inhibit learning. Strangely, planned learning activities instead of enhancing often prove to inhibit learning. Our school environments distort the thinking processes of our students. Solely focused on getting good grades and able to move in to chosen fields of vocation. Determining the extent to which learning has occurred involves the analysis of measure or indication of change; before, during, after and long after. In terms of lecture this would mean examination of student prior knowledge before a lecture, the understanding taking place during the lecture and what retained after it. Also a test of long terms retention is also required. Why learning occurred to the extent measured or observed is even more challenging. Here the scientific cognitive theory helps in gauging learning; how much, why, and how. It also deals with how student attention and retention can be enhanced; an area in which technology can play a crucial role. Performance is something that can be observed, assessed, measured and rated against a standard or other point of reference. This can be greatly enhanced by technology, a case of which we will discuss in detail later. Change in performance, especially improvement in performance is particularly important to an instructor. Providing feedback on performance very soon, even instantaneous, after the actual performance, is very effective in improving performance; if feedback is specific and constructive.

As a dean in university, our institution has a system of quizzes, leading to midterms, leading to Finals. We have discovered that if quizzes are graded in time, positive and constructive feedback provided the midterm results are positive and vice versa. The role of administration, along with technology and education necessarily implies the human factor. This is the hardest to change and requires a long time. In top universities of Pakistan, quizzes are still not graded on time. To counter this technology is greatly utilized in mitigating the human factor and providing instant feedback. The approach of preaching and teachers training which has been going on for 50 to 60 years has proven ineffectual.

> *Educational technology involves the disciplined application of knowledge for the purpose of improving learning, instruction, and/or performance*. The notion of disciplined application of knowledge is included here to reflect the view that educational technology is an engineering discipline in the sense that principles based on theory, past experience, and empirical evidence guide what professional educational technologists do.

These principles are derived from basic science and empirical research in such areas as cognition, cybernetics, information science, human factors, learning theory, mass communications, message design, organizational theory, and psychology. Educational technology is inherently an interdisciplinary enterprise. The principle of encouraging problem solvers to reflect on the nature of the problem first can be traced to research in cognitive psychology (perhaps it goes back much further).

LEARNING - PERFORMING - ASSESSING - DOING - EXPERIMENTING - EVALUATING -CONNECTING - REFLECTING ARE ALL ARE HAPPENING AT THE SAME TIME? WE SHOULD NOT SEPARATE THEM?

WE HAVE SEPARATED THEM INTO LECTURING - EXPERIMENTING AND EXAMINING?

WE HAVE SEPARATED THEM INTO LECTURING - EXPERIMENTING AND EXAMINING?

THE FACTORY PIPELINED MODEL WHERE THERE IS NO TIMELY FEEDBACK?

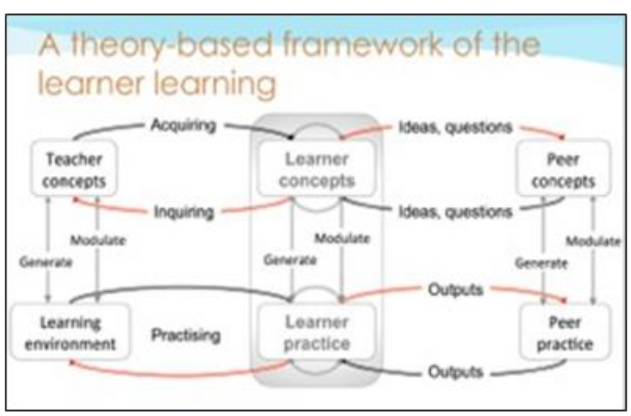
Topic 175

Instant Feedback

What happens if there is no feedback? When coming over here one was not feeling well. Seeing my rather depressing posts on Facebook, even my son abroad called and enquired as to why I was so depressed. The matter was that at our university the final exams were to take place in a week or so. In most subjects almost half of the class has dropped out. The reason, I believe was that we had not provided them with appropriate feedback in their quizzes, labs, assignments and midterms. Due to this the final year came as a surprise, full of uncertainties. Now each of these students had paid Rs.25,000 for each course. For a middle class family, this implies a serious amount of money. Unfortunately, the onus of this failure resided with us, in terms of not providing appropriate feedback, and consequently my anxiety. It was not a matter of replacing teachers, since a significant majority of new teachers would also repeat the same mistake. Change is the most common denominator which can be measured quantitatively through technology. If we had gotten the appropriate warning signals in time we could have attempted to tackle the situation. If learning has occurred a person can do something which he or she could not have done earlier, showing change has taken place. New technologies and knowledge have made this possible.

Developing an individual's ability to monitor and asses his or her own performance is often a desired and measure able goal for advanced learners. For example in English we can break down the subject in various smaller components, i.e. compression, reading, expression, etc., and asses where he stands and then focus on that aspect to make sure everybody is on par. The one size fits all approach does not work and technology is the answer. Also, this is a cheaper solution. Technology does not scold or indulge in sarcasm and is also available anytime and anywhere.

Performance is a holistic concept that typically involves cognitive as well as non-cognitive abilities. Performance may vary with an individual's mood or other factors affecting the individual's performance at that particular time. Our understanding of human performance is reasonably well developed but far from complete. Any variations in performance across different individuals and tasks are not predictable based on current evidence, knowledge and theory. Performance and learning are closely coupled concepts. Performing tasks and activities can result in learning; as learning develops in a particular domain performance in tasks in that domain is likely to improve. Learning, performing, assessing, doing, experimenting, connecting, thinking, reflecting are all happening at the same time when learning is taking place. We should not separate this, something which we have managed to do. This happened due to the absence of technology which could have consolidated disparate facets. The straight pipeline model (manufacturing), where there is no feedback, cannot work. A feedback pipeline model will need to be developed, where learning, experimenting, teaching, doing, reflecting, connecting, evaluating, examining and assessing will need to be carried out in conjunction.



Topic 176

Turning of Days

There are many perspectives from which we can look at our course:

Kyon gardish-e-ayam say ghabra na jai dil

Insan ho, pyala-o-sagar nahi ho mai

Why should the heart not troubled by the turning of days

A human after all, not a cup or wineglass am I

The significance of this famous Ghalib couplet will be highlighted later. Prior to that, since we have covered a significant portion of our course, a summary might be in order, along with what we plan to cover later. Earlier we had discussed the design of intelligent learning applications. The critical points were it adaptive nature: that it is able to adapt itself to cater to individual student learning styles; Interactive and provision of instant feedback; record keeping, keeping track of individual learning styles. We have also learned some golden rules. Whether the form of teaching; classroom setting, interactive or blended learning, the problem should be presented in the form of a story and not in symbols. Mathematical if mathematics, equations is chemistry and so on. This is now a universally accepted norm which unfortunately here we do not follow. We also assume that before commencing 'prior knowledge' is tested for. This can only be achieved through technology, its methodology discussed earlier. No learner would be allowed to progress, until his prior knowledge certified.

In the university I am currently associated with approximately 700 students apply for computer sciences. English is a key issue. Reading with comprehension and writing with understanding, listening and speaking. If you are not proficient in these facets, learning computer science is extremely difficult. If you cannot express what is in your mind properly you cannot clear an exam. Here I am not saying that all students should be able to speak with American accents, rather you should be able to express yourself with clarity and simplicity. Apart from any learning institution, these conditions also apply for any organization, where you may choose to work. The students which apply to our university comprise of great diversity. This is especially true for English, in other subjects there is more correlation. The main issue is with speaking and comprehension/listening. While this diversity may not exist for LUMS, NUST or for that matter UET, it is a serious problem in our university. This is a great challenge for us, i.e. the use of information technology for English. Yesterday an applicant for a teaching position visited an MPhil and a position holder from Kinnaird College. She was expecting an interview, instead I told her; this is our problem and if she could solve it. I told her she would require various resources and deliberately omitted technology, to bring all the students to a standardized, acceptable minimum standard. We have three English courses and the lecture is standard for all and does not cater to the diversity. I asked her if this was impossibility and if not how do we solve it? I told her I was not expecting answers to the effect that one would try their best or that the children are not intelligent enough. We had discussed this point earlier, whether pedagogy, technology or its mix, in universal learning design, no student is unable to learn. The fault lies with the teacher. When I joined and reiterated this point there was a great hue and cry. Strict administrative measures were required to get this implemented.

Topic 177

English Vinglish

This problem with English is not only confined here, rather an international one. There are some vested interests, for example students enrolling in MIT, Stanford and other top universities, and at forefront of increasing American knowledge/research mostly foreigners. These graduate students go for their MSc and Phd degree with English as perquisite. So it is imperative for these universities to provide quality English education: a matter of survival if you will. Now this teaching is not possible through conventional lecturing. A lot of financial resources were directed towards fixing this problem and various packages designed, which we attempted to explore. The best automated software we were able to locate, one used by the earlier mentioned top universities, was provide to us along with a license for ten students and three teachers. The first thing, which the interactive package, does is to analyze where each student currently stands; without embarrassing them. After assessing their placement it starts bringing them to par. It also allows for teachers to localize or adapt the software. The software also allows for flexibility in terms of time required for completion of certain proficiency. Now if you compare this to what we are doing currently you will see how our standardized system compares with this variable one a complete paradigm shift.

Returning to our summary, a learner is also encouraged to look at the bigger picture. Instead of attempting to solve a part of the problem students should look and think about it holistically. Feedback too is provided continuously, instant feedback, so periodic exams do not come as a complete surprise. We had also discussed cognitive disequilibrium and the importance of danger signals: how to create, generate and exploit them. We stressed the need for approaching a problem from multiple perspectives/methodology and the importance of artificially introducing cognitive disequilibrium in a problem. We had also addressed conflict resolution. We also looked at concept maps, a pedagogical tool, which helps in charting your thinking processes and another aspect of technology, i.e. unlike humans its capacity for infinite patience. Now we turn to the remaining course and some truly exciting and ambitious problems. Here we will only describe these problems to pique your interest. Most of these are based upon real challenges which I am facing as a dean at a prominent university.

Topic 178

Of Universities

Despite the fact that it is not customary to talk about universities in a public forum, probably extension of the fact that we do not like to express our emotion or thoughts, especially publically - a fact of which I am very much guilty. I have been asked by numerous universities, with which I have been associated, not to do so. But how can one not express himself? Ghalib captured this nicely in his couplet, with which we started this section. At my current university I have been given three year tenure, as dean of computer sciences, in which I have to rectify the situation. Of the 700 students enrolled every year, fifty students each are placed in 14 sections. When I joined the university, I was not told why the earlier dean had been dismissed on days' notice. Also my challenge was not highlighted. Sounds interesting, to be given an important post and not told what you are supposed to be doing? Rectifying a problem without its identification can be problematic. So as I mentioned the division of students in sections is not a problem.

We have well stocked labs. Computers are available. The fee structure I had told you about earlier: a student pays Rs.25, 000 for a course and in a semester the typical workload is four courses or Rs.100, 000. So if all this is available, what is the university's problem? Very few universities have this kind of infrastructure and a custom built facility. Teaching Assistants and graduate students, who also serve as laboratory engineers, are there to assist faculty and students if they choose to do so.

Library facilities are world class, with no financial constraints. Since it is a private school, there is no bureaucracy or red tape; decisions are immediate. Multimedia is available in each class. In our days in UET there were only overhead projectors, most of which were dysfunctional. I remember that for my PhD symposium I had to borrow one. There is student unrest in terms of unionization and students receptive to faculty and administration. All classrooms are air-conditioned. The university buildings are surrounded by beautiful landscaping and contain appealing artwork. The university higher fee structures should point to intrinsic motivation on part of the students. In comparison the fees at UET were so low that people said that this was the reason students were not motivated. Infact the salaries of accountants for monitoring fees were higher than the actual fees. The converse excuse given at our university is that since rich kids not really interested in studying. The university curriculum is the best I have seen; despite being associated with many universities. Yet, a sense of inferiority complex remain, upon enquiry internally I was told that there is no comparison to LUMS. A perception that is factually wrong. In large universities the scale is so extended that it is difficult to alter subjects within a curriculum. At our university this can be done with a short notice. A student evaluation mechanism exists for instructors. Some of the best faculty is available, a significant number pioneers in their fields and involved in setting up these disciplines in earlier varsities. Based on these attributes, what should be the performance of such a university?

Topic 179

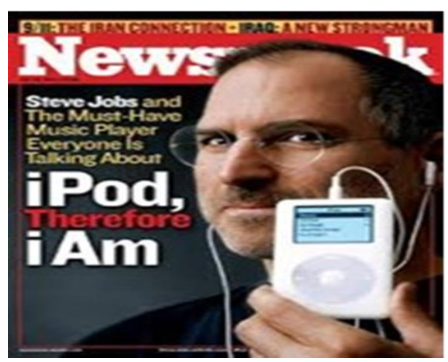
Communicating and Feedback

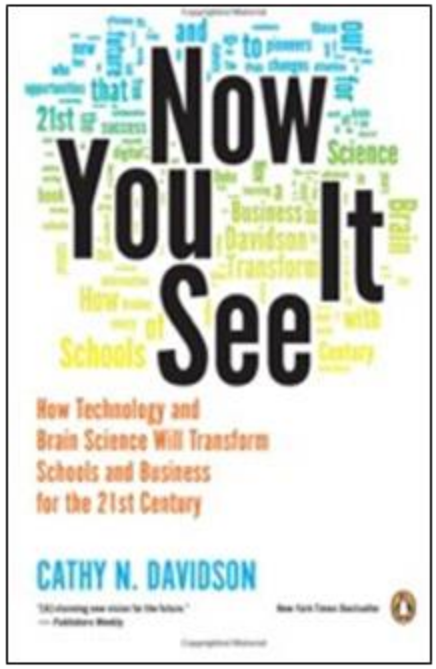
Upon joining the university, meeting with faculty and students, looking at the syllabi and visiting the facilities, there seemed to be no apparent problem. On further investigation, the underlying problem turned out to be that the students were completely fearful of talking. There was no interaction between them and faculty and administration. The only medium of communication open to me seemed to be Facebook. Despite it being misused often, sometimes people do actually put down their actual thoughts. When I started using this medium I was told it was beneath the dignity of a dean. Also they had issues with the fact that all university matters were posted on an open forum. There are many detractors to this medium, for instance a head of computer sciences at another university wrote a Ramadan greeting and then posted that he would not be using this medium for the rest of the month. The implication being that somehow it interferes with ones religious obligations. The story of how Facebook started is quite interesting.

Started by Mark Zukerberg at Harvard; the Harvard Crimson states that it started off as a social dating site called facemash. It consisted of photos of female students from facebooks of nine houses at Harvard. Two pictures of girls were paired and posted for comparison as to who was the 'hottest'. These pictures were often hacked and taken without permission. The initial site mirrored and paired physical community with real identities; this later went on to become Facebook. The initial reaction from Harvard was one of great opposition and even legal ramifications. Naturally later on this was modified due to its success. At the time Mark

Zukerberg wrote in his blog; "I am jerk for making this site, oh well, somebody was going to do it eventually." The site was sent to several servers at other universities but was shut down by the administration. Mark faced charges of copyright infringement, breach of security, invasion of privacy, theft among others. Eventually all charges were dropped. Many stories circulate as to what transpired: after having been called in front of committee, Mark appeared totally unrepentant and said he would do so again. While the site was up Harvard's computer was overwhelmed in 25minutes to which Mark replied it took only two. Realizing what had happened, the Harvard people realized they were onto something. A teenager had created something innovative which they could never think of. In terms of ethics was he very much different from how large corporations operate? It current popularity attests to the founder vision. Yet, some negative connotations associated with Facebook still linger. People, including my wife, object that why are you always on Facebook. For me it's a medium of expression. In our MSIT program everyone was connected via Facebook and any problems and issues were immediately posted to be tackled. Also, I revert to it when despondent. Facing resistance at work I often express my feelings on Facebook, something which is not looked upon favorably by the university's administration. To which I replied with Ghalib's couplet mentioned earlier: Why should the heart not troubled by the turning of days, a human after all, not a cup or wineglass am I.

Let us look at who else was opposed to technology. Cathy Davidson, in her interesting book, "Now you see it", tells the story of iPods at her university Duke. The news at that time appeared on the cover of Newsweek; Steve Jobs quoting – IPod there for I am. Duke University was distributing IPods to all its undergraduate students. This was frowned upon. Why a world class university with plush endowment, stoop to such a cheap publicity stunt. The Chronicle of Higher Education, one of the popular research magazines, for which professor vie to be published, had this to say: "Transforming the IPod to an academic device, when the simple fact of the matter is that IPods are meant to listen to music. It is an unnecessarily expensive toy that does not become an academic tool simply because it is thrown into a classroom." Most other senior members of the higher education community agreed with the assessment. If this was the opinion in the US, think what opinions about technology exist in our context. Whatever the pundits thought Duke's efforts were based upon an Apple initiative in which it would partner with six campuses in sharing its technologies for proposed campus wide usage – a business and education partnership. The partnership was entirely exploratory in nature and no concrete use, perhaps the reason for the intense opposition. One university selected Apple's PowerBook loaded with I life video and audio software. Another chose e-portfolio online workspace, which would develop multimedia projects (quite understandable from an academic viewpoint); while another Apple's audio software for creating audio archives. Duke's choice of flashy music listening gadgets, which young people loved but baffled adults, created a strong reaction amongst the academia. At this time the IPod had no single educational application, since it was not designed as such. Nor did it seem to fall in the overpriced category of information technology (IT). In the backdrop meanwhile huge billboards had sprung up everywhere showing young people dancing against vivid colors. What could all this have to do with education? At the time no one was thinking in terms of their learning potential, since they were clearly about young people and not IT administrators. This was the reason that that intrigued Duke. Their thinking was that educators had to start thinking about the incoming students, who were born after the information age was in full swing. They were the last entering class who as a group would remember the before and after of the internet. If born roughly in 1985, they would have entering grade school when Tim Berners-Lee was writing his first protocols for the internet. These kids would have grown up searching for information online, socializing online, playing game and sharing music. Categories and distinctions that an earlier generation of students would have observed in school and at home, between knowledge making and play, which came bundled in a new way for this first generation of students who were learning in an informal way the boundaries between learning and play were eroding. Their schools had not changed much but at home online they were already information searchers – they had learnt by goggling. What if instead of telling them what they should know, we asked them to continue the lesson on the internet itself? And let them lead us to a new exploratory way of learning to see if this self-directed way might mean something when it came to education. What if we assume that their experience online patterned their brains to a different kind of intellectual experimentation and what if let them show us where the pedagogical results of such an experiment might lead to?




Now You See It
How Technology and Brain Science Will Transform Schools and Business for the 21st Century
CATHY N. DAVIDSON

Topic 180

The Future of Thinking 1

Another book by the same author "the future of thinking," narrate the story of all the professors who might be found my college. Like all god teaching our lesson begins with a story of a typical classroom. The instructor is reading aloud from a passage in the assigned work for the week. He looks up to find all students deeply engrossed. Their rapture is alas is not for him but their laptop screens. Their attention on messaging on Facebook. These children do not want to learn. What needs to be done, the professor did what any professor would do. Later that day the professor sent off an email to his colleagues stating that laptops during class should be banned or at least at the minimum Facebook should be banned. What could you comment on this? An outrage! More familiar that students are distracted by their laptops, their attention too readily drawn away from class activities and lessons.

Perhaps another response might be that I am the most hated teacher, few would go down this route. Perhaps the professor should not be sitting at his desk and reading aloud from a book – something quite basic. Incidentally an interesting story: a student came to me in college and told me that he attended every class and lab, a fact which can be verified and consequently I should let him pass. I said without an exam and he replied yes. Upon asking why he said that each teacher goes to his class, you too as a dean come to your office, yet we do not what you do since there is no exam and you get your salaries. Consequently I should be allowed a passing grade for just attending. Technically he was right, if the teacher's sole function is to read aloud from a book. Each of the responses deserves some consideration. The latter/last raises some questions. Our teaching methodology needs to be reanalyzed.

1 Introduction and Overview: The Future of Learning Institutions in a Digital Age

A university classroom. The instructor is reading aloud from a passage in the assigned work for the week. He looks up to find all his students all deeply engrossed. Their rapture, alas, is not with him but with their laptop screens, their attention worlds away. Later that day, the professor res off an email to his colleagues suggesting that laptops be banned from the classroom because of incidents like this. At least FB should be banned?

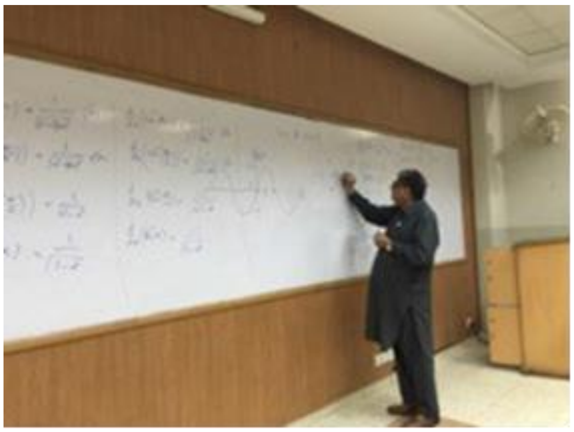
Why is a professor at the front of the classroom at all? Why is he reading out loud? What are the forms of learning implicit in such an act, and how do those forms edify our concept of learning, education, and the whole process of communicating ideas? How do laptops change the way we learn? And how *should* they change the way we teach?

Topic 181

The Future of Thinking 2

The book we are discussing is a very recent one. The question raised in it critical and much more basic. Information technology and other considerations come later. Why is that classroom architecture designed to give prominence to the professor? While the students are ignorant the professor's job is impart /transfer knowledge; known as the banking model in pedagogy. What are the forms of implicit learning in this act of reading aloud? Is there any learning and what type? How does this edify education, learning and the whole process of communications? The question should be how laptops can be used to teach. Instead of banning them we should utilize them. But prior to that we need to understand what learning is. In our college we face the same problem; here teachers can even fine students. The wish most universities to become highly ranked through strict academic discipline and coercive measures, is paramount.

This was the crux of the problem at our university. Faculty point out that multimedia and technology are the culprits. As a student sits in front of the dean in fear, once Mark Zukerberg once sat in front of the committee at Harvard. One day I enquired of my senior instructors as to the strengths and weaknesses of our students. The strengths were stated in writing and included: reasonable intelligence; posses' rudimentary knowledge; no learning disabilities; digitally smart; energetic; will to learn; optimistic; and healthy. What then is the issue? Out of the 700 students enrolled, 550 dropout every year. We will discuss this in detail later. The stories behind this started coming to light through face book. In terms of weaknesses: there failure rate was very high; did not possess academic habits (what are these); no fundamental knowledge of morality; short attention span (but this common according to pedagogy); zero expression; weak analytical skills (these need to be de-learned from earlier teaching); no contemplation; cultural change; distraction due to girls. Now from this book, “disrupting class,” we will try to look at what constitutes a good university.



Topic 182

Troubleshooting at the University

Earlier we were discussing that upon joining my new university one came across multiples issues in terms of: education; pedagogy; systems; classroom; examinations; lab conduct; etc. Now this has two aspects; the diagnosis of the problem and its treatment. As to the diagnosis part this is done through an 'educational audit,' something which is not available in Pakistan. Unlike a financial audit this is not a purely a quantitative exercise. Once the correct diagnosis is made a remedy can be sought. Again two areas need to be analyzed: systems; mostly procedural including, books prescribed, how exams conducted, what pedagogy utilized, and other similar aspects.

The other consideration is, a system's implementation, how efficiently, with what intentions, biases is this implemented. Problems can exists in each individual aspect, systems and Implementation, but when compounded a serious issue. There are no ideal systems, every system has some flaw. Yet, some systems are naturally more conducive; greater output with little effort. Leaving human inefficiency aside, constant for our purposes, what is the better system? We look at this in context of an actual case study at my new university. We will analyze all aspects in relation to education; administrative measures, assessments, classroom and lab pedagogies. We would discuss these based upon the prior knowledge we have acquired earlier in the course. But before opening this Pandora's Box, I would like to narrate some of my own stories in relation to our discussion. These personal stories are closely intertwined with tales of technology, pedagogy and a blending of the two. With this let us look at how we can arrive at a correct system assuming that the human element remains the same. What changes and system is required?

Topic 183

Early Learning

When I was around nine or ten my mother was quite taken by the desire for me to formally learn recitation of the Quran (Qirat). My maternal grandfather, who was proficient in English, was also able to read and write Arabic. The task of teaching me fell on him but after a while a formal teacher was appointed. From a pedagogical perspective there were issue of understanding, making understand, remembering, goals and my reaction. I was attempting recitation in a language of which I had no inkling. Since no prior knowledge, mentally I could make no connections. The daily lessons of around an hour were a virtual impossibility for me. There was a rebel within me, who questioned the teaching being imparted to me and its requirement. My mind's pedagogical setup was not designed to understand and this lead to frustration, confusion and impatience on my part. During this time, the teacher, who was rather old, passed away. His son took over and since he was closer to me in age we formed a friendship. This allowed me take frequent breaks, during which we chatted. Those were painful days and time dragged on. My mother seeing my distress stopped the lessons, but handed me over to her father my grandfather. My grandfather apart from teaching me recitation also taught me English. The textbook used was called 'Radiant Reading' a very popular book with lots of illustrations. In those days little was known of pedagogy and now it is know that there should be entirely separate textbooks for foreign learners and native speakers. I became deeply troubled and tended to avoid my grandfather at other times. My aunts used to tell me how lucky I was to be taught by him – my luckiness I failed to understand. Now in hindsight I realize why my brain was resistant to this teaching. Our brains are designed that if you try to teach something which he cannot relate to (pedagogical theories) any prior experiences and will face great difficulties in learning.

I had started school rather late, apparently around the 4th or 5th standard. Before that I spent most of my time with grandmother, since my mother and aunt's away teaching. My grandmother would sit out in the verandah. Our house contained many quarters and also temporary low income housing. In the winters I remember gypsies too would join this community. Young girls from these families would come to my grandmother for lessons in the Quran and basic Urdu: which she did without charging anything. The presence of these girls at time would annoy me since after a couple of month they became quite proficient in their studies. Naturally, I considered them to be less intelligent than I was. There was no fixed time for their teaching, since most also worked in other houses; they would come to my grandmother when free. She would cater to this diverse student body by understating and catering to their unique individual styles of learning. At this juncture you must be questioning the reason behind my narration of my grandmother's story. Was she a great pedagogist –no! But what she managed to do was to treat every girl at her level. For girls whose basic knowledge was lacking she used to focus on that aspect. For more advanced students she focused on their particular requirements. She also took into consideration at what speed, depending upon her ability, a girl was able to learn. Due to their humble background most of these girls were quite submissive and used to obey their teachers instructions, unlike me. What was interesting that they were all pretty much able to become well versed in the subjects? Something in which I had failed to do! The reason I believe was that my grandmother taught each girl, according to her ability to learn. She did not treat the entire group, in which there was great diversity, in terms of age and ability – not a standardized lecture. In today nomenclature and in terms of science of pedagogy this is called 'formative assessment.' This entails making a student aware of what his mistake is immediately and only giving him a workload which they can handle. Now I realize that despite her times she was using a very modern methodology, which was quite prevalent at that time, especially in Madressas. In the next module I take you to another personal story which has great linkage with ‘formative learning’ and ‘summative learning’.

Topic 184

Board Examinations

When we came to school, naturally the annual grade system was in place. The school was part of the Punjab Board system and we fell under the Multan Board. Board examinations were held after the eight standard, which very few students opted for, or after the tenth standard. Our schools conducted its own exams, attempting to make the board’s summative system into a formative one. The purpose, collective progress for all students: the more the more successful their attempt the better there exam results. My results were quite good for FSc exams; securing 10th place in my board exams for Punjab. Applying for my undergraduate degree, I chose UET, which at that time was known as PUET and had one wing in West Pakistan and one in East Pakistan. For admission first priority was given to those who had graduated from Punjab University and the left over seats allocated to other colleges. It was big achievement for me, since at that time the cream of undergraduates from all over Pakistan and even abroad used to constitute the college body. Upon entering the university we discovered a strange system, which by now is forgotten. It was entirely summative system based upon annual examinations. Classes continued for the entire year with little interruption for exams. Throughout the year a lecturing format was used and annual exams the sole tool for student assessment. Those who could not pass their annual exams were given supplementary exams. In the laboratory things were the same; open experiments in which discovered, were not allowed. The experiment, methodology and reading were agreed upon earlier and results recorded. Annual exams were given every year. The irritants which are a part of any system become necessities. Our summative system was no different. One of these necessities was the demand of students for preparatory leaves prior to exams. Having attended the entire years lectures, mostly idling away of time, nearing the exams the students realize their predicament. Since no feedback was received during the entire year, we were quite unsure of our grasp and understanding; also probably looked at their textbooks for the first time. It is not that the students were not intelligent but intelligence does not imply cramming a year long course in one week.

Continual assessment is required which a summative system does not account for. The students, cream of the country, were there to study. They were motivated and wanted to get good results in their exams; consequently the demand for study leaves. These were usually granted, after student protest, implying about two months wasted in a year. In the exams 40% were considered pass marks. Out of a total of eight questions, five had to be attempted. This meant that focused and limited preparations were made to secure passing marks. If there is an inherent limitation in a system it is natural for it to be exploited – the blame does not lie with the students. For those who could not pass the exams, supplementary exams had to be taken. The logic behind these exams was strange. For those who had studied throughout the year there was no room in the summative system for repeating earlier learning. Due to this students and some faculty started protesting concerning the deficiencies of the system. This was happening with the backdrop of political changes – democracy was reintroduced.

These political changes were reaching to universities, where there was hope of change. Students sensing the changing atmosphere increase their demands: grace marks for passing an exam were demanded. To counter this university had two options; either to eliminate the existing flaws in the system; or comprise with the system, giving way to student pressure – this is what eventually happened with the university succumbing to the system. The system contained no margin for repetition of learning, without which they could not pass their exams. Consequently, the need for supplementary exams and grace marks. Despite it limitation this system still managed to produce many highly qualified engineers, entrepreneurs and innovators.

I remember distinctly that a movement was incepted at the university around 1974, in which some faculty and students pointed out that this was an obsolete system, whose time was up. A new system was required in which teaching occurred in parallel. When these demands became widespread and with a changing political and social scenario in the background; a committee was formed comprising of students and faculty. The committee’s mandate was to bring about an alternate system; in which testing and assessment would take place in conjunction.

Topic 185

Adopting the American Model

I too was part of this committee, along with two professors who played an important role in molding and defining me. I am where I because of them - Asif M. Hassan and Dr. Q. U. (Qamaruddin) A. Khan. At the commencement of the committee meeting we were given exciting new ideas. We were told of their experiences in America; semester system; quizzes, graded on the same day; midterm and finals with results available in a couple of days; no preparatory leaves; repetition of course for those who do not pass. All these were new ideas for us and underlining this was the fact that teaching and assessment should be done in parallel. At that time we did not know what the pedagogical difference between an annual and semester system. While was entirely summative in nature the American system was designed to be formative. In the committee we proposed a semester system, consisting of four month and an evaluation/exam for every month. No midterms or finals and weekly quizzes would be introduced whose results would be provided immediately.

Theoretically this constitutes a move towards the formative system; in an ideal system there would be instant feedback. There was an almost palpable quality to our anticipation of changed system. The change was later made but unfortunately due to lack of proper implementation the annual system was reverted to. It was not a failure of the system rather the associated people, whose work load increased. Apart from the extra exams, quizzes and assignment needed to be marked and returned to the students. Even till date the most answer papers are not shared, let alone discussed. If you ask for rechecking of your paper today at the Punjab University, it implies that the paper is checked to see that all the answers are marked and total added properly. If a student has another query or proposes another viewpoint contrary to the examiner or enquires as where we went wrong there are no answers - a major deficiency of that system. After these stories we turn back to the problems facing our existing university and see how the two are related.

Topic 186

Flawed Logic

In the committee discussed earlier, the point was often made that there was no need for a new system. If all the students start studying and teacher's teaching properly there would be no issues. An argument much like: if all human beings became good there would be no problems. Dr. Asif's retort to this, I still remember after a gap of around fifty years, it is people that affect the system and the system effects people. There is a system which needs to be implemented and people that need to implement this system. How these people tackle various variables during implementation would discover its effectiveness.

Similarly, once the system is place it determines what output would take place, i.e. summative system leading to annual exam based system. So according the professor it is the right combination of people and system which effects society as a whole: invaluable advice which remains with me. You will see how this applies in our case. In our developing country there are major issues of; poverty, lack of resources, little education, issues of economic and social justice, intolerance and violence. Is it because we as a people are terribly flawed? There are other nations where things are entirely the other way around. Are they better human being than we are? No rather it the system which affects the people and people the system; the right combination of the two effecting society.

Topic 187

Problems despite Facilities

But before going onto the actual problems we also need to look at all the salient points of the existing system. Our task then would be to take a look at the entire scenario and determine if it is a problem of the people, system or of combination of the two. We have qualified instructors, teaching assistants (TA) support and assistance from laboratory engineers (graduates), again rare in our context. Customized university infrastructure with a well-equipped library is also situated. Since a private college, things are expedited and there is no red tape. No student unrest or demands; a semester system in place; air-conditioned classroom; most modern and excellent curriculum; teacher evaluation by students in place. Fees are relatively high which should create extrinsic motivation for students to study. Exam and quizzes answers shared with students or supposed to be?

We now need to look at the symptoms of the prevailing disease/problem. Having described the inputs we need to see what output. Student dropout rate within two years is more than 70%. I equate this to a 100 customers walking into a giant retail shop and purchasing goods, for which they have already paid, yet receiving nothing. Can this shop remain viable? This dropout rate is truly surprising and the fee money involved more than significant for a majority of these students. Once they dropout they go to places which are comparable in terms of fees and facilities but lacking: qualified and celebrated faculty; no quality control function as in our university; no TA support afforded or provided. The students who choose to stay are in a constant conflict and disgruntled, despite all the facilities. They complain that they have lost their self-confidence. They are extremely dissatisfied and not optimistic about their future. They are disturbed and extremely fearful.

Topic 188

Educational Audit

Now we turn towards the underlying reasons behind the prevailing situation. The administrative challenge of a 70% dropout in two years is daunting and the main reason for my induction into the university. To come to grip with this challenge I approached the qualified faculty members. A well know faculty member and celebrated professor in Lahore, upon enquiry, had this to say. First the strengths were highlighted: reasonably intelligent; rudimentary proficiency in subjects (prior Knowledge); no learning disabilities; digitally smart (proficient in terms of information technology); optimistic, or at least were prior to joining; fundamental will to learn; energetic and physically healthy. What then are the weaknesses?

The main ones lighted include: no academic habits, implying lack of learning habits, not their faults since we taught them (wrong pedagogy) and we have to make them unlearn; weak moral sense (not sure how that applies); short attention spans, this is how we are designed; weak comprehension, issues with speaking and understanding since immense diversity; non-reflective capabilities, no thought on repercussion or reflection; weak analytical skills; cultural shock via gender issues, not really understood. As you know there are three presences in a classroom; social, teaching and cognitive. The absence of any one of these elements can result in failure in learning; the most important of these elements is social. A classroom atmosphere needs to be nurtured which is open and where students co-mingle and discuss (peer learning). Reasons like these only seemed to me an effort in glossing over their own incompetency. At this point we felt the need for a comprehensive survey which was carried out. The results not only informative but critical to our diagnosis of what was ailing the university.

Topic 189

Balanced Results

This course varies in comparison to other courses. The modifications and advances we face in terms of technology have to be considered for the course to remain relevant. Today, again we commence with a line from a couplet which I had recently received from quite a few people:

Bohat dair kar di meherban attay attay

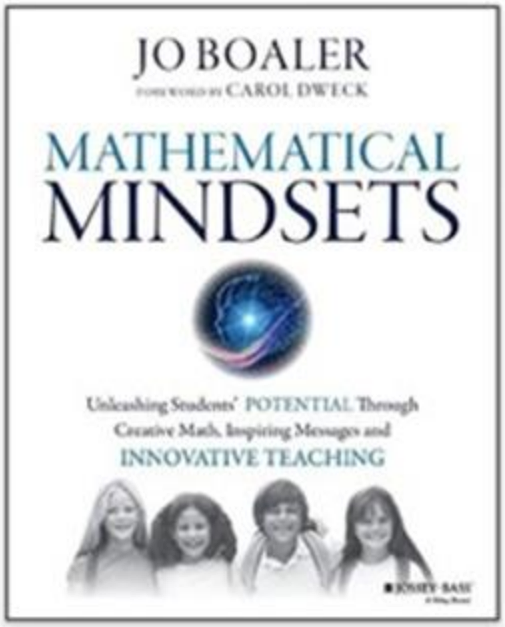
Too late your arrival o benevolent one

As you know I am currently dean at a university. We have a semester system there and recently our final exams were held. These have been marked and the results in process of compilation. According the existing process, before finalization these papers come to me to be signed off. The first thing I see is that if the results are balanced. Recently the aggregate result for calculus papers came to me. The subject is being taught by a seasoned and senior female instructor. She is considered the most qualified mathematics teacher in our department. When her results came in, I saw that half of the class had failed. Upon, enquiry she told me that she had not failed them rather they had failed themselves. If they were not going to study properly or prepare what other results were expected? At this juncture I showed her an email by one of her students, describing her class: what transpires in her class; what pedagogy used; interactivity; her non-receptiveness to student queries; and lack of support to students. To this she rightly said that it was not appropriate that I should blame her based upon one student's input. I told her that I too had audited one of her classes and prevailing atmosphere was at the least not friendly. Her response was that education was not designed for friendliness and is not conducive to learning. She kept referring back to the fact that I had blamed her for failing 50%of the class and broke down and started crying. She kept insisting that I had questioned her dedication and integrity.

Mathematics is one of the fundamental subjects and much work had been done on it in context of education and its learning globally; especially in its branch of calculus. I told the lady teacher that she must be around 45 and associated with teaching mathematics for the past 15 to 20 years; there was one question I would like her to answer; a question which I would like to put across through the assistance of this program and virtual university; to the million of mathematics teachers in Pakistan and globally. You must have studied hundreds of books on mathematics, yet have you come across any books; one book, on pedagogy, learning, problems of learning of mathematics or teaching mathematics? A fundamental question the answer to which I knew. She replied in the negative and despite the fact that she did not say so; I felt that she did not feel the need for it. Having completed her higher studies in mathematics, she felt that this was enough: a fundamental flaw or oversight which extends across most of our faculty. As soon as she left my office, I thought about all the books and resources available and the tremendous amount of work that is taking place in this field. I have been involved in this field for the past fifteen years, yet every time I go to a website like Amazon or search for new pedagogical resources, so many new things come up that one is amazed and joyous at that same time. On her departure I again searched for these resources and found a book, which I had not come across earlier. The book was entitled, 'Mathematical Mindsets'. I greatly felt the desire to order this book and others related books; the website provides you with similar books being purchased. I could not wait for it to come in time for the workshop on mathematics, which I am trying to organize. For the workshop I would be distributing books and relevant literature. Unfortunately, I did not have my credit card at the moment, but Amazon allows you some preview of the content, which I thought could be posted on Facebook. While reading this content had a strange dense of déjà vu, the author was reaffirming my viewpoints, intuitive, but with neurological and psychological justifications. The topic was conflict resolution.

Having posted it on face book and requesting my friends that it they were coming to Pakistan, they should pick up a copy for me, I went home. Opening my computer and lo and behold on my messenger the book was available – technology. I immediately started reading and found it to be very enjoyable. I had received another message from a former student at LUMS who was traveling to Pakistan, over the weekend, saying that he would bring the hard copy of the book for me. Initially, I refused since already had a copy, but requested him for a hardcopy. What was so interesting about the book?

In the first page of the book, it refers to a Stanford professor who has this to say: "Every time a student makes a mistake in mathematics: they grow in knowledge; they move forward in learning something important; they move a step higher towards knowledge." While what we do is to fail them. When he made this statement at Stanford, a hush fell over the entire room. Most thought this was entirely absurd. "One reason it is so significant that it speaks to the huge power and value of mistakes, although students everywhere think when they make a mistake they are not a math's person or worse that they are not smart in mathematics. Many good teachers have told students for years, that mistakes are useful and that they show we are learning. New evidence on the brain and mistakes says something much more significant."



The Power of Mistakes and Struggle

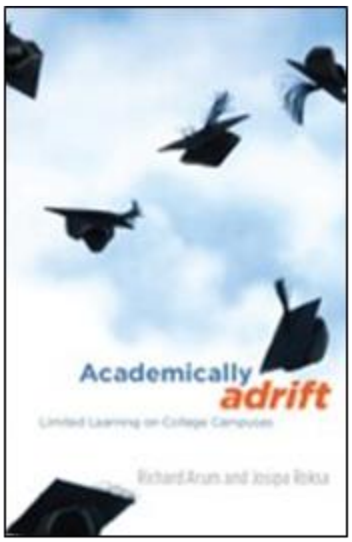
I started teaching workshops on how to teach mathematics for a growth mindset with my graduate students from Stanford (Sarah Kate Selling, Kathy Sun, and Holly Pope) after principals of schools in California told me that their teachers had read Dweck's books and were "totally on board" with the ideas but didn't know what it meant for their mathematics teaching. The first workshop took place on Stanford's campus, in the light and airy Li Ka Shing center. For me, one of the highlights of that first workshop was when Carol Dweck met with the teachers and said something that amazed them: "Every time a student makes a mistake in math, they grow a synapse." There was an audible gasp in the room as teachers realized the significance of this statement. One reason it is so significant is that it speaks to the huge power and value of mistakes, although students everywhere think that when they make a mistake it means that they are not a "math person" or worse, that they are not smart. Many good teachers have told students for years that mistakes are useful and they show that we are learning, but the new evidence on the brain and mistakes says something much more significant.

Topic 190

Reasons for Failure

In our department at the university, out of 700 total admissions, the failure of 550 or so students was the topic we were discussing earlier. The major reasons highlighted by our highly qualified faculty: : no academic habits, implying lack of learning habits, not their faults since we taught them (wrong pedagogy) and we have to make them unlearn; weak moral sense (not sure how that applies); short attention spans, this is how we are designed; weak comprehension, issues with speaking and understanding since immense diversity; non-reflective capabilities, no thought on repercussion or reflection; weak analytical skills; cultural shock via gender issues; were not really acceptable to me. We should then look at what the experts (technology, assessment, learning and pedagogy), in this field, have to say: facts which should help us in identifying the critical weaknesses in our case study.

Before we turn to them we should also look towards you, who by now should have acquired some expertise. What if this problem at my university was put to you? Why the high dropout rate despite the availability of all facilities; how would you go about an educational audit? This forms a critical component of our course. Information technology and pedagogy, there right blend, can only play a role in education, once the underlying problem has been identified. This is what happened in the West, statistical data on these problems was gathered and studied based on the rules of science of learning. The findings thus are not solely based upon teaching experience, rather on actual research. The book 'Academically Adrift', contains the following quotation from Harvard University's president: "Colleges and universities, for all the benefits they bring, accomplish far less for their students than they should." Many students graduate college today, according to Bok, "without being able to write well enough to satisfy their employers … reason clearly or perform competently in analyzing complex, nontechnical problems.” While concern over undergraduate learning in this country has longstanding roots, in recent years increased attention has been focused on this issue not only by former Ivy League presidents, but also by policy makers, practitioners, and the public.



“Colleges and universities, for all the benefits they bring, accomplish far less for their students than they should,” the former president of Harvard University, Derek Bok, recently lamented. Many students graduate college today, according to Bok, “without being able to write well enough to satisfy their employers ... reason clearly or perform competently in analyzing complex, nontechnical problems.” While concern over undergraduate learning in this country has longstanding roots, in recent years increased attention has been focused on this issue not only by former Ivy League presidents, but also by policy makers, practitioners, and the public.

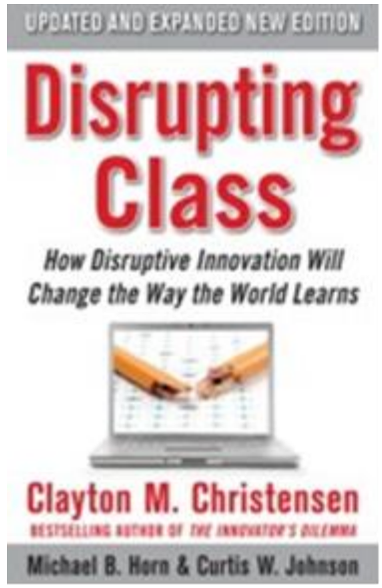
Topic 191

Critical Thinking

What was happening was that at top American universities only the content knowledge was tested. Critical thinking, analytical and problem solving abilities were not tested and compared to what abilities they possessed upon graduation. Upon testing the results, which we had mentioned earlier, were shocking. In the top university the difference was not apparent, since the output was of high quality so was the output. While in the less academically sound universities the difference was apparent; somewhat similar to our situation here.

Another Harvard professor, from his book 'Disrupting Class' initially attempts a definition of education: I continually reiterate this point since an innate understanding of education is prerequisite. The mains point are: maximize human potential; facilitate a vibrant participatory democracy, in which we have an informed electorate hat is capable of not being spun by self-interested leaders; capabilities, skills and attitudes that help our economy remain prosperous and economically competitive; nurture the understanding that people can see things differently, and that those difference merit respect rather than persecution. In the book he goes on to further state that: "managing innovation successfully has been the primary focus of my research and writing at Harvard. I am teacher, the husband and son of teachers, but I am not an expert in education. I have practiced it for sure but until we began writing this book I had not studied education." Strange thing about most people involved with technology, pedagogy and education come from other backgrounds. For instance by training I am an electrical engineer. "Nearly a decade ago however, representatives of a national network of school reformers called education evolving men such? who had played a pioneering role in the chartered school movement, visited me with a proposal." Their main query concerned the amount of innovation in what was being taught. This is the point where he started thinking about education and how content knowledge is not a sole academic criteria/goal. “We simply cannot get all the schools; we need, by trying to fix the ones that have compelled me to accept this invitation. I thank these pioneers who have dedicated their lives to the improvement of our schools in persuading me to join the movement.” The movements main thrust was on reduced costs in providing world class education to the poor and the oppressed while remaining sustainable – anywhere, anytime, anyone. This naturally hinges upon effective use of information technology.

In terms of American schools, the author feels they are a failure. He accepts that they meet none of the objectives of education described earlier and are in a rather sad state. As we look at what deficiencies, he thinks exists, we can perhaps compares to our own case here. “We are not doing very well in the journey towards these aspirations, weakening churches and families must shoulder their share of the blame for our backsliding and wheel spinning, but most of us wish schools were playing a much more effective role in moving our society towards goals like these.” Our university here too falls within this category. “Why do school struggle to improve, everyone has a favorite theory; one is that schools are underfunded.” To the contrary our university is overfunded. There are no limits on the capital expenditure which I can approve on improving facilities. In fact we have now started to use classroom response systems, which provide instant feedback. So this issue of funding does not seem to apply.



We're not doing very well in the journey toward these aspirations. Weakening churches and families must shoulder their share of the blame for our backsliding and wheel- spinning. But most of us wish schools were playing a much more effective role in our efforts to move society toward goals like these.

OUR UNIVERSITY IS DOING A PATHETIC JOB?

Why do schools struggle to improve? Everyone has a theory. One is that *schools are* ***underfunded***.

BUT OUR UNIVERSITY IS OVER FUNDED?

Topic 192

The Blame Game

Another reason put across by people is; not enough computers in the classroom: another myth which we seem to have accepted as reality. Again in the case of our university, it is flooded with computers and there are no restrictions in purchasing any further amounts. Another camp blames students and their parents. Teachers often resort to this point. “Educators complain about students who are uninterested and not ready to learn and parents who do not monitor homework or show up for conferences this argument resonates with the public. They say that kids on street corners with their hats in backward pose and their trousers dragging and droopy.” Do these look like kids who want to study? “Indeed just to explain the problem facing schools, a number of students from minority backgrounds who have historically performed least well in the US, have skyrocketed in the recent years: from just over 20% in the 70s to around 35%. This entirely refutes the theory of students not wanting to study. “The population of those who do not speak English at their homes, a population that has also underperformed historically in the United States, has also climbed from just under 10% before 1980 to around 20% today.

Another camp blames the students that they do not want to study. I have taught in five universities and am a witness to the fact that students want to study. The complaint that they are discards is not valid and the students are equally intelligent on the average as in other universities. I have measured their comparative learning ability and they turn out to be similar. Other people point out another flaw, but which is only applicable in the States: teacher unions must be the problem. Here we do not have any teacher unions, particularly in our university. As the dean I have a complete mandate to hire and fire teachers. “Whatever has been described here shows that whatever is needed in a good university is already available, here in my university.

This is rare is a context of a developing economy like ours, where a small minority can afford such education. What then is wrong? Currently my opponents in context of technology and admirers of conventional learning feel that there is no need for distance, virtual or blended learning. The classroom provides the right teaching atmosphere and the physical presence of the teacher is critical to student-teacher interactivity. In response this is what is currently happening, high classroom facilities and qualified faculty is available. How do they explain this anomaly? The example of our university challenges the very basic assumptions about learning.

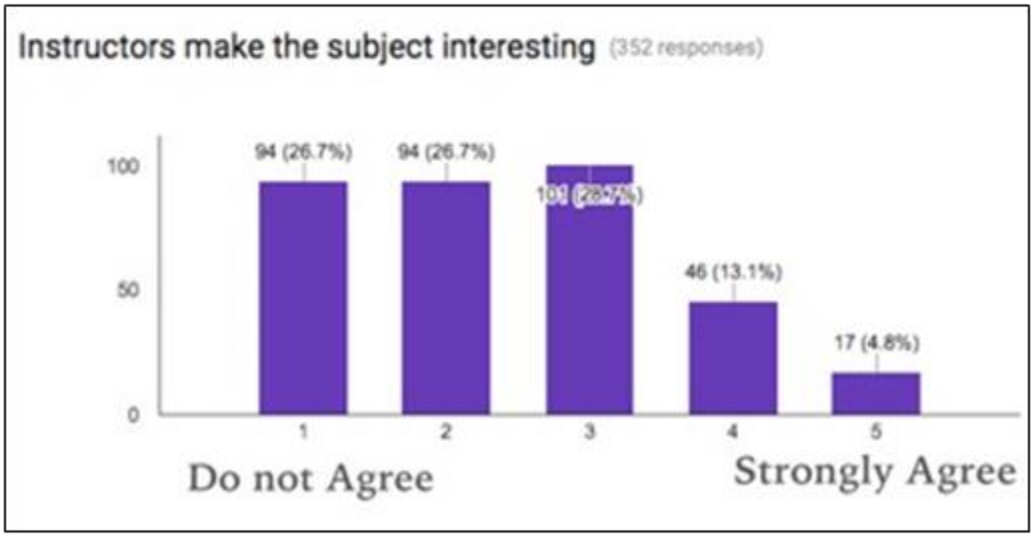
If we look at the dropout rates in America. There are significant dropouts during transition from high school to college. Why in our context? This is a dangerous exercise we are attempting and can lead to significant redundancies. We will have to be honest and transparent; otherwise we cannot get to the actual root cause. Thus the necessity of an online survey to find out what the students thought about us: our primary customers and hence their importance. Why the alarming dropout rate, enormous prepaid fees and their consequent decision to opt for lesser educational institutions? One thing is quite clear that the major failure of our system is that there are no inbuilt warning signals to flag the problem. We only find out once they dropout; something prevalent in all universities. We only find out about their failure once they fail their midterms. The heads of department do their best by running around to find out what is happening in the classrooms; even if it is taking place - a fact which can be easily ascertained through technology. Automatic and instant feedback is missing. An alarm should continue to beep in all the concerned offices if no learning is transpiring in the classroom. This feedback should be openly available to all concerned. Here we are talking about a paradigm shift in which only technology can solve these problems.

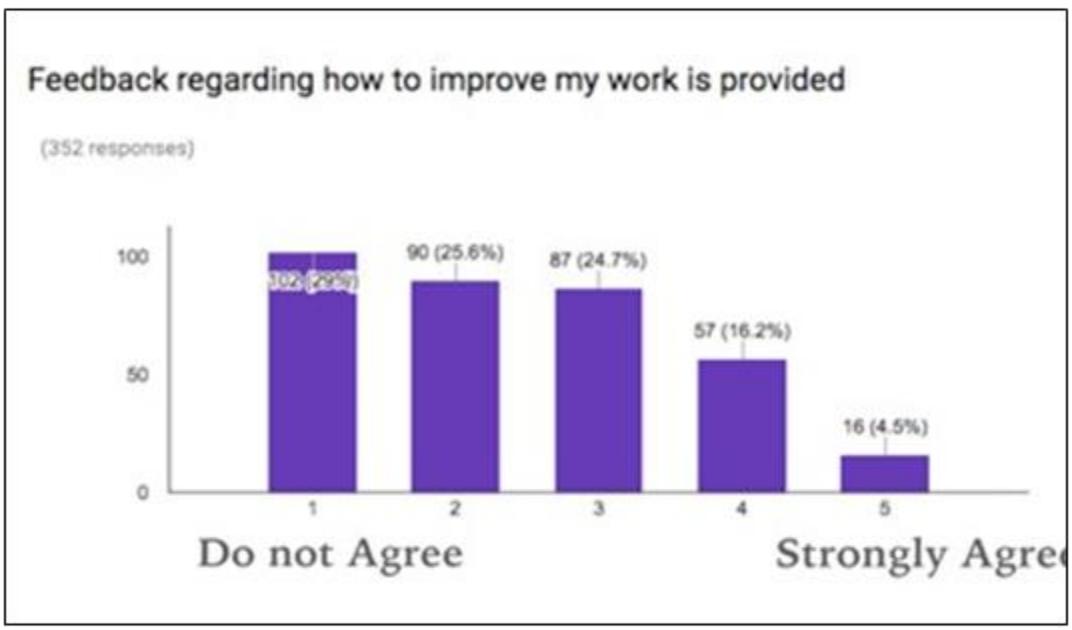
Perhaps there's a problem because there *aren't enough computers in the classroom*.

BUT OUR UNIVERSITY IS FLOODED AND MORE CAN BE PURCHASED?

THE BASIC ASSUMPTION THAT WE SHOULD HAVE NICE INFRASTRUCTURE - GOOD INSTRUCTORS - LABORATORY SUPPORT AND YOU WILL END UP WITH A FIRST CLASS UNIVERSITY?

THIS CHALLENGES SOME OF THE VERY BASIC ASSUMPTIONS?


Instructors make the subject interesting (352 responses)
100
50
0
94 (26.7%)
94 (26.7%)
101 (28.7%)
46 (13.1%)
17 (4.8%)
1
2
3
4
5
Do not Agree
Strongly Agree

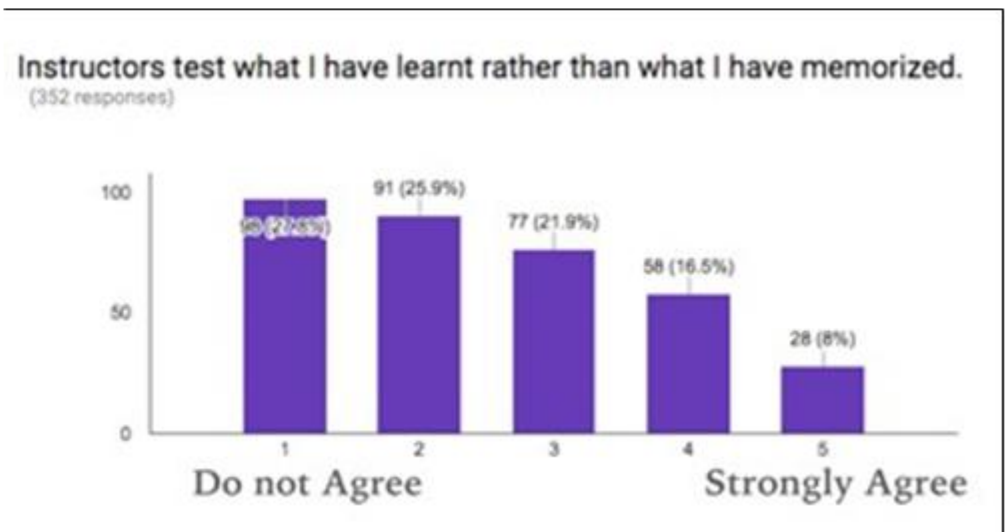

Feedback regarding how to improve my work is provided
(352 responses)
100
50
0
102 (29%)
90 (25.6%)
87 (24.7%)
57 (16.2%)
16 (4.5%)
1
2
3
4
5
Do not Agree
Strongly Agre

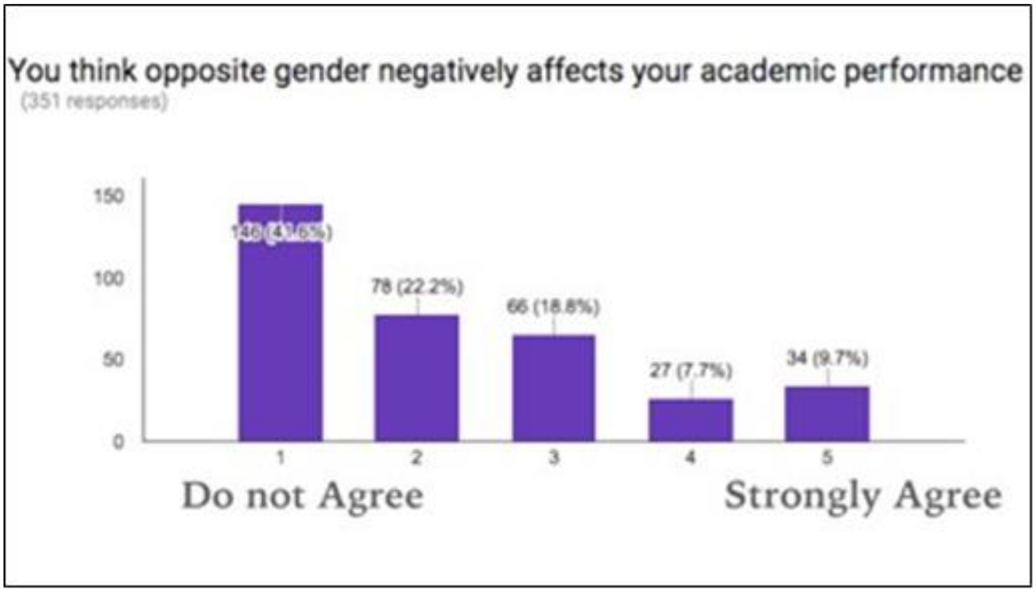
Topic 193

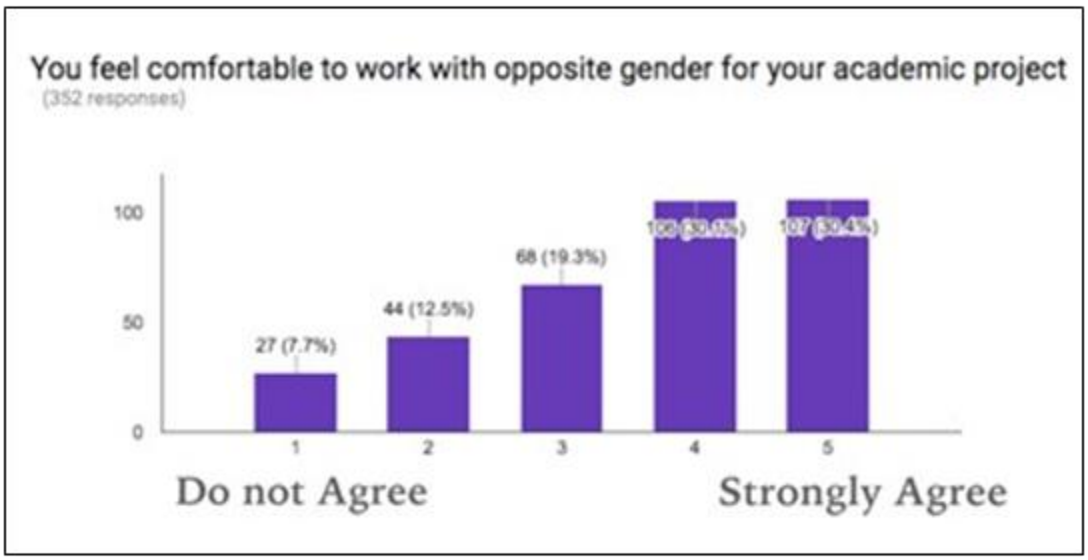
Assessing Instruction 1

What did we discover through our survey? The survey comprised of 352 students. Do the instructors make the subject was the first question; an important one. The unanimous consensus by the students was that this was not happening. Is there feedback concerning improving my work? The majority replied in the negative. If their mistakes are not highlighted what chance is there for improving their work. What is the point of a singular lecture? You could just provide a recording of it. The question was; that do the instructors test what I have learned or memorized. The third consensus was that memorization took precedence over understanding. What is the point of rote learning instead of exciting problem which they can grapple with? A deliberate question inserted was that does the presence of other gender effect you studies negatively. Overwhelming majority responded that it was not an issue. Some even responded that not our issue but perhaps for teachers it was. The question was reinstated; do you feel comfortable working with the opposite gender for your projects. Again, the answer was no; they had no issues. As it is once in the workforce this is what the situation would be. Have you thought about leaving this university program? Most answered in the affirmative since no actual opportunities of learning. As mentioned earlier mistakes are way to advance knowledge; in our environment the opportunity to leverage their mistakes to learning is not provided: only used to cut marks and their self-esteem. In conjunction these are not small errors but a huge mistake that we are making.

Apart from these questions we also asked for individual comments in the survey. The majority believed that the classrooms were not friendly. The social presence in terms of a pedagogical perspective was missing. An environment of fear prevailed. Discussions, interactions, questions were discouraged. Some of the teachers were more interested in exercising their authority rather than focusing on learning. A quotation by a Harvard dean seems applicable: “A university is composed of senior scholars who are faculty members or instructors and junior scholar who are students.” There is no differentiation per se between the two. “Another third entity known as administration, functions to facilitate senior and junior scholars in advancing knowledge.” This learning is a mutual exercise with the students sometimes teaching us and us teaching them. In our case most of the instructors are not teaching instead covering the course outline. Another common comment was that the teachers did not understand the students. They are not aware of what the students are thinking. We had earlier spoken of the Harvard gazette advertising a workshop which was needed for all universities on what the students were thinking. This has implications for prior knowledge, if the teachers do not know this how they can hope to advance learning. The interesting thing here is that the students are diagnosing their own ailments. An often recurring comment and a strong one at that was: the teachers are only interested in covering the course outline on time and if someone did not understand, to hell with them.




You think opposite gender negatively affects your academic performance
(351 responses)
150
100
50
0
146 (41.6%)
78 (22.2%)
66 (18.8%)
27 (7.7%)
34 (9.7%)
1
2
3
4
5
Do not Agree
Strongly Agree

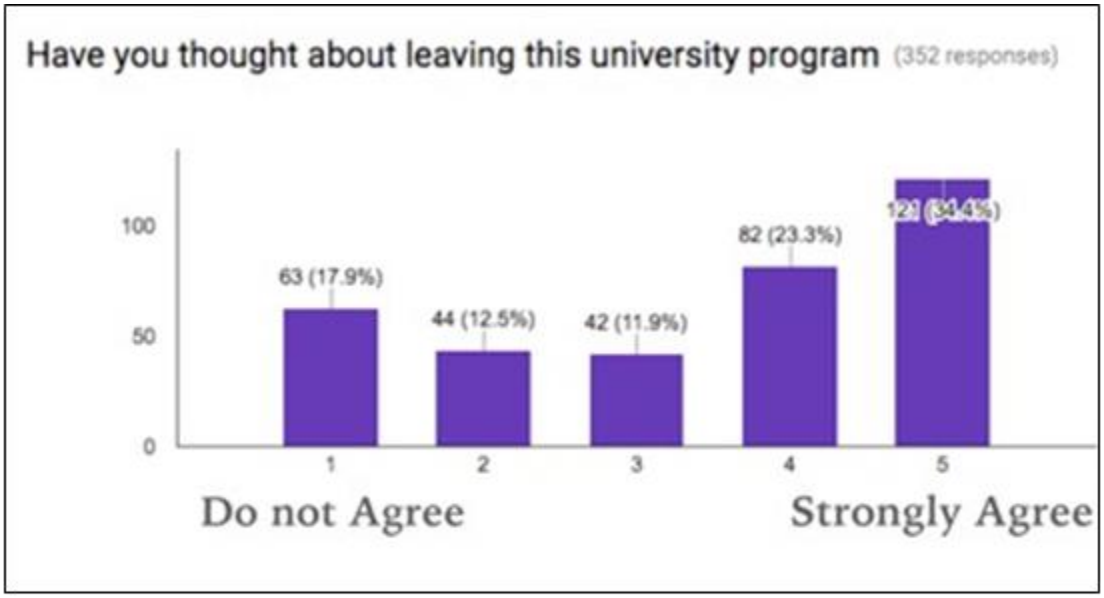

You feel comfortable to work with opposite gender for your academic project
(352 responses)
100
50
0
27 (7.7%)
44 (12.5%)
68 (19.3%)
107 (30.4%)
1
2
3
4
5
Do not Agree
Strongly Agree

Topic 194

Assessing Instruction 2

These comments seem like they are coming from pedagogical experts. They say a friendly atmosphere should prevail in the class and teachers should not ridicule our questions rather try to make us understand our mistakes through example which have application in real life: leading to us being motivated rather than depressed. The linkage of prior knowledge to new knowledge is the first principle of pedagogy. There has to be conflict in terms of prior knowledge for the requisite excitement and friction to generate new knowledge. We should be learning from the students. I realize these views do not add to my popularity, which is rather low as it is. In other comments the students address the second principle of pedagogy.

Feedback concerning our assignments and quizzes are not provided. Through this comment the entire problem lays bare. The patient himself has diagnosed the ailment. This is truly an astonishing insight from so young and those considered not quite intelligent. That we have to learn from them is a sad state of affairs. They go on further to add that without feedback they have to appear in exams, where they are doomed to repeat their earlier mistakes. This leads to disagreements between the faculty and students, since they want marks for mistakes which they do not consider as mistakes: a vicious cycle which leads them to eventually dropout from the university. In the context of this extensive educational audit the next step was verification of these insights. This I carried out through attending classes and labs.


Have you thought about leaving this university program
(352 responses)
100
50
0
63 (17.9%)
44 (12.5%)
42 (11.9%)
82 (23.3%)
121 (34.4%)
1
2
3
4
5
Do not Agree
Strongly Agree

Topic 195

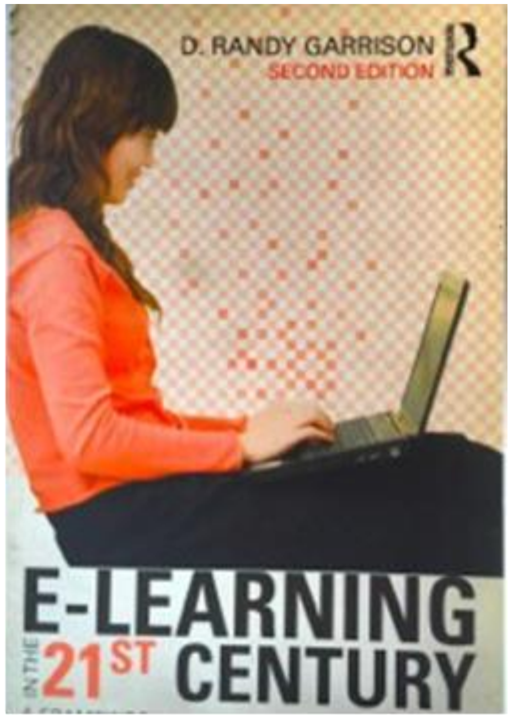
Enhancing Student Learning

The nations that focus on education, especially its equitable distribution and prevalence, will only be able to advance. The extremist strains and increasing incidence of terrorism, that you observe around us is the other alternative. We now look at " ", also seen earlier and revisit some quotations. In the introduction there is one from George Bernard Shaw: "The reasonable man adapts himself to the world.

The unreasonable one persists in trying to adapt the world to himself, therefore all progress and change depends upon the unreasonable man." Some of you upon listening to this must have felt unease or are unsure about the statement. This is good and one of the purposes of our course is to create this friction/conflict for you to learn. The second quotation is, directly related to education, teaching and the classroom by Bertrand Russell (philosopher, mathematician, social scientist) from his book, 'the unpopular essays' concerns the flaws within our society, especially its double standards. "Passive acceptance of the teacher's wisdom is easy for most boys and girls. It involves no effort of independent thought and seems rational because the teacher knows more than his pupils. It is moreover the way to win the favor of the teachers unless he is a very exceptional man. Yet the habit of passive acceptance is a disastrous one later in life. It causes men to seek, to accept a leader and accept as a leader whoever is established in that position. " We had discussed this earlier in the 'Pedagogy of the Oppressed', and is known as the banking model. As you can see from the quotation an entirely false premise and one which require a complete paradigm change? Existential threat

The final quotation from: "Thus an educational experience has dual purposes: the first is to construct meaning; reconstruction of experience from a personal perspective; the second is to refine and confirm this finding collaboratively within a community of learners. At first glance this dual purpose would seem to reflect respectively the distinct perspectives of the teacher and student, however close consideration of the transaction reveals the inseparability of the teacher and learning roles and the importance of viewing the educational process as a unified transaction. We are simply viewing the same process from two different perspectives; teachers are learners and learners are teachers. These two perspectives raise fundamental questions concerning responsibility of learning and control of the process." These are radical thoughts and ones which need careful contemplation by you.

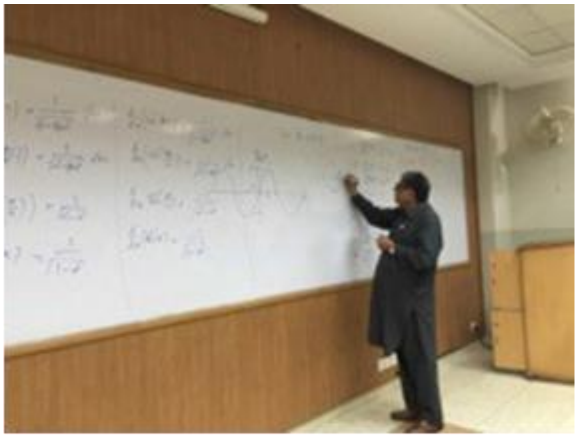
In our department at the university, out of 700 total admissions, the failure of 550 or so students was the topic we were discussing earlier; this is the dropout rate in the first year. This implies a financial loss of Rs. 55 to 60 crores to the university - a bad business proposition. The prevailing state of affairs, that can only be addressed through the right combination of technology and pedagogy. The amount of financial loss can be utilized for education and a quantum for augmenting learning in the classroom through automation of assessment. In all respects a successful business. Last time we had looked at some comments from students, most of whom were seeking a friendly environment; instead of one where they were belittled upon their queries and their misconceptions not addressed. Also feedback on assessment is demanded, which is not presently occurring. Once the backdrop and a context to the prevailing situation were acquired, the next step was to actually visit the classrooms and witness what was transpiring. With my extensive educational experience the least I can discern, from the students expressions and their body language, is their state and the amount of learning taking place.



Re: 70 percent dropouts
24 June 2016 at 2:16 PM

Fee per semester = 125,000
Number of dropouts (estimated) = 500
Total loss per semester = 125,000 x 500 = 62,500,000
Total loss per year = 62,500,000 x 2 = 125,000,000 (not including Summers)

Tentative Degree duration = 4 years
Loss incurred in 4 years = 125,000,000 x 4 = 500,000,000/-



Topic 196

Teaching Class

At the crime scene, where a crime was occurring on a daily basis, this is what was happening. The teacher was writing equations on the board and lecturing. Upon discreet enquiry from students, I understood that nothing was being absorbed. Not being able to contain myself, I enquired of the teacher about functions. The teacher immediately drew a diagram of what functions he was trying to integrate. Yet, all this teaching had no connection in the students mind and it was just a case of the teacher imparting his wisdom to the students, which they were passively receiving. This harks back to the traditional class structure, where a teacher on a high pedestal, in front of the class, with students looking up to him. In the book, "Educational Innovation beyond Technology' by Nancy Law, Robert Yung and Robert Fox, they address the question of" nurturing leadership and establishing learning organizations." "Many commentators and researchers consider the classroom environment in which the teacher teaches in front of a class of students seated in rows as an educational solution suited only to the industrial age, where mastery, conformity and obedience were seen as the prime goals, rather than creativity, realization of individual talents and empowerment. Many of today's classrooms are still typically organized in ways that allow teachers to teach students so that they can master the knowledge and skills in the prescribed curriculum and have the quality of their learning assessed through standardized tests." Here we are talking about summative assessment.

Now that you have glimpsed a typical classroom we look at the laboratory settings. Why go to a laboratory, many students and teachers enquired of me. The dean's job is academic administration. Earlier the same people had come to me, upon joining and my announcement of an open door policy, to advise me to not to do this – a view based on a conformist perspective.

They told me that once I open this door, it would imply opening a Pandora's Box. This only added to my anxiety. Only a month had passed and I remember the day distinctly. They told me that in one of their programming labs 'programming fundamentals', I should consult the register. It has been four to five weeks since the lab has started; it begins with a theory class. After which the students are told to translate the problem provided in theory to actual program and run this. In the lab there are qualified laboratory assistants, from FAST, who are also highly motivated. These enthusiastic engineers showed me the register which surprisingly contained zero marks in front of the each student's name. The first zero was for the ungraded portion of the task assigned soon after their first lecture; which was derived from it. Apparently this was their first or second exposure to programming. They were allocated a fixed time and the task assigned relatively simple. Yet, no student managed to complete his program and consequently was given a zero. Upon my enquiry that if any feedback was given concerning their mistakes?

The reply was none, since only asked to assess their programs – a perfect example of summative assessment. Next the students were assigned another small programming task, with some linkages to the earlier task. Again the results were the same. No student managed to complete the assigned task in the required time. Consequently they were awarded zero marks. There was also a third ungraded task. I was sure that again the students were given a zero and this proved to be correct. Out of a three hour lab, in the last hour their graded task began. I told them they did not need to tell me what had happened and what marks were given. In the initial ungraded part, which they could not finish, due to a small syntax error, their mistakes were not pointed out. How could they hope to accomplish the reminder of the tasks? But that was the system and one which they considered very efficient, transparent and strict. It would only allow the students capable of advancing to go forward while those who could not discarded. I told what was the need of formality and wasting of time, since you could have directly given them a zero. They disagreed and since it was their duty. When all students continually got zeros for five or six weeks, the students that since a new dean has joined and has declared an open door policy, perhaps we can approach him.

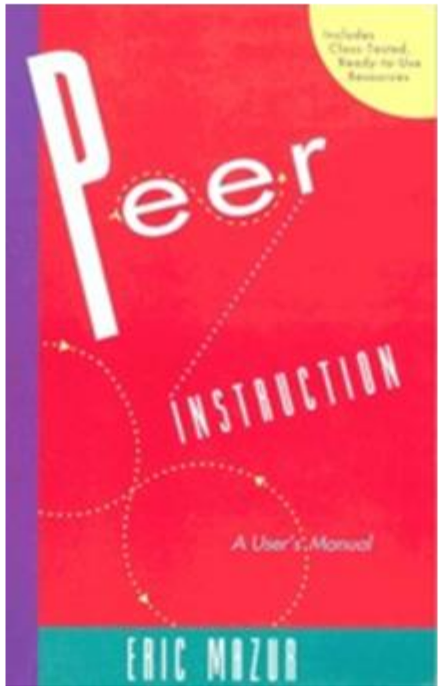
They came collectively and hesitatingly (passive acceptance, obedience, fear and respect) to my office - a victim of our society's conformist norms. I told them to sit; which they again did with great reluctance. They explained to me their entire dilemma, which led me to visit their labs and the crime scene. When I got there they were attempting the first ungraded part; most could not complete the compilation and those that could not get the appropriate result. I enquired why did they did not consult the lab assistants or among themselves, they said they were not allowed. I sat there for an hour and half and saw that the students wanted to learn, they had paid serious fees to attend, and teachers wanted to teach and paid got rather well to do so in addition to the lab assistants. Yet, the learning outcome in labs was zero. I called a teacher and showed him the students and their frustration. No one seemed to be enjoying the experience. If things continued in this manner all students would be failed. He agreed and told me this is what happens and after the first year they dropout.

They are not capable of learning programming. How did you come to this conclusion I enquired and he told me he had explained all this in his lecture, prior to the lab. He also told them that I had two hours of office timings in the evening, where they could sort out their queries. I knew that the teachers were honest and there were no questions of implementation. He also said that not even a single student came to him during his office hours: a clear reflection of the student's unwillingness to learn. I told him that this could have another meaning from a pedagogical and learning perspective, if he had bothered to consult it. You would then know why they do not come to you. Since they have no inkling in class, what would they consult you for? New knowledge requires connection with prior knowledge, where conflict is created, and friction happens and a student feels uncomfortable, errors take place along with neurological changes take place. On the other hand if teaching is entirely receptive (passive); no questions arise. To this he told me that if they wanted to study, they would have made an effort. I told him perhaps this is the treatment which should have been meted out to him – perhaps that is why I am the most hated dean in the university. Teaches should realize that if the students are not learning anything in class, it is entirely their responsibility.

If you remember what Harvard University's physics professor Novak had to say about this: stage occurs where the teacher becomes unsuccessful and is not able to put across learning to students. He just falls into a rut, where he repeats himself. Some intervention is required. Students would not be embarrassed in front of technology. In our English language center when we put students in front of technology, to learn proper pronunciation and speaking, some students asked us to leave the classroom. These were students with the worst pronunciations and who never spoke English in front of us. Yet, they had no hesitation in speaking front of the computer.

> Many commentators and researchers consider the classroom environment in which the teacher teaches in front of a class of students seated in rows as an educational solution suited only to the industrial age, where mastery, conformity, and obedience were seen as the prime goals, rather than creativity, realization of individual talents, and empowerment.

Many of today's classrooms are still typically organized in ways that allow teachers to teach students so that they can master the knowledge and skills in the prescribed curriculum and have the quality of their learning assessed through standardized tests.



ACTUAL PRACTICE: THE FAILED PHYSICAL CLASS ROOM? WHY?

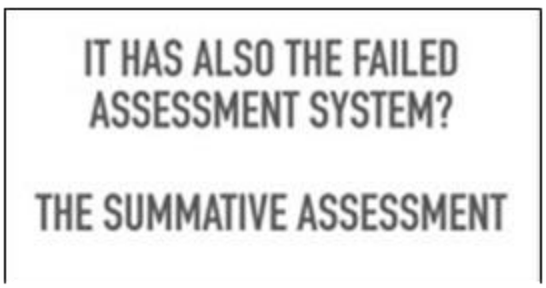
IT IS ALSO THE FAILED LABORATORY EXERCISE? WHY?

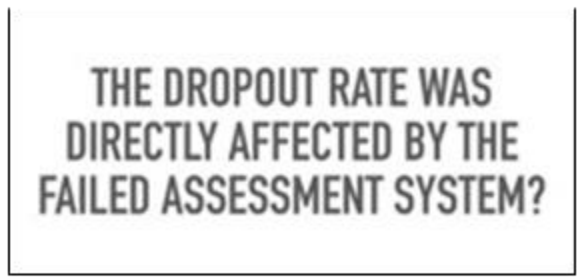
Topic 197

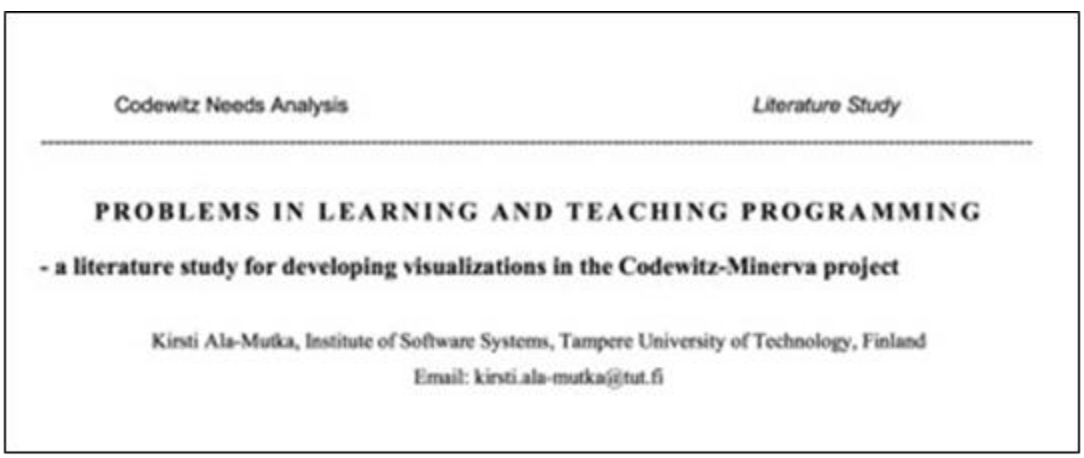
Programming 1

Now we look at a holistic picture of how all these elements integrate. A failed classroom, a failed laboratory exercise, a seriously failed assessment system: a crime which is taking place all over Pakistan. Teachers who have taught for around thirty years are relics from the past. Their mantra is that; those who want to study do and those that do not do so. The students who still manage to transverse the system end up as the best in the world. I told them that I had interacted with the best students, since I had worked at the top universities in Pakistan and consequently fired from them. In my opinion the dropout rate was directly affected by the failed assessment system. The root cause of this failed system was its philosophy. There could be issues with implementation but these could be rectified.

Now let us turn towards assessments; what is happening and what is possible. First programming, since relevant in our context and also a basic understanding critical for all disciplines: a paper entitled, 'problems in learning and teaching programming, a literature study for visualizations'. The paper states that: "learning to program is generally considered hard pedagogically and programming courses often have high dropout rates. It has even been said it takes about ten years for a novice to become an expert programmer. A student can learn to explain and understand a programming concept for example what does a pointer mean but still fails to use it appropriately in a program." There is a vast difference in understanding a concept theoretically and its practical implementation. If the faculty does not realize this fundamental difference then a system like ours would be in place. For most of you some of the mystery should have cleared up by now. "Winslow noticed that students many now the syntax and semantics of individual statements but they do not know how to combine these features into a valid program." Prior to solving the existing problems through pedagogy and technology our primary task is to identify these problems. "Even when they know how to solve the problem by hand, they have trouble translating it into an equivalent computer program." What was then the proposed solution? "To help students learn concept knowledge and strategies for their use in programming they developed a problem solving approach for a programming course. In their approach language features were introduced to students only in context to specific problems, little by little. This was shown to have positive effects on student score results and their programming confidence." There are other solutions then failing all students or telling them that they are incapable of programming. Destroying their confidence and self-esteem is a crime.






Codewitz Needs Analysis — *Literature Study*

PROBLEMS IN LEARNING AND TEACHING PROGRAMMING

- a literature study for developing visualizations in the Codewitz-Minerva project

Kirsti Ala-Mutka, Institute of Software Systems, Tampere University of Technology, Finland
Email: kirsti.ala-mutka@tut.fi

Learning to program is generally considered hard, and programming courses often have high dropout rates. It has even been said, that it takes about 10 years for a novice to become an expert programmer [32]. Educational research has been carried out to recognize the characteristics of novice programmers and to study the learning process and its connections to the different aspects of programming. Lately also differences between procedural and object-oriented education approaches have been studied, as Java and C++ have become common educational languages. We will now explore these issues more closely.

Even when they know how to solve the problem by hand, they have trouble translating it into an equivalent computer program. To help students to learn both concept knowledge and strategies for their use, Deek et al. [7] developed a problem-solving approach for a programming course. In their approach, language features were introduced to students only in the context to specific problems, little by little. This was shown to have positive effects on students' course results and their programming confidence. More discussion on problem-based learning in computer science courses can be found in Kay et al. [13].

Topic 198

Programming 2

Continuing with the research paper it tells us: "It takes quite a long time to learn the relationship between a program on a page and the mechanism it describes. Students have difficulties in understanding that each instruction is executed in a state that has been created by the previous instructions. There should be a simple national notational machine that simplifies the language so all the programme transformations can be visible, for example logo??? It is based on the fact that all instructions concern moving a turtle that is drawing on the display thus making the program state and transformation clearly visible. However most of the universities are required to teach the programming languages that are close to those used in the industry and only rarely is it possible to select the approach for an introductory programming course based only on pedagogical reasons.

Now the entire problem should be clear; we should not be starting with languages like C++, instead use languages which are easy to teach and understand. Despite the fact that C++ is a powerful language, it is pedagogically difficult to understand. As a teacher this conflict needs to be addressed. "There is often little correspondence between the ability to write a program and ability to read one. Programming courses should include both, in addition some basic tests and debugging strategies should be taught." Something we do not do. "There are often mistakes in the design and bugs in the code, this requires an ability to track code and build a mental model of the program and predicts its behavior. This is one of the skills that could be developed by emphasizing program comprehension and debugging strategies in the programming courses.

Give them examples of programs that will not run properly, that may give compilation errors that do not run according to our expectations. Allow them to make mistakes in class and start with the wrong programs." The labs should be a place of trial and error and learning. This was all from the book "Mental Mindsets," a hardcopy of which I should be getting soon. In this the author emphasizes, the power of mistakes and struggle. This is not only applicable to programming but applies to all learning.

Students have often great difficulties in understanding all the issues relating to the execution of a program. Du Boulay [10] stated that "... it takes quite a long time to learn the relation between a program on the page and the mechanism it describes." Students have difficulties in understanding that each instruction is executed in the state that has been created by the previous instructions. He stated that their should be a simple "notional machine", that simplifies the language and the machine so that all the program transformations can be visible. For example, LOGO language is an example of this kind of approach [24], and was commonly used in 80's in introductory programming education.

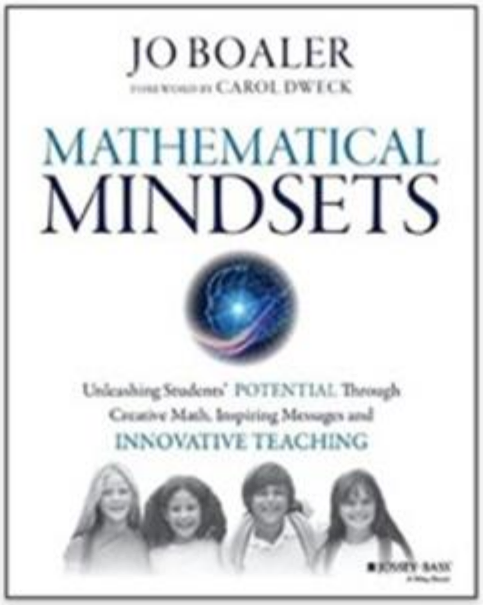
It is based on the fact that all the instructions concern moving a turtle that is drawing on a display, thus making the program state and transformations clearly visible. However, nowadays most of the universities are required to teach programming languages that are at least close to those used in the industry, and only rarely it is possible to select the approach for an introductory programming course based only on pedagogical reasons. Pedagogical concerns requires not to use standard Languages

Topic 199

Programming 3

In our days we relied on punch cards for our IBM 1130. This was followed by interactive computers which used to provide you with feedback concerning your program instantaneously, unlike punch card based computer which used to provide feedback the next day. Despite the fact that interactive computers addressed one aspect, instantaneous feedback, but no pedagogy was involved. There was no formative assessment and entirely based on the summative model. Programming is much like an apprenticeship in acquiring a particular skill, which cannot be taught in a conventional manner. How does one learn to ride a bike or drive a car, make a turn or change lanes? Usually, we can do actually by doing it and making mistakes and not through lectures. Tell them how technology - interactive computers have gone forward while the pedagogy is still the same?

> There are often mistakes in the design and bugs in the code. Also in working life, programmers face daily the need to understand a program that is running in an unexpected way. This requires an ability to track code to build a mental model of the program and predict its behavior. This is one of skills that could be developed by emphasizing program comprehension and debugging strategies in the programming courses. Give them examples of a program that is Not running according to expectations - Teach them Mistakes?



The Power of Mistakes and Struggle

I started teaching workshops on how to teach mathematics for a growth mindset with my graduate students from Stanford (Sarah Kate Selling, Kathy Sun, and Holly Pope) after principals of schools in California told me that their teachers had read Dweck's books and were "totally on board" with the ideas but didn't know what it meant for their mathematics teaching. The first workshop took place on Stanford's campus, in the light and airy Li Ka Shing center. For me, one of the highlights of that first workshop was when Carol Dweck met with the teachers and said something that amazed them: "Every time a student makes a mistake in math, they grow a synapse." There was an audible gasp in the room as teachers realized the significance of this statement. One reason it is so significant is that it speaks to the huge power and value of mistakes, although students everywhere think that when they make a mistake it means that they are not a "math person" or worse, that they are not smart. Many good teachers have told students for years that mistakes are useful and they show that we are learning, but the new evidence on the brain and mistakes says something much more significant.

Topic 200

Mathematical Mindsets

As you know we are attempting to study this interesting course. I use the word interesting since keeping abreast of technology and it uses, that we are studying, is a truly interesting exercise. Last time we were looking at a case study of a failed classroom and laboratory system in terms of assessment. In the computer science department a dropout rate of 70% is alarming and entails issues of pedagogy which need to be addressed through technology. An internationally recognized research fact is that commence teaching utilizing programs like C++, Java or object oriented which work? Naturally, what else would a teacher teach? In actuality we should be teaching programs that do not work!

Traditionally, students attempt programs, after being lectured in theory and are unable to get them to work. We should initially allow them to understand the nature and solutions to basic programming mistakes; syntax or designed based errors. In the slide in front of you it says: “This is one of the skills that could not be developed by students emphasizing program compression and debugging strategies in program courses. Give them examples of a program that is not running according to expectations. If you have programmed you would realize how complex and frustrating a task it is; problems can occur due to multiple reasons. The importance of mistakes; an entire course can be dedicated to this. In our conventional educational system mistakes are considered bad: a student’s marks and grades are adversely affected. In the book, mentioned earlier, “the power of mistakes and struggles,” the basic deals with this subject. When a student commits an intelligent mistake his knowledge increases. How this transpires is a big challenge. We now turn towards a problem, addressed earlier. Despite it being simple it needs to be reiterated since it addresses our real world problem of why 70% of computer science students at our university fail.

Topic 201

Chasing the Rabbit 2

In the book “Chasing the Rabbit” by J. Spear, a doctorate from MIT, he addressed the question of Japanese challenge to the American car industry. In our days at the UET, I remember only two professor, graduate from the States, possessed cars – both Datsuns. This was the mid-60s. In actuality the industry was incepted in the States with the Ford Model-T. As Japanese cars entered in the US market the middle classes soon increasingly turned towards them. Naturally, this was a cause of consternation for the American car manufacturers; who protested since their business was being adversely effected. The two main demands were to impose quotas on Japanese cars and have them build their factories in the States, where all employees would be Americans.

The thinking was that since the same manufacturing facilities (in most cases American facilities more advanced), same workers and quality control, the difference between the products would be eliminated and consumers would turn back to American cars. A similar experiment was tried in education, American universities were replicated exactly in Saudi Arabia, even down to the building yet, the quality of education imparted was not the same. Anyway, once the Japanese manufacturing commenced in the US and imports almost eliminated, the consumer demand for Japanese cars remained the same. To cope with this challenge the car manufacturers turned towards leading educational institutions: a critical function of educational research in the developing world. A graduate engineering student Stephen J. Spear, from MIT, was assigned the task to visit both competing factories and observe what was happening and why the Japanese car preferred. When I was in the States the rule was that only American cars could be rented, to encourage their business. What Spear discovered has great implications for the real life example we are addressing. It is a simple, small difference which if applied in our classroom can change the face of education.

Topic 202

Chasing the Rabbit 3

On visiting the factories, instead of looking at the quality control function or speaking to management he went directly to the production assembly line and asked for work. He requested for the simplest task, which turned out to be mounting of the first seat. For the assigned task he had two to three for completion, failing which the entire assembly line would have to be halted and production decline. Upon his enquiry as to how the task would be accomplished, he was given a demonstration by the instructor; consisting of mounting, checking for alignment and screwing the seat in place. As an engineer, from MIT, he assumed this would prove no difficult task. When the actual assembly line started he had difficulty in the proper setting of the seat and exceeded the allocated time – failing the task. He was told a worker like him would have to be retrained or let go.

He next visited the Japanese factory. Immediately, he enquired to be assigned to mounting the front seat. This raised some eyebrows; a qualified engineer from MIT requesting for this assignment? Upon hiring he was demonstrated the process by an instructor according to stringent SOP’s developed in Japan. The process was based on five steps, similar to the American model, with the first step in fixing the seat and ensuring its alignment. The real difference commenced from the second step, a difference

which if able to be implemented in our classrooms, would make our education world class. Upon enquiring about the second step he was told that he would be shown this only after he acquired proficiency in the first step. The assembly line would start and he would have 15 seconds or so for his allocated task. This was surprising for Spear’s but soon was able to complete his assigned task successfully. He was next given the next task, but upon enquiring about the other steps he was told he would only be given these after acquiring proficiency in the second task. As you can probably now see how such a minor difference would make such an impact upon financial and other variables.

If this philosophy and process could be brought into the classroom: that children only advance in a lesson based upon learning and testing of preceding knowledge, where we would be? We will address this in pedagogical terms and see why this is not being applied, why this system prevails and when it was applied, a century or so earlier. A case of creating requisite foundation upon which a sturdy building can be built; with technology this can be addressed and we can replace our old Ford with a Lexus.

This may seem like a small step but can lead to a huge growth for an economy or conversely a meltdown. So as with a manufacturing education needs a fixed outcome, time can and must be variable. **Testing an assessment at every step is essential**. What will be the results? Stephen was able to master the first step and subsequent steps correctly in the first attempt at the assembly line. This was the difference between Toyota and American car - quality. "Assessment or inspection is interdependently woven into content delivery with fixed results. This minimizes the repair work at the end of the pipeline and there were essentially no dropouts. Without this the results would be catastrophic for Ford motors or a educational

Topic 203

Teaching at Home

We turn to another story: as I had told you earlier we had a great rambling house in Multan. The vast grounds were surrounded by low-income dwellers. Since my father and grandfather had passed away and I lived with my mother and aunts, who would go to teach, my grandmother was alone in the house. She would gather young girls from the adjoining houses and hold a regular class in basic Urdu, Mathematics and recitation of the Quran, out in the veranda. Each girl was of a different age, differing intellectual levels, motivational levels and leaning styles. Her mode of teaching did not consist of lecturing she paid individual attention to each girl. Reminding each one their mistakes the previous day and based upon that what further learning was required. She tried to ensure that the earlier mistakes were clarified before proceeding further. Her teaching maxim was to each according to their need.

What seemed strange to me was that after a while all girls achieved the basic level of proficiency, in what they were studying. Please consider, for each student; the pedagogy and learning styles are different, each is prescribed different time limits, they are not being assessed through an exam, their prior knowledge is considered. Each factor is variable apart from the output, minimum proficiency in subject matter being handled. Does this not appear strange to you; despite everything being variable the output being constant. What happens in our school, the old industrial model prevails. When giving a lecture it is the same for all students. When they are assessed it is the same. The same preparation and time is allocated for all students. The fees they pay are the same. All are treated equally. The only difference is their grades, i.e. the output? In our school, with its high dropout rate, we are continuously told that these kids do not want to study. Strange that my grandmother who was not even a graduate can lead all students to success. She learned English from her husband, so that she was able to read stories. In Urdu she had not even cleared the tenth standard. Yet, she managed to teach students who had no previous schooling. In our case we have faculty trained in the States, England, and Europe but cannot teach these students; and 70% of our students feel that they cannot learn computer and leave.

Topic 204

A Story of UET

Now I want to narrate story, which took place in 1988. As a professor at UET, despite the fact that our salaries were quite meager, we were allocated rather large houses which also contained a few servant quarters. The custom was that large families would move into these quarters, rent free, and in exchange they would provide a few free services. The stability provide lead to a large number of children, they outnumbered all other residents. Since they had nothing much to do and were not going to schools, they created quite a bit of ruckus. My wife, who is quite energetic in these things, told me that we should open a garage school for these children. She gathered all the students, some entirely there because of curiosity. She had books and stationary donated for free. The one room school was set in motion. All the students were of different ages, but my wife along with other neighbors and volunteers paid individual attention to each student. Again no lecture was given, no exams conducted. The funny thing was that the word of this school reached the vice- chancellor.

At that time the IT bubble had not burst and the authorities thought that we had opened an IT school to make money on the side. Two people came to interview me, upon enquiry as to who they were they told me that were from intelligence. At that time the students were learning multiplication tables, much like we did in our days – reciting in rhythm. They said that I had opened up a school and was making serious money from it. This was happening while the Kargill was taking place. I told them the computer school was right in front of them, where servant's children were being taught free of charge. While there is a war going on the intelligence services are engaged in this petty investigation.

Topic 205

Formative Assessment

We now turn towards definitions of pedagogy which explain the differences between what was occurring in my grandmothers and wife's school, in comparison to what was happening at proper surrounding schools. The main difference was that the students were learning. This is what was happening at my grandmother's improvised school and my wife's; at Toyota and in our Madressas a hundred years ago. Please, observe that I have not out rightly delved into the realm of pedagogical. In the recent language of pedagogical research this is referred to as Formative Assessment. I have used Wikipedia as a reference since, another example of which now available to us through our cells. This refers to it as 'formative assessment including diagnostic assessment.' From the prefix (formative) you should be able to grasp that this refers to early development; something being formed. In context of our examples: on the assembly line a car being formed; and in my grandmother's school grasping the basic concepts of schooling. Naturally, this does not occur in isolation since any development entails assessment. What does this imply?

It is logical that once a process is completed and something built, i.e. a car; it needs to be tested. Similarly, once taught a student tested. Yet, here we do not refer to this. Formative assessment implies that a thing is tested while being developed or built; this falls under the realm of diagnostic testing. In medical terms this would mean we are diagnosing for disease while it has not formed. "Diagnostic testing is a range of formal and informal assessment procedures conducted by teachers during the learning process, in order to modify teaching and learning activities to improve student attainment." In simpler terms testing becomes an inherent part of the teaching process. In our case, the students have just enrolled and it is the first week; little has been taught, no topic completed. Yet, the assessment commences; "conducted by teachers during the learning process, in order to modify teaching and learning abilities to improve student attainment." This allows an assessment of prior knowledge and the current status of the student with respect to where he stands and what should be taught. Pedagogically, while a student is being taught a feedback loop is created while being taught new knowledge.. It is imperative for a teacher to modify his/her teaching accordingly; a continuous process of adjustment.

If this is not done the final product would be flawed and it would be too late to rectify the problem. In terms of car manufacturing this is referred total quality management: a process which was not there for American car manufacturers and one which led to their decline. "It typically involves qualitative feedback rather than scores for both teachers and students that focus on the details of the content and performance." This is very important, our emphasis is on grades. In my grandmother's or my wife's school there were no scores, yet the children were able acquire proficiency is what they were being taught, which was their objective. This also happens in a vocational setting where children act as apprentices in various crafts. Some will acquire the requisite skills in earlier than others, but almost all will eventually acquire these skills; no grading takes place. During the process continuous feedback is provided by the master, another case of formative assessment. "This assessment is commonly contrasted with summative assessment." By summative we refer to the existing system which is currently in place, consisting of periodic testing. "The assessment seeks monitor outcomes often for purposes of external accountability." Michael Skriver in 1967, had this to say about evaluation: "there are differences both in terms of goals of the information they seek and how the information is used for striven formative evaluation gathered to assess the effectiveness of curriculum and guide school system choices to which curriculum to adopt and how to improve it."

“Benjamin Bloom took up the term in 1988 in the book, ‘learning for mastery’; formative assessment as a different tool for improving the teaching-learning process for students. His subsequent handbook on formative and summative evaluation written with Thomas and George showed how formative assessment could be linked to instructional units in a variety of content areas. It is this approach that reflects the generally accepted meaning of the term today. For both these authors, assessment, whatever its other uses, is only formative; if it is used to alter subsequent educational decisions.” This implies changing the entire methodology or content if required in moving forward. “Practice in a classroom is formative to the extent that evidence about student achievement is provided.” Once understanding is ensured further progress is made. In our schools and those around the world the inverse is true. “Evidence about student achievement is interpreted and used by teachers, learners or their peers to make decisions about the next steps in instruction that are likely to be better or better founded than they would have taken in the absence of evidence that was provided.” This not being the case, in our schools there is tremendous pressure to promote children, which results in high dropout rates once transition is made from schools to colleges based on summative evaluation; at which point it is too late rectify the situation. The existing sad situation of our education is entirely our responsibility and not that of the children.

This leads us to technology and interactive learning applications; these contain the provision for instantaneous feedback. In the existing format through which I am addressing you, there is no room for feedback – a model based on summative assessment. Why are we so interested in game, technology based or actual sports? The element of instant feedback, arising from a player’s actions creates the requisite interest, for players and spectators; a fact which has great repercussion for interactive game design and learning applications, content design criteria.

Formative assessment, including *diagnostic testing*, is a range of formal and informal assessment procedures conducted by teachers during the learning process in order to modify teaching and learning activities to improve student attainment.[1] It typically involves qualitative feedback (rather than scores) for both student and teacher that focuses on the details of content and performance.[2] It is commonly contrasted with summative assessment, which seeks to monitor educational outcomes, often for purposes of external accountability

	Summative Assessment	Formative Assessment
Time	At the end of a learning activity	During a learning activity
Goal	To make a decision	To improve learning
Feedback	Final judgement	Return to material
Frame of Reference	Sometimes normative (comparing each student against all others); sometimes criterion	Always criterion (evaluating students according to the same criteria)

Topic 206

Formative or Summative Assessment

Again turning to Wikipedia, a comparative summation of formative and summative assessments are provided through a table. The key distinguishing criteria are; time, when employed, goals, availability of feedback and frame of reference. Summative assessment takes place at end of learning activity; which at most time is too late. Comparatively, formative assessment contains instantaneous feedback. In terms of goals in summative assessment a final judgment, based on grades, has to be made. While in formative no judgment is made rather the learning process continues: to improve learning and not grade students. Learning should not be grade driven rather the process itself should be enjoyable and its own reward. The elements of frustration, conflict, fun, excitement and cooperation are necessary constituents. In summative assessment feedback is periodic, while in formative continual.

Summative assessment often leads to final results which are less than desirable and have huge adverse connotations for college if they go on to it. When a teacher at our college narrated that 70% of the students had failed, and I asked why he had failed them, he said they had failed themselves. I enquired how many quizzes were given, none was the answer. In classrooms they were no interactive question and answer sessions. Only the final judgment at the end of the year was in place. We will continue to revert back to these assessments, since critical in terms of pedagogy. Since becoming dean I have tried to bring in some reforms. A course in algorithms design course which had a very high dropout rate, we have created refresher courses for the summer. There are four sections consisting of fifty students each. Summative assessment no longer holds sway, students are encouraged to engage small groups and see what they comprehend. Similarly, students are encouraged to engage more and think rather than sitting mutely and taking notes. Classroom response systems are being deployed. We need to learn our lessons from the earlier stories and lecture no longer.

Topic 207

God is my Only Helper

In the earlier modules we were looking at a case study of a university where I am the dean. We are particularly analyzing the high dropout rate and its reasons; in context of theories of learning, technology and pedagogy. As you know the monsoon season has begun and the weather milder. While lecturing at another place and trying to convey the necessity of passion for teaching and learning. Some topical verses penned by me which related to the weather and passion:

Khuda he hai wahid madadgar mera
Kay dekhay hai mai nay uske jazbo kay toofan
Kay dekhi hain mai nay uske zulfain pereshan
Kay dekhi hain mai nay uske chahatt kay saman
Vo jazbo kay toofan, vo zulfain pereshan, vo chaat kay saman
Vo jazbay gin ki hararat say jal kar uthi hai sawan ki uudi ghattain
Vo zulfain gin say samhi hoi hai shumali samandur ki thandi hawai
Vo chaat jis ki baho mai aakar, uthti nahi hai uppar nighain
God is my only helper
That I have seen her emotions in a storm
That I have seen her troubled tresses
That I have seen her state of love
Her emotions in a storm, her troubled tresses, her state of love
On seeing these, envious purple storms clouds arise
The cold northern winds fearful of her tresses

The love in whose embrace entwined, the eyes unable to rise

We further look at the differences between formative and summative assessment and how, in our case, attempted to transform the summative system to a formative one. In the slide presented here the rationale for formative assessment is given:

- “To provide feedback for teachers to modify subsequent learning activities and experiences;
- To identify and remediate individual and group deficiencies: here the lack of learning is not due to any lack of ability rather due to different learning styles;
- Focus away from achieving grades and onto learning processes: this is critical and a thing which I continually reiterate to my students. Do not go after grades, take some risks and do not be afraid of failure.
- In order to increase self-efficacy and reduce the negative impact of extrinsic motivation: a passion for learning has to be developed where intrinsic motivation is present.
- To improve students meta-cognitive awareness of how they learn and frequent ongoing assessment, which allows for fine- tuning of instruction and student focus on progress: learning, teaching and testing should go side by side.”

Topic 208

Instant Feedback and Summative Assessment

Instant feedback is the central function of Formative assessment. It typically involves a focus on the detailed content of what is being learned rather than simply a test score or other measurement of how far a student is falling short of expected standards. Nicole and Rick?, synthesizing from the literature list seven principle of good feedback practice:

- It clarifies what good performance is; goals, criteria and expected standards - this function cannot be replicated by technology and still requires human intervention.
- It facilitates the development of self-assessment in learning – as I narrated earlier the computer science students at our university has serious deficiencies in the English language, in terms of comprehension, vocabulary, writing and speaking. Teaching them in medium is terribly difficult. Self-assessment is required, which is done through technology based interactive learning application which asses their level of proficiency and gradually build upon it, through instant feedback.
- It provides high quality information to students about their learning – this is done both for the teachers and students.
- It encourages teacher and peer dialogue around learning.
- It encourages positive motivational beliefs and self-esteem.
- It provides opportunities to close the gap between current and desired performance – this cannot be achieved through the traditional lecturing style.
- It provides information to the teachers that can help shape teaching and it can also help them assess – the system allows for all to be certified at a certain proficiency level, despite varying times contingent upon effort put in.

We had dealt specifically with English education since crucial for collegiate education, whatever the subject. Similarly, in mathematics there has been an enormous amount of research in terms of technology and pedagogy; especially in context of information technology in education. Globally, it is understood that whatever the discipline a certain basic proficiency in mathematics is required; probability, risk analysis, statistics, etc. In the slide you see that mathematical knowledge is essential: "it is important for teachers to see how their students approach the problems." The criticality of learning from one's mistakes cannot be emphasized. Also, the onus is upon teachers to discover what approach they are adopting; the traditional bookish approach or one which takes into account real problem solving based upon their individual and innovative approaches. "How much mathematical knowledge and at what levels students use when solving problems."

Grades should not be the sole criteria rather learning in itself should be an objective. "That is knowing how students think in the process of learning or problem solving and that makes it possible for teachers to keep their students overcome conceptual difficulties and in return improve learning in that sense formative assessment is diagnostic ." One approach is to make students make mistakes, which allows for greater conceptual understanding. "In math's education to employ formative assessment in the classroom a teacher has to make sure that each student participates in the learning process by expressing their idea – there is a trustful environment." Again a critical point which is related to our actual case studies and one the grievances students expressed at our college.

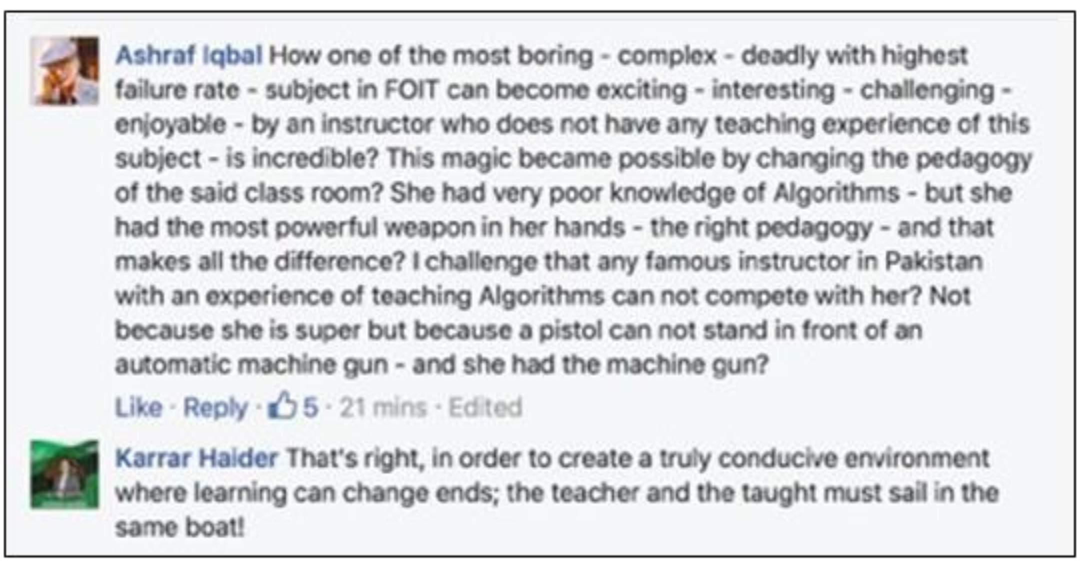
"A friendly environment in which students can provide each other feedback: the teacher also provides feedback. All the instruction is modified according to student needs." A fundamental change since the teachers is forced to change his teaching style in conformity to student needs – a dynamic change. The inherent feedback provides the requisite clues in adaptation of teaching styles. “In math’s classes thought revealing activity such as modern eliciting activities and generative activities provide good opportunities for covering these aspects of formative assessment.” Turning to an example of formative assessment and instant feedback, which as you know run in parallel, but for formative assessment a better term might be formative learning, since we need to look at it from a higher perspective. This is real example based upon my experience with the science of learning for the past fifteen years and also leads to the use of technology.

Topic 209

Winter and Summer in Lahore 1

In the example we assume a dialogue between a teacher, or should we say a facilitator, and students. There is formative assessment and learning along with feedback taking place. There is also discussion taking place between the two in clarifying the questions put across. The facilitator instigates a discussion by introducing a question and then observes what discussion occurs. A small incident needs to be narrated before going further with the example. In our summer school sessions there are a lot of failed students, particularly in the course which I teach, graph theory and analysis of algorithms. In an interesting and exciting course there are more than 200 failed students over the past couple of years. We had to create four sections for them, for which we found three teachers. We had difficulty finding the fourth teacher. At that time there was woman who had applied for a job and was qualified but had no prior teaching experience. I decided to test her out much to the reluctance of our head of the department, who was not quite sure about this. Even the teacher herself was hesitant and told me she had studied the subject but never taught. I told her she did not have to teach, only ask a question and observe what the students discuss and to facilitate this discussion.

She was still reluctant so I coached her a bit. With hesitation she went into the class but followed instructions. Comparatively, in the other section senior teachers with five to ten years of experience, in this course, were available. Two of these teachers were my past students in this subject and were familiar with the pedagogy required. Can you guess what occurred after a ten day or so? Complaints from all three section started pouring in along with requests for transfer to the inexperienced teacher's section. The main reason citied was the students in her group were enjoying themselves. What was the difference? The vast experience for the senior teachers was standing in their way. While they were teaching the lady teachers was discussing. Since she did not know her subject very well she empowered the student and instilled a sense of self-belief in them. I deliberately employ this methodology, by feigning ignorance in a subject and not giving any answers to the students, rather letting them arrive at it on their own.



Ashraf Iqbal How one of the most boring - complex - deadly with highest failure rate - subject in FOIT can become exciting - interesting - challenging - enjoyable - by an instructor who does not have any teaching experience of this subject - is incredible? This magic became possible by changing the pedagogy of the said class room? She had very poor knowledge of Algorithms - but she had the most powerful weapon in her hands - the right pedagogy - and that makes all the difference? I challenge that any famous instructor in Pakistan with an experience of teaching Algorithms can not compete with her? Not because she is super but because a pistol can not stand in front of an automatic machine gun - and she had the machine gun?

Like · Reply · 5 · 21 mins · Edited

Karrar Haider That's right, in order to create a truly conducive environment where learning can change ends; the teacher and the taught must sail in the same boat!

Ashraf Iqbal Samina Akram - please share your experiences and the environment that you create in one of the most hated subjects in FOIT?

Like · Reply · 1 · 3 hrs · Edited

Muhammad Ali Sir ' 'AA is well known as one of the most difficult subject of the CS course outline. But i must admit that with the change in teaching styles and the student teacher relationhip AA has changed the entire course of the CS dicipline. What was once expected as the most difficult course has now proven to be the most 'fun learning' and 'practically important course' toward the completion of the degree. And a hats off to Maam Samina Akram's approach toward teaching the course, without which this course would'nt have been such a success. And thanks to you sir for providing us with such an enviroment .

Like · Reply · 1 hr

Mujadad Rao This has been a really good and a new experience for us... We never dared to discuss anything in the class (talking about two years of experience in UCP) but Mam Samina forced us to discuss and share problems with each other in class. In whis way we were able to solve almost every problem thrown to us. This has been a brand new experience for me and every classmate of mine in UCP 🙂

Like · Reply · 1 hr

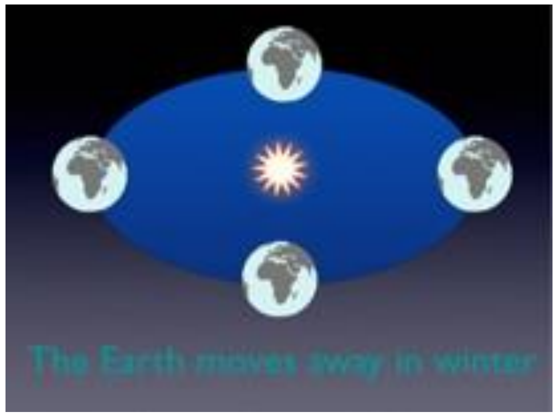
Topic 210

Winter and Summer in Lahore 2

Returning to our example, the discussion occurring between a facilitator and student; the facilitator put across a question which should be comprehensible to any field of study. Why is there winter and summer in Lahore? Student A gives the following response, an intuitive and common sense response which the teacher should seek to elicit from all students. Also, an answer which we have all provided at one point in time but since no friction was created in mind and no linkages between prior and new knowledge created, most have forgotten. “Because the earth comes closer to the sun in summers and goes further away in the winters.” This answer is naturally based on observation that as you come closer to a heat source, i.e. heater, you feel more heat and further away less heat. The summer interject; “when there is summer in Lahore, is there summer in all parts of the earth?”

In actuality this should not have been said by a student but rather one of the students. As a facilitator the most pertinent job is keep quite as far as possible. The second student’s response to this question is that; “yes it should be because the whole earth is closer to the sun and it is also rotating on its axis.” Student C has this to say; “when it summer in Lahore it is winter in Australia, South America and South Africa.” Naturally, he must have some acquaintances in these palaces and thus his answer. Student D reply to this was, “that means winter and summer do not occur because of the distance of the earth from the sun.” From you see the original basis of the argument, distance, is refuted. An essential step in the process of learning where you build an argument and then try to test it by attempting to refute it. Based on negation student E says; “why argue about distance, when facts can be checked on the internet through your cell phone.

Student F immediately does this and says; “it is the other way around, in the winter the earth is closer to the sun and vice versa.”



Topic 211

Winter and Summer in Lahore 3

Seeing this argument the facilitator says we have arrived at deadlock. Where he again interjects another question based upon student curiosity which is created by the opposite conclusion and which causes friction in their minds; “have you ever seen the sun setting in the evening, you can see it with your bare eyes.” Despite the fact this has no direct connection with the earlier question; many questions are raised which are divergent in nature but there purpose is to allow students to create new linkages based upon their prior knowledge, by stepping out of their comfort zones.

We have studied this earlier but here we are trying to attempt the same problem from formative assessment/learning perspective- foundation knowledge of constructivist theory. The question put across is based on an observable phenomenon which the students can see for themselves. Student A takes the argument further; “but you cannot see the sun when it is at its zenith.” What is the significance of this? You have to realize that answers are not as important as the questions. Student C states; “does the distance of the sun increases when it setting as compared to midday?” Earlier we discussing the sun’s distance during the seasons and now we have come to days. In both proposition the distance variable is confusing the students. Student D again refers them to the internet to check for facts. Student F does this and finds out that the distances are the same. Since the earth’s diameter negligible compared to the distance from the sun no real difference. Student G adds that summer and winter are also not contingent upon distance; there may be a common reason but which we do not know. At this stage two processes are simultaneously running in the student’s minds which are linked to distance. Now that the distance factor has been clarified their minds are receptive. The facilitator again reverts to a question which apparently has no link to the earlier question; “we use multiple x-ray plates to see the sun, especially during an eclipse.” Student A immediately tries to connect this comment to the earlier process in his mind; “but when the sun is setting we can see the sun without multiple x-ray plates.” Student further develops this argument; “it seems that x-ray plates get in the way viewing a setting sun.”

Now the students have started to make connections and learning has started. Student C comments; “the sun is not as hot when it is setting because as you suggested some sort of x-ray plates appear to come between us which also reduces its heat and light.” Despite the distance being same, how does this occur? A fact which is confusing the students and this is as it should be. If they are agitated they will learn. Student D says; “the winter may also be like the setting sun.” Again observe how linkage to previous thought is attempted. Many types of superstitions are like this; for example if a black cat crosses my path and I have an accident, my mind creates a connection, despite it being wrong. The concept of x-ray plates apparently has solved the student dilemma. Student E further reinforces this saying that these plates disappear during the summer and when the sun is at its zenith. At this student F enquires in frustration, as to where these plates come from. As you see now multiple processes are running in the students minds, the conflict created is a necessary and an important point of learning.

Topic 212

Winter and Summer in Lahore 4

Now if we were to attempt this through technology. What you see before you see a scene from winters, where there is snow. In contrast now you see a picture by Van Gogh, which illustrates the summers. We continue showing these series of pictures to the students. First the sun, if its size increases naturally there will be a significant impact. If the distance changes a significant impact occurs; while the diameter of the earth does not count, since negligible compared to the distance from the sun. Here we are not discussing anything only showing the students pictures. As you know the earth is tilted and revolving on its axis, this too is shown. Next we show a picture where the tilt increases, for students to think about it. Could this be the reason? Now we reverse the tilt, to show another aspect to the students. Pictures narrate a thousand words but also raise many questions; addressing our curiosity. Having provided this slide show we now start discussing it. The learning application begins with the same, earlier, question; "why is there summer in Lahore."

Next it shows you multiple options/answers which need to be ticked by the students. The first that the sun comes closer to the earth is usually selected by a significant majority. As designers and teachers we should be aware of all the wrong answers to a particular question; so that we can lead the students to make all the possible mistakes which ultimately lead them to the right answer. If you have read the Sherlock Homes novels, you would appreciate this deductive process. The second is the earth spins about its axis. The third choice is that the earth spins and rotates about the sun. Next the earth has a tilted axis. Some other reason (we do not know).

Whatever answers they provide a new question would be put forth, through technology. In the first case the program would go this slide. The sun coming closer has some ramification in terms of the question. If the earth is rotating about a fixed axis around the sun there will be no changes in the distance. The new questions include; the earth moves in a circle with the sun at its center. If they click on this option they will be taken to a new slide where they would be shown that since the distance cannot be changed this is not possible. The second choice is that the earth moves in an ellipse with earth at its exact center. Here the distance can be altered. If they tick on this they will be taken a scenario with an animated ellipse, where the earth moves closer or more distance as it orbits. At this stage most of the students would consider the problem resolved. But this too has certain ramification which are essential for them to understand even if wrong.

When we demonstrated this learning application, the student had an interesting thing to say, of which we were not aware. They said according to this there would be two winters and two summers in a year. What was this based on? This needs to be understood and incorporated into our formative assessment in terms of interactive learning application design. Next we remove the sun from the center of earth's orbit and assume it is at a corner of the earth. This is another possibility which needs to be exhausted. All mistakes they make have a certain rationale and ramifications, which need to be addressed. The earth spins only is another assumption. The ramifications for this are too illustrated. Similarly, what happen if the earth spins and rotates? Can it be due to a tilted axis? All these questions need to be addressed, which creates a design tree, through which a successful application can be created. Let the question of the absence or presence of x-ray plates keep you agitated, till next time.

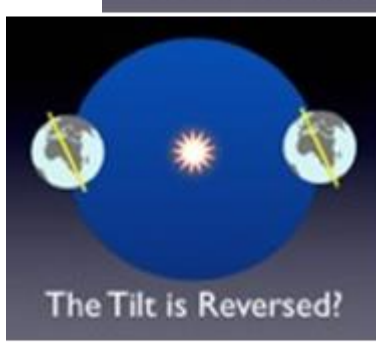

The Size of the SUN


The Size of the SUN


The Amount of Tilt


The Amount of Tilt


The Amount of Tilt


The Tilt is Reversed?

Why there is summer?

- The sun comes closer to Earth?
- The Earth spins about its axis?
- The Earth spins & rotates around the sun?
- The Earth has a tilted axis?
- Some other SECRET?

The earth comes closer

- The Earth moves in a circle with sun at the center?
- The Earth moves in an ellipse with earth at its exact center?
- The Earth moves in an ellipse with sun at a far corner?
- Some other SECRET?

Topic 213

Variation in Seasons

In this exciting course we are studying, I sometimes feel a deficiency. Instead of facing students, I face a camera and am unable to see the glimmer of interest in their eyes; nor their reactions to what I am teaching. At the end of each session I usually show the recording to my students, who are working with me in pedagogy and technology. Their comments, questions and answers are truly interesting and invaluable for me. An occurrence which can only take place in a lively classroom setting. If you remember in the last module we were discussing the variations in seasons; why is there summer and winter. Why is a day hotter in the afternoon as compared to the evening and why we can observe it at that time with our naked eyes? We were also looking at a supposition by students of x-ray plate like mechanism intervening to blunt the heat and allow for us to observe the sun. Based on this a strange question was raised; "why is the sun at its zenith during the summer month cast its rays directly at on top of a person's head when outside." From a pedagogical perspective all questions are valid. Perhaps the student had studied some material somewhere of which only a portion was retained. Despite, its phrasing the question is valid. Recently observing a drawing class at our university, who are doing sketches outside in the morning, around 10:00 am or so, they were drenched in sweat. The essential underlying point was that the in the afternoon the sun rays are traveling in a straight line, while in evening striking us at an angle. Is this what determines the difference in temperature and brightness?

Does this point hold some resonance for you? Let us now look at a picture; of the sun and earth the distance between the two is noticeable. There is a person stationed on the earth at around 12:00 pm and the sun is directly overhead with its rays falling straight on him.

Conversely in the other picture the sun is setting and the sun rays are falling almost at a ninety degree angle. Based on this difference a student came up with a possible answer. To prove his point he assumed that the man in second picture in made to lie prone on the earth. This implies that the sun rays are also falling directly on his head and the distance of the sun in both scenarios is also equal. The actual positioning on earth does not really matter since diameter of earth negligible compared to distance from the sun. This clearly refutes the earlier point raised by a student despite the fact that it was right to a certain degree but incomplete.

In our earlier actual example of a college where the computer dropout rate is almost 70% we were looking at the reasons for this; while we were looking at examples of seasons in terms of formative assessment. Despite varying examples the context remains the same: how do we rectify this situation at our college.

Topic 214

Assessment of Learning

Returning to our college case study we again refer to a book we had earlier looked at; Mathematical Mindsets by Joe Boaler with foreword by Carol Dweck. The book deals with unleashing student potential through creative mathematics, inspiring message and innovative teaching. In this course we used books from experts in different disciplines; pedagogy, technology and content; some from experts in multiple disciplines, i.e. all three. Till now we have somewhat tentatively established summative assessment to be the culprit and formative assessment as the right methodology. Now we look at what experts with mathematical pedagogy and content knowledge have to contribute. It is stated in the book that all mathematical teachers should be made to watch a movie; 'Race to Nowhere', which is about the use of information technology for education. "Part of the power of Race to Nowhere is in its personal story. The film carries into discovering that pressure of school; homework and tutoring were making her middle school daughter physically sick.

The notion that her daughter, a seemingly normal teenager had been diagnosed with stress induced illness: it was a painful wakeup call and a catalyst for change. Race to Nowhere is a documentary highlighting the stress students are placed under US school, colleges and universities." It was released a couple of years ago and highly acclaimed. The New York Times said it was a must watch movie for all the instructors in the world. It ran to packed houses showing the damaging effects of testing, grading homework and over scheduling on students health and wellbeing. Race to Nowhere has continued to gain support from tens of thousands of educators and parents. "When I watched the film I saw mathematics everywhere as the main source of student stress and anxiety." The basic thesis of the book is that in mathematical education the stress and anxiety need to be replaced by fun, adventure and discovery. “The film Race to Nowhere features the sad story of a high school student, Devon, who had always done well in mathematics. She was a highly motivated young girl who saw maths as part of her identity.

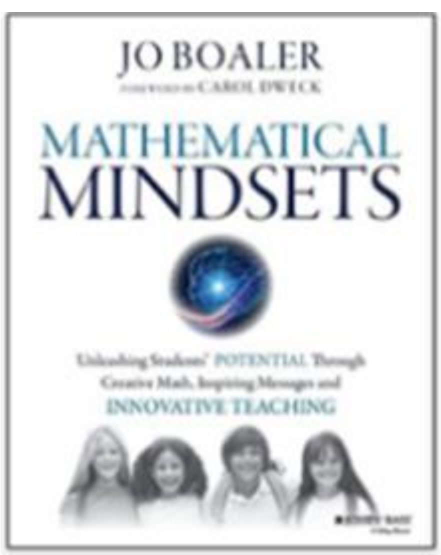
One day she received an F on a maths test and tragically she committed suicide.” As you can imagine what you are studying can be a matter of life and death. “For Devon and many other students the grade she received did not communicate a message about an area of maths she heeded to work on in her growth learning path.” This growth learning part is the foremost responsibility of an instructor, whatever the pedagogy or technology utilized. “It gave her a message about who she was as a person; she was now an F student. The idea was so crushing to her that she decided to take her life.” From the pictures in front of you, you can see that apart from the girl’s death the headlines state that this was the second one.

In a typical lecture setting the learning potential is dramatically reduced, especially these days with the help of multimedia. Earlier I had told you about a survey carried out a LUMS, my former university, concerning calculus learning where only 20% learning was established. It was suggested that we do away entirely with multimedia teaching. “When we give assessment to students we create an important opportunity for well-crafted tasks and questions accompanied by clear feedback. Offer students a clear growth mindset, pathway that helps them to know that they can learn to high levels and critically how they can get there. Unfortunately most systems of assessment in classrooms in the United States do the opposite; communicating information to students that cause many of them to think that they are a failure in mathematics and they can never learn mathematics. I have worked with teachers in recent years who shied their methods of assessment from standard tests with grades and scores too. “Based on her findings the author of the book launched a movement. “This resulted in dramatic changes in their classroom environments.” This was entirely through the incorporation of feedback in the classrooms. “Math’s anxiety formerly common amongst students disappeared and was replaced by student’s self-confidence, which led to higher levels of motivation, engagement and achievement.”

The author is a teacher of mathematics and not pedagogy. Yet, she had to study pedagogy and now is in a position to teach it to us – an interdisciplinary jump. She say: “A little background will be helpful, there are two types of assessments formative and summative. Formative assessment informs learning and is the essence of assessment for leaning or assessment A4 learning. Formative assessments are used to find out where the students are in their learning, so that teachers and students can determine what they need to know next. The purpose summative assessment in contrast is to summarize a student’s learning to give a final account of how far a student has gotten as an end point. One problem in the United States is that many teachers use summative assessment formatively that is to give students an end score or grade, when they are still learning the material. In mathematics classroom teachers use summative tests weekly and then move onto the next subject without waiting to see what the tests reveal.” Things were pretty much the same in our college; only four quizzes were required given. If marked the students were not told what their weaknesses were. The quizzes were examined for underlying patterns, a necessity which is quite impossible without the employment of technology. I hope you can follow the parallel with American schools and our college. “In A4 leaning students become knowledgeable about what they know and what they need to know and ways to close the gap between the two. Students are given information about their flexible and growing learning pathways that contributes to their development of a growth mathematical mindset. Assessment for learning can be thought of as having three parts:

- Clearly communicating to students what they have learned – not grading but rather assessing;
- Helping students become aware of where they are in their learning journey and where they need to reach;
- Giving information to students in ways of closing the gap between where they are now and where they need to be.

The approach is called assessment for learning rather than of learning, because the information teachers and students get from assessment for learning helps teachers make their instruction more effective and helps students learn to the greatest extent possible." This, I cannot emphasize enough, is the paramount job of all levels of instructors in ensuring that it is taking place in their classrooms.



Topic 215

Rethinking Education

Having discussed mathematical teaching we take you in another related but separate direction; 'Rethinking Education in the Age of Technology' a book you have seen earlier. It states that prior to the industrial revolution, when schools had only three to four pupils for each instructor the format was that of formative assessment. After the industrial revolution the population of students increased dramatically and this type of assessment was no longer possible and schools shifted to summative assessment. We are now at a point that technology has progressed so much that we can reapply the earlier model. "We are trying to go into the future and the future is in our past."

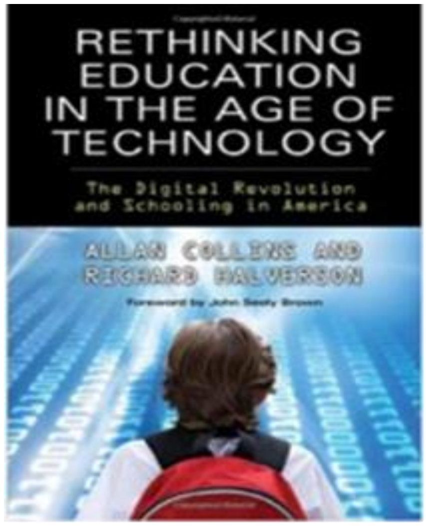
The author also talks about the one room school in the old days, where each student was taught according to his ability; grading was not the sole criteria. Another interesting thing was that the students and instructors are intermingled- a very modern concept in terms of pedagogy. A situation in which there is collaboration and senior students are helping, junior students, since more familiar with how their minds work. The author goes onto narrate about Norman Fredrick; who came up with idea on how to clear navy guns during the Second World War. During that time summative assessment was considered very modern and he was asked to provide a lecture in training other navy personnel after which they would be tested. According the gunner this was not the way to teach them, and this would imply unclean guns which could lead to the destruction of the ships. The navy personnel would need to be trained on the job; a form of formative assessment.

Returning to pedagogy we refer back to an earlier quotation "The educational process as two sides, one physiological and one sociological. It is essential that students be actively engaged in the process of inquiry. When action is divorced from thought, teaching becomes information transmission. So for this reason higher education experiences are best conceived as communities of learning. According to Dewey educational enquiry is a process to investigate problems and issues and not to memorize solutions. Inquiry within the educational community focuses on intended goals and learning outcomes.

It is a systematic process to define relevant questions, search for relevant information, formulate solutions and apply those solutions and not to memorize formulas. A community of enquiry depends upon sustained communications and collaboration, where the participants share experiences and insights. Education defined as a process of enquiry goes beyond even accessing or assimilating information; enquiry joins process and outcomes. Means and ends in a unified iterative cycle, it links reflection and content by encouraging students to collaboratively explore and reasonably question the organization and meaning of the subject matter. Inquiry is both a reflective and collaborative experience."

Before you are a table which highlights the need for three presences: Social presence – a collaborative arrange where there is open discussion and students are comfortable with each other. This will enable risk free expressions, encouraging collaboration and expressing emotions.

- Cognitive presence – Is a recursive process that: encompasses stages of puzzlement, information exchange, connection of ideas, creation of concepts and the testing the viability of solutions. This is not to suggest however that the actual practice of enquiry is linear.
- Teaching presence



John Dewey strongly rejected dualism and argued that the value of the educative experience is in unifying the internal and external worlds. Dewey stated, "the educational process has two sides—one psychological and one sociological; and that neither can be subordinated to the other or neglected without evil results following"

According to Dewey, educational inquiry is a process to investigate problems and issues—not to memorize solutions. Inquiry within the educational community focuses on intended goals and learning outcomes. It is a systematic process to define relevant questions, search for relevant information, formulate solutions, and apply those solutions.

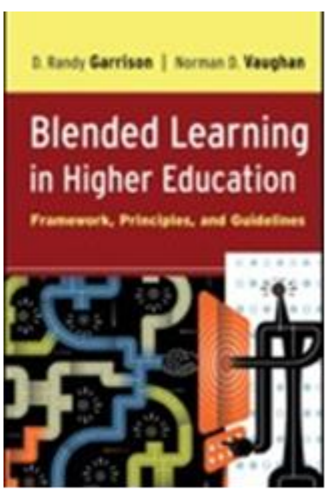


Table 2.1 Community of Inquiry Categories and Indicators

Elements	*Categories*	*Indicators (examples only)*
Social presence	Open communication	Enabling risk-free expression
	Group cohesion	Encouraging collaboration
	Affective/personal	Expressing emotions, camaraderie
Cognitive presence	Triggering event	Having sense of puzzlement
	Exploration	Exchanging information
	Integration	Connecting ideas
	Resolution	Applying new ideas
Teaching presence	Design & organization	Setting curriculum and methods
	Facilitation of discourse	Sharing personal meaning
	Direct instruction	Focusing discussion

Topic 216

Schools & Assessment

Four pictures are shown here, where a teacher is teaching in a formative assessment format. This could be any country historically. A teacher is teaching three or four students in a class. One student has understood the first principle of geometry and is ready to progress to the second principle. While another child is still stuck on the first principle and will stay on till an innate understanding is acquired. All gaps is disparate knowledge are closed and right learning pathways developed. In comparison a modern classroom, air-conditioned and with modern technology, the teacher tells the students that their homework has been marked but was unable to being their copies to school. We now move to new lecture on a different subject. In this setting the teacher has no idea where the students stand in terms of knowledge, all she know is that she has to take them a certain point in terms of the course work. If an exam is taken at this point this will only lead to a summative assessment focused solely on grades.

We now turn to a school of the future. As you probably realize the most expensive component of the school is the building, this here has been removed from the equation. Instead of very qualified teacher we have a facilitator. This would in actuality happen since with an exponential population growth qualified teachers would be hardly available. Here computers and technology are playing the same role which teachers used to do in the olden days – formative assessment framework. If a particular student has read and understood the first principle of geometry, a fact verified by the computer than is he allowed to progress. Through technology we can determine where a particular student stands, where he needs to be and how. While another student who is not fully conversant in the first principle is held back by the computer till he thoroughly understands this concept. The future and past in this respect remain similar. Through the IT revolution and low cost technology we can now impart world class education to students. So as you see we have moved from the one classroom containing a form of apprenticeship in a formative assessment framework; to modern classroom post industrial revolution where conventional teaching and summative assessment took place; to post IT revolution, technology driven formative assessment based learning. Another advantage of technology over the earlier formative system is the number of students which can study in comparison to an instructor.

If you observe the state of our existing schools and colleges, they are entirely driven by a grade based system. Now if you resort to summative assessment in the classrooms, as was happening in our college, and use periodic tests like the midterms to assess them; without letting them know where they are and have to be and how to fill these gaps – only 20% to 30% would pass a systematic failure. Considering this failure rate unacceptable we turned to relative marking; comprising on quality. Next we turned to interactive learning and a formative assessment setup but retained absolute grading. In a real life example, an apprenticeship usually falls in this. A master is not bothered about grades but rather if the apprentice can successfully carryout the assigned task. You can further improve or align the summative system but it would create tremendous difficulties and conflict. Comparatively, formative assessment would require little effort, yet the results would be disproportionately positive. This shift requires little cost.

Let us now turn towards a comparative summary which you see before you. In the Madressas, one classroom model the following activities took place – absorb, do and connect or select, organize and integrate. In the technology model the same holds true. These fall under the realm of formative assessment. While in summative assessment there is only one activity taking place; that of absorb. Now it must be clear to you why there was such a high dropout rate at our college? A major contributing factor was summative assessment. The fault did not lie with the students or teachers but a fault with the system. How are we trying to rectify the system? We have increased the number of quizzes by threefold, i.e. 12 in a semester, but this has been done, without putting any additional burden on the teachers. The quizzes are automated; they are marked instantaneously and students are able to acquire immediate feedback. There are no grades and students are not penalized for mistakes, rather they are told where they lag behind and helped to overcome this deficiency. The teachers only task is to design these quizzes along with built in feedback; what mistake points to what deficiency in terms of subject knowledge. These gaps are filled through tutorials where no lectures are given but actual conceptual problem solving occurs. The classroom response system is designed with the aid of technology and pedagogy.

آج ہم نیوٹن کا دوسرا قانون پڑھیں گے۔

آج ہم نیوٹن کا
دوسرا قانون پڑھیں گے۔

تم نے تو پہلا قانون
ختم نہیں کیا، میں
تمہیں ایک کہانی
سناتا ہوں۔

Topic 217

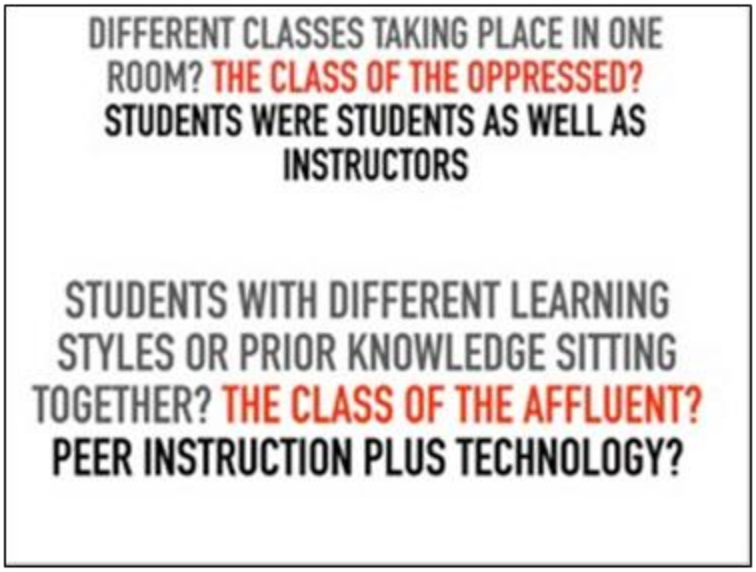
Recap

One hopes that you are finding this course interesting and its inherent evolving nature constantly creates more questions and ideas in your minds. If you remember we were discussing our college where, in the computer sciences department, there was a 70% dropout rate. We had looked at some reasons and arrived at some conclusions. In terms of technology we had discovered apparent advantages for two types of students:

- For the affluent, who go to well recognized schools, yet have different learning styles and prior knowledge, there is very little peer instruction, deployment of technology or formative assessment. Technology can easily enable an environment where this takes place.
- In comparison those who belong the less affluent class, where most students have to also work in addition to their studies, technology is the sole means to providing them a quality education.

Some concepts which we would like to reiterate consist of; constructivist pedagogy, formative assessment and instant feedback.

These are especially relevant in terms of classroom response systems: an automation which we have deployed in our classrooms to counter the high dropout rate. Some of the reasons for these high rates were the lack of formative assessment and feedback. Most students only discovered where they stood academically during periodic testing, which was rather late. Apart from the classroom response system, we will also look at the design of multiple choice questionnaires and they are used to provide feedback. While earlier there were four quizzes in the entire semester we have increased these to twelve out which four take place prior to the midterm. These quizzes are graded immediately and requisite feedback provided to students, in terms of where the learning gaps are. In parallel we also creating an intelligent database based on the results. In an actual case study on deployment of classroom response system we look at rivers with the title ‘the river flows with music’.



Topic 218

River of Fire

As always we attempt to incorporate art with science, so turning to a famous novel: ‘Aag ka darya or River of Fire’ by Quratualan Haider, a highly regarded author of the Indo-Pak subcontinent. “I do not know much about gods, but I consider the river is a mighty mud caked god; capricious, angry, incharge of its season and moods, destructive. It keeps reminding people of what they do not want to remember. It waits watches and waits. The river is within us and we are surrounded by the sea. Where is the end to these voiceless screams? The silently withering flowers in the fall; that without sound shed their petals? What end to the drifting defeated pieces of a ship? There is no end only gain. Of continually dragging hours and days. Yet we managed to find moments of closeness. The question is not that this closeness was mistaken.”

Returning to classroom response system, I had highlighted the fact that with any discipline a multidisciplinary approach is required. Omar Khayam is famous for his verse yet he was an outstanding mathematician. Steve Jobs for his computers in addition to calligraphy. Leonardo De Vinci was not only a painter, architect and a scientist but also a teacher. His pedagogical principles hold to this day; curiosity, experiment, refinement of the senses (observation), research, development of a balance between science and art, logic and imagination, whole brain thinking, cultivation of grace, fitness and poise and an appreciation and recognition of the interconnectedness of all things. By whole brain thinking the allusion was to understanding the deeper meaning of things, especially in the sciences where a dry formulaic approach is usually prescribed. Similarly, by grace and poise things of design have to go beyond being sufficient, the work has to be a thing of beauty. This beauty, an integrals part of sciences earlier, needs to be rediscovered to make the subjects more interesting and fun to learn. By interconnectedness he implied a system approach to things. If the prior knowledge within you or rather concepts are not interlinked then no real learning takes place; what is learned is by rote. These connections have to be created or rather discovered by you to create true learning. Concepts such as why the seasons change, the price differential of land in urban areas compared to rural, the flow of rivers towards the west, the reason for the wind blowing require a rationale and connection to truly absorb. Curiosity leading to observation and then creating connections, thinking about these and creating new connections, is essentially learning.

Before introducing the classroom response system a tutorial was provided for faculty members. With over 50 sections and cover 26 subjects, the system is responsible for generating quizzes and their immediate grading –instant feedback. It points out their mistakes and why these were made. This is essential, as we keep reiterating, since the principal task of any educational system is to assess where each students stands in terms of learning, where he needs to be and how he will get there. Some pictures, our faculty lounge, where you see a screen with questions on it.

All the teachers have their laptops and tablets, which are also used in conjunction with a classroom response system; they are all given a certain time period to answer individual questions. The answers in the form of multiple choices are displayed and once an answer is clicked upon, on the other screen a histogram begins to be formed. The director center for learning and design is explaining to the teachers that the histogram demonstrates the relationships in their answers. It not only quantifies the right and wrong answers but also what underlying concepts, gaps and misunderstandings that need to be redressed.

The Seven Da Vincian Principles are:

Curiosità—An insatiably curious approach to life and an unrelenting quest for continuous learning.

Dimostrazione—A commitment to test knowledge through experience, persistence, and a willingness to learn from mistakes.

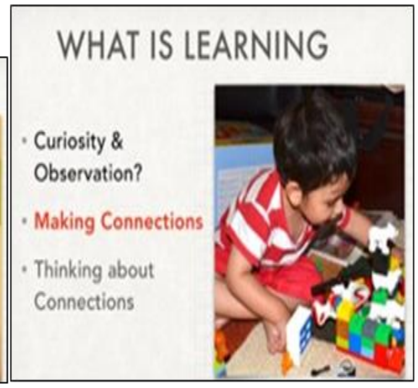
Sensazione—The continual refinement of the senses, especially sight, as the means to enliven experience.

Sfumato (literally "Going up in Smoke")—A willingness to embrace ambiguity, paradox, and uncertainty.

Arte/Scienza—The development of the balance between science and art, logic and imagination. "Whole-brain" thinking.

Corporalita—The cultivation of grace, ambidexterity, fitness, and poise.

Connessione—A recognition of and appreciation for the interconnectedness of all things and phenomena. Systems thinking.



میں دیوتاؤں کے مُتعلق زیادہ نہیں جانتا ، لیکن میں سمجھتا ہوں کہ دریا

ایک طاقت ور مٹیالا دیوتا ہے۔ تُند مزاج ، غُصیلا

اپنے موسموں اور اپنے غیض و غضب کا مالک ، تباہ کن

وہ ان چیزوں کی یاد دلاتا رہتا ہے جنہیں انسان بھول جانا چاہتے ہیں

وہ منتظر ہے اور دیکھتا ہے اور منتظر ہے

دریا ہمارے اندر ہے ۔ سمندر نے ہمیں گھیر رکھا ہے

خاتمہ کہاں ہے........ بے آواز چیخوں کا

خزاں میں خاموشی سے مر جھا تے پھولوں کا

خزاں میں خاموشی سے مر جھا تے پھولوں کا

جو چُپ چاپ اپنی پنکھڑیا ں گراتے ہیں

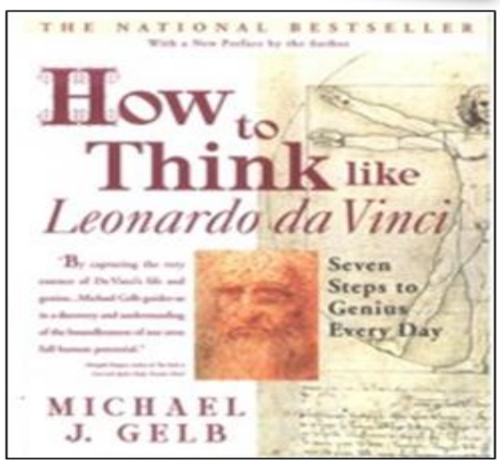
جہاز کے بہتے ہوئے شکستہ ٹکڑوں کا خاتمہ کہاں ہے؟

خاتمہ کہیں نہیں ہے۔ صرف اضافہ ہے۔

مزید دنوں اور گھنٹوں کا گھسٹتا ہوا تسلسل

ہم نے کرب کے لمحوں کو ڈھو نڈ نکالا

(سوال یہ نہیں کہ یہ کرب غلط فہمی کا نتیجہ تھا



Topic 219

Which way the River Flows

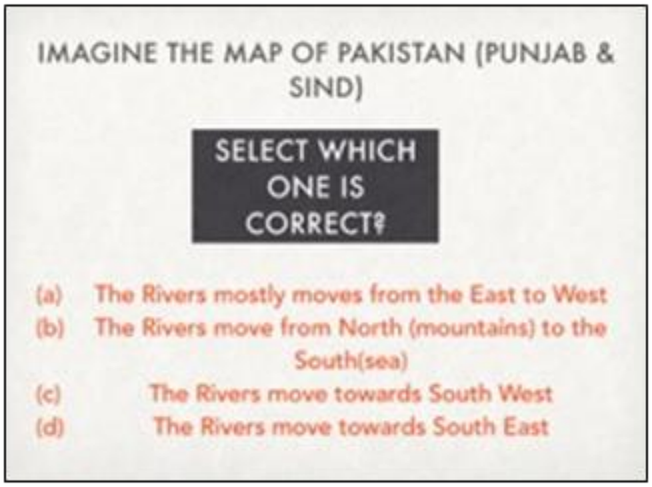
In the section we will be looking at the actual responses and statistics. Please, understand that the statistics provided here for a particular faculty are similar to other universities and is in no way a standard of comparison. The point here is to understand the process of learning. Let us then look at the first question. We are asking the teachers to imagine a map of Pakistan, particularly the province of Punjab, where we are currently located. There are probably no faculty members who would have not seen a map of Pakistan since they were students a thousand times; or not studied that the province of Punjab is named after the five rivers which pass through it or not have heard of the historical Indus valley civilization. What we are trying to assess is their ability to observe: the difference between looking and seeing enormous. Getting back to the question there are four possible options as answers: all the rivers located in the province move from East to West; from the mountains in the North to the sea in the South; the rivers move towards the southwest; and the rivers move southeast. Most of you have also seen a map of Pakistan and we let you ponder this question.

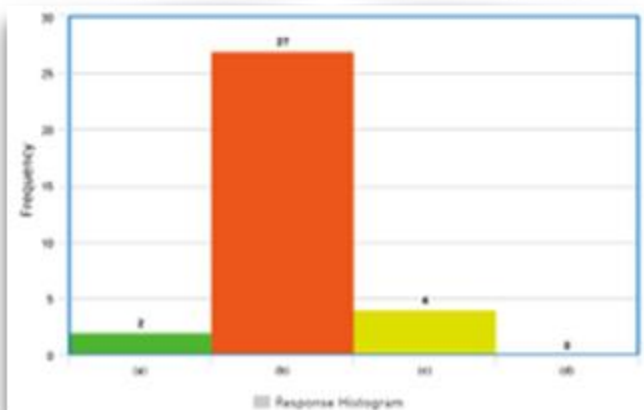
Turning to the answers and a histogram of these answers; 27 percent answered selected B, a couple A, four selected C and no one selected D. Sometimes it happens that you may have seen a thing many times yet but you brain does not register it. When asked what you have observed the usual response is what the brain wants to see. If your brain is thinking that rivers should flow from the mountains in the North to the sea in the South, which seems logical, you will always choose this option. In terms of answers I am not in the habit of providing them; I would prefer it if you would figure it out on your own. This discovery is the underlying point behind technology and pedagogy. Having asked you this question now the way you will look at a map again would be entirely different. The factual and wishful direction of rivers flow would soon be discovered. This dichotomy is often one the major roadblocks to learning.

We again put up the map and repeated our question; what is the direction of our river flows? The faculty immediately clicked on an option, a histogram which was also made. In the new histogram one person persists in saying that the rivers flow from east to west. Two people opt for the north to south option. Twenty seven people, who upon their observation, despite the fact that the logic may escape them, choose southwest; four people choose southeast.

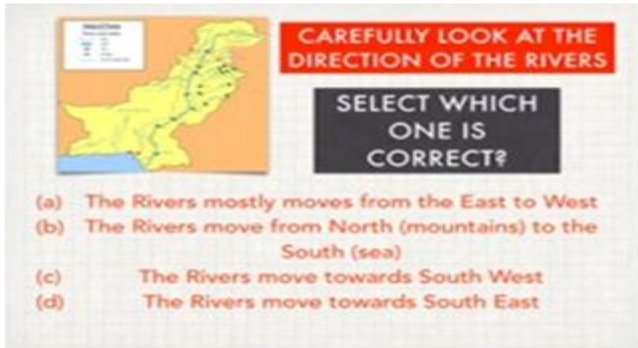
This conflict is a necessary part of the learning process. As you can see the issues seems to be with observation. This is the logic behind a classroom response system. You pose a question and provide numerous options as answers; but these need to be designed to make the students think. This is currently the dilemma I face in terms of our classroom response system, which has just been deployed, the necessity of designing intelligent answers. The wrong answers should also contain some element which leads you to right answer. If all the students are answering correctly then there is something wrong. This is not the point of the test. Rather the whole underlying rationale of this, as of the course, is the determination of where each student in a class stands in terms of knowledge by an instructor and how this disparity needs to be addressed.

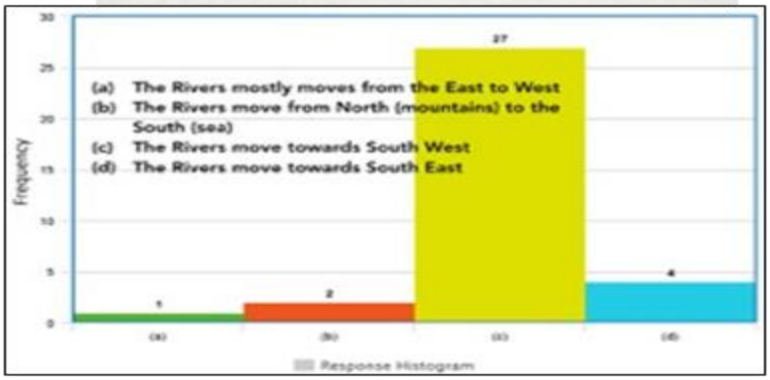
Returning to our quiz we have arrived at the conclusion that all rivers run southwest. This was not an easy decision for the teachers intuitively; rather it was based on observation. At this point we could add another dimension and let them discuss the problem – peer instruction

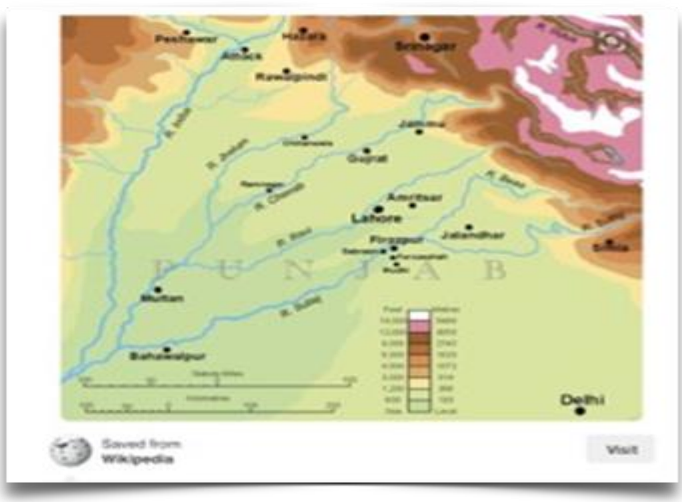

IMAGINE THE MAP OF PAKISTAN (PUNJAB & SIND)
SELECT WHICH ONE IS CORRECT?
(a) The Rivers mostly moves from the East to West
(b) The Rivers move from North (mountains) to the South(sea)
(c) The Rivers move towards South West
(d) The Rivers move towards South East


Frequency
Response Histogram


PAKISTAN
Rivers and Lakes
BALOCHISTAN
PUNJAB
SINDH


CAREFULLY LOOK AT THE DIRECTION OF THE RIVERS
SELECT WHICH ONE IS CORRECT?
(a) The Rivers mostly moves from the East to West
(b) The Rivers move from North (mountains) to the South (sea)
(c) The Rivers move towards South West
(d) The Rivers move towards South East


(a) The Rivers mostly moves from the East to West
(b) The Rivers move from North (mountains) to the South (sea)
(c) The Rivers move towards South West
(d) The Rivers move towards South East
Frequency
27
1
2
4
Response Histogram


Peshawar
Attock
Srinagar
Rawalpindi
Jammu
Gujrat
Amritsar
Lahore
Firozpur
Jalandhar
Simla
P U N J A B
Multan
Bahawalpur
Delhi
Saved from
Wikipedia
Visit

Topic 220

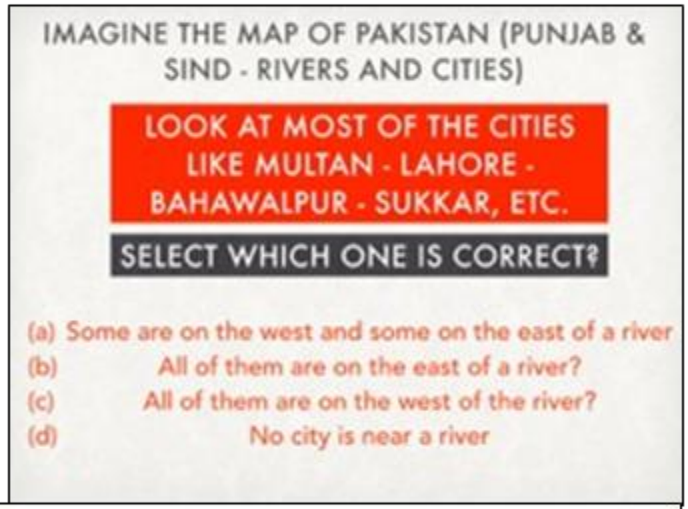
Why South West

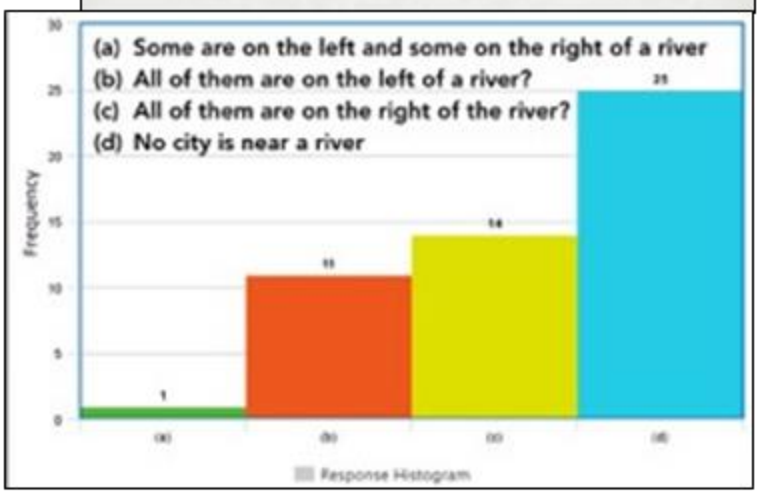
We now turn to a more difficult question: Why do most rivers flow towards the southwest? The options are: they are driven by some unseen force; due to gravity; since shortest path to the sea; due to wind. The most popular answer was unknown force. I had personally thought gravity would be selected, since quite popular when replicated earlier at different educational institutions. Three people choose wind. Only two choose gravity. At this point we show them a color coded map, which clearly refutes the gravity option, i.e. upon entering Punjab the effects of gravity are almost nil (plains). We repeat the question again; the same answers are found, even the gravity people. We see some scenes of the faculty lounge while this exercise was being conducted. Perhaps you might have noticed that these answers are interlinked, a point we were trying to achieve.

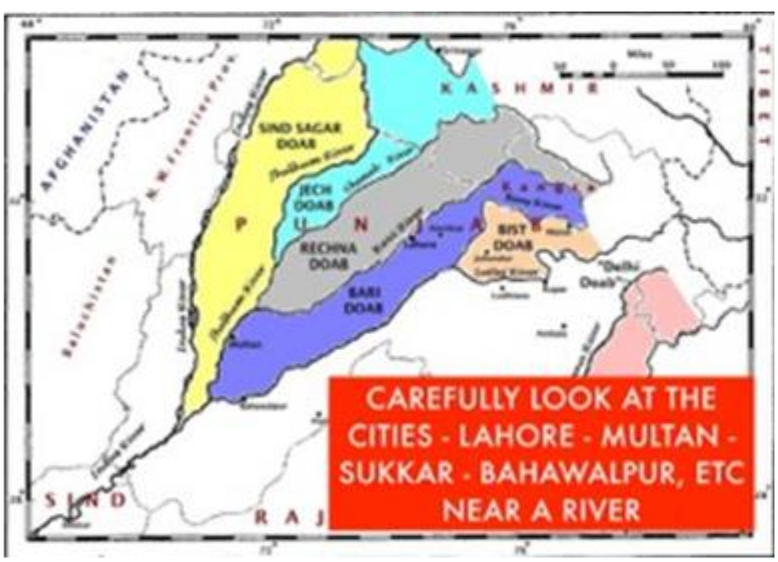
We again ask them to imagine the map of Pakistan again and specifically ask them to focus on rivers and the large cities. Lahore as an example had Shadarah as a suburb on the other side of the river. The options provided were: some are on the west and some on the east; all of them on east; all of them on the west; no city is near a river. Again we draw a histogram and the answers are; 25 people are saying that the cities are not next to river. A surprising results since a map was shown earlier; yet it seems it was not seen. Next we actually show them these cities on the map and again ask them which side the river is on. This clearly illustrates the fact that most rivers are on the right bank. Why is this so? Apart from this we ask them further question, we cannot discuss all of them, but will show some illustrative examples. When Pakistan was formed Lahore was located towards the Indian side, after which the river

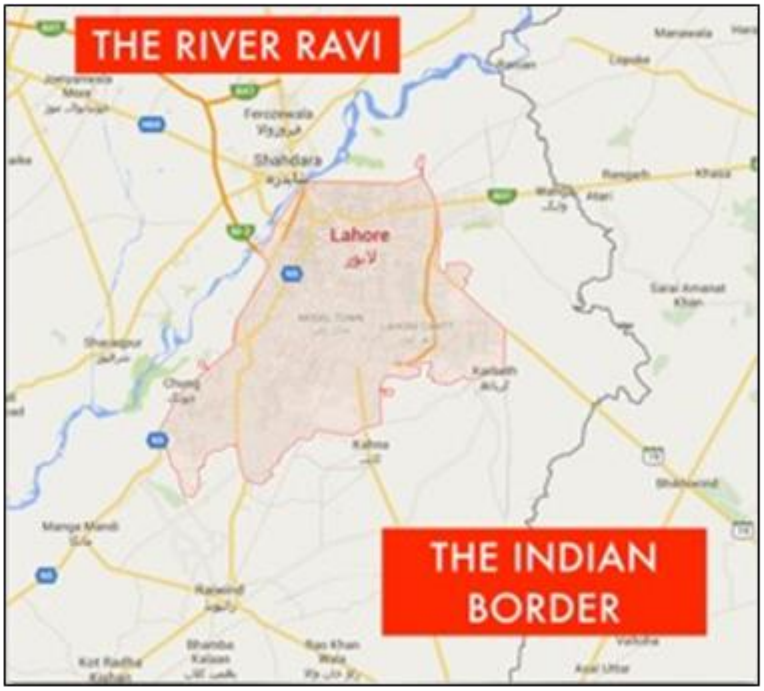
Ravi flowed, followed by the adjoining areas of Lahore. At that time there was a great threat of an attack by India and subsequently the BRP canal was built as a barrier, in which even students volunteered. This is precisely what happened in the1965 war and the Indian advance was checked at the very canal. Another interesting thing in those days all industry and housing colonies in Lahore were located on the other side of Ravi, away from the border, unlike today's development which adjoins the border. Strangely no one earlier considered developing Lahore on the other side of Ravi, as a natural barrier. Why is the land cheaper in Shadarha? I often ask this question. Once I asked an auditorium filled with 200s tudents and faculty that I can bet no one would be from Shadrah. Also I enquired if a marriage proposal came from a family residing in that area, and another from someone residing in Lahore, which infact is nearer the border, who would be preferred?

Getting back to our question, people now knew that cities are located on a certain side of the river. The reason for this is that flooding usually occurs first towards the west. Rivers also tend to turn west. Naturally, this is contingent upon the level of flood. Why does this occur? As you can probably start to see all is connected. The teachers having arrived at a conclusion we introduced a 'Do' activity - a fun activity which you can do on your own; one which hints at why the rivers run west and related question.


IMAGINE THE MAP OF PAKISTAN (PUNJAB & SIND - RIVERS AND CITIES)
LOOK AT MOST OF THE CITIES LIKE MULTAN - LAHORE - BAHAWALPUR - SUKKAR, ETC.
SELECT WHICH ONE IS CORRECT?
(a) Some are on the west and some on the east of a river
(b) All of them are on the east of a river?
(c) All of them are on the west of the river?
(d) No city is near a river


(a) Some are on the left and some on the right of a river
(b) All of them are on the left of a river?
(c) All of them are on the right of the river?
(d) No city is near a river
Frequency
30
25
20
15
10
5
0
1
11
14
25
(a)
(b)
(c)
(d)
Response Histogram


AFGHANISTAN
KASHMIR
TIBET
SIND SAGAR DOAB
JECH DOAB
RECHNA DOAB
BARI DOAB
BIST DOAB
"Delhi Doab"
SIND
RAJ
CAREFULLY LOOK AT THE CITIES - LAHORE - MULTAN - SUKKAR - BAHAWALPUR, ETC NEAR A RIVER



SOME OBSERVATIONS

- Most of the cities are planned on the right bank of a river?
- Flooding Initially Takes Place in Shahadra - It does not take place in Lahore initially - or it takes place in Lahore when it is very high FLOOD?
- The Prices of Land in Shahadra is less than in Lahore?
- Shahdra is much safer than Lahore in case of an Indian Attack
- Almost all the rivers - all turn towards South West?
- What force drives the rivers towards WEST?
- All rivers initially floods towards one bank first?

Topic 221

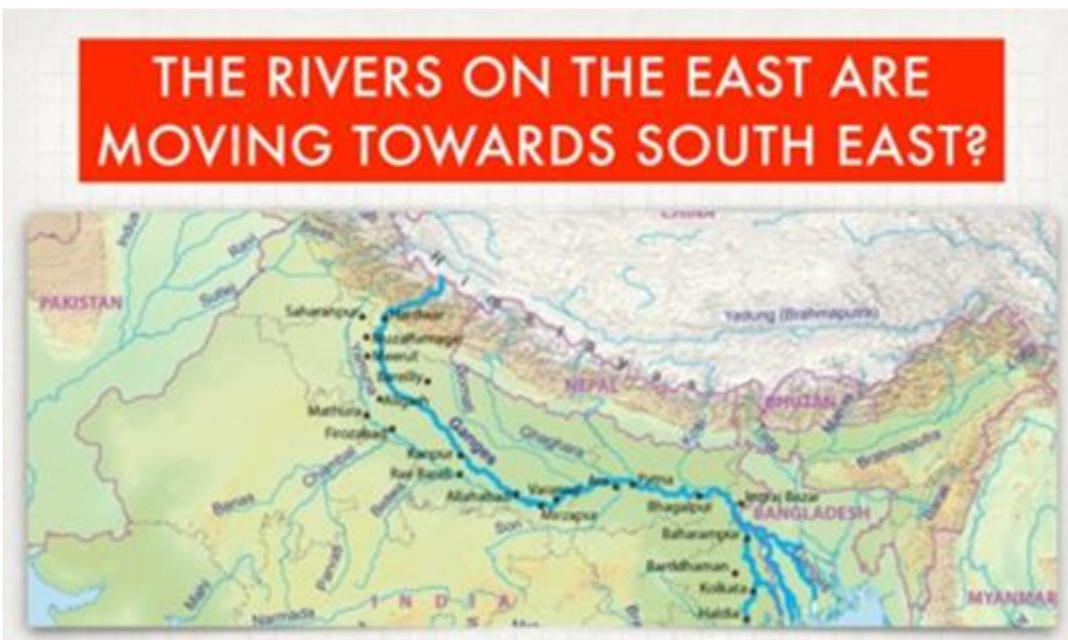
Rivers and Cities

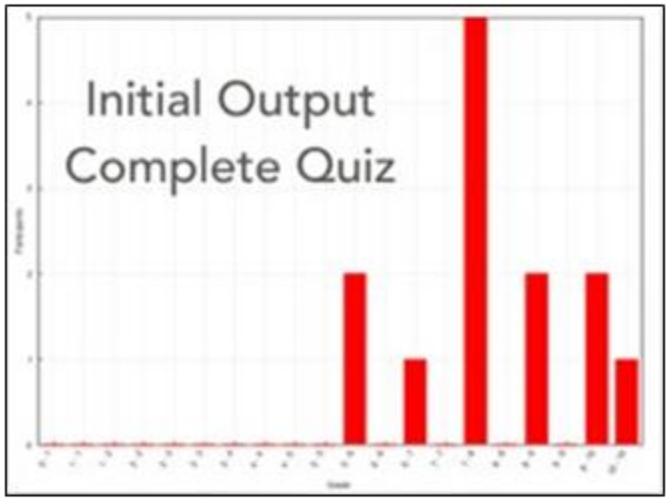
You must have all travelled by Lahore's ring road. You would have also noticed that there are a lot of flyovers/bridges and many sharp turns. Try this, next time you take a turn do this at a slightly higher speed and spray your windshield with water. You will observe that the water drops on the windshield would be moving downwards due to gravity but also turning in a particular direction. Note the direction they move. Moving to the next experiment; clean your windshield and again spray it, turning in the opposite direction at a high speed. You will see the same phenomena as earlier but the drops turn in an opposite direction. Why is this and how is it linked to the rivers flowing west? Is it the earth's spin? All these questions should be arising in their mind.

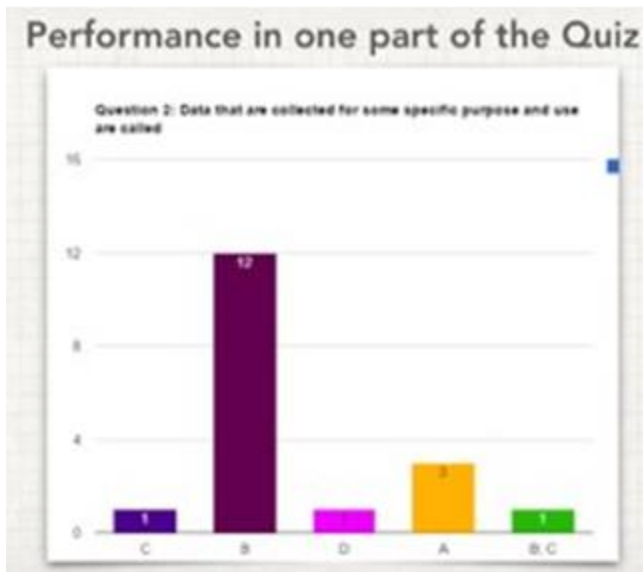
Due to the interconnectivity of these questions it is quite possible that they arrive at the right conclusion: the flow due to Earth's spin. Despite the fact that this might be the correct answer we will not let them know this too easily. We would want them to go through the frustration, friction and conflict. Again, a map of the subcontinent is show from which it can be seen that the rivers originate from the North and their flow through India and Pakistan. The origination of these rivers is almost the same. Those that flow into Pakistan turn towards the west. If they were traveling south they would have cut across India and not turn towards Pakistan. The surprising thing for you might be the fact that the rivers flowing into India (Ganga and Jamna) turn towards Bangladesh in the east rather than the south. Due to these facts the theory seems to stand disproved. The right answer is not as critical as creating the requisite linkages in discovering knowledge.

Returning to our classroom response system, we look at some pictures. As you can see the students are really enjoying it. Why is that? The answer lies in instant feedback, as you can see from the interfaces of their tablets. The technologies we are developing at our center of design of learning is not solely for the well-off rather focused towards the less privileged: people in small villages (remote areas), those who work for a living, etc. We tested this technology based on intranet, i.e. no internet connections were required. You will also observe that while travelling there the system was also utilized in the bus. What does this mean; imagine a mobile school which can move around the entire day focusing on provision of education to those in need. Lessons can be uploaded or down loaded and assessment also provided; allowing us to understand where each students stands and where he needs to be taken and how to accomplish this. In the next scene, returning to the classroom, when given permission to discuss the more difficult questions; you can see how engaged they are.

Nobody is using Facebook or gossiping. Now we look at the output of these quizzes, based upon four to five questions with multiple choice based answers. On analysis an integrated picture comprising of individual questions is formed. Only one student scored 10 out of 10, two children got 9 out of 10, between 7 or 8 out of ten there were approximately five children and so on. As soon the quizzes were over I started getting emails from fifty sections giving me the results immediately. If 70% to 80% students are getting full marks, it would imply that the skew would turn towards the right. Reflecting a fact that our quiz was not properly designed, which I could see right away and point out to the relevant faculty. From my perspective it is more pertinent to see mistakes – what mistakes they are making and why. Where they stand and where they need to be. After this we started creating histograms for each individual question. From these we started getting the relevant information. What part of the quiz was found to be the most problematic by the most students? As you can see this is clearly illustrated by the histograms of different subjects for one section. The histogram at the bottom seems to be problematic since all correct, the red lines the largest. Similarly, the results for same subject but different sections, here more realistic and the red lines the smallest. As you can see this is a treasure trove of useful data which can be critically analyzed. The concepts where help is required can be scheduled for tutorials. In the center of design for learning there is collaboration from the pedagogy, content, quality control, and technology. The main focus of all these areas is towards designing of an appropriate quiz which can discern problem areas for students. The questions have to clear in terms of reflecting what underlying concept or concepts are captured and are clearly understood or not.




Initial Output
Complete Quiz

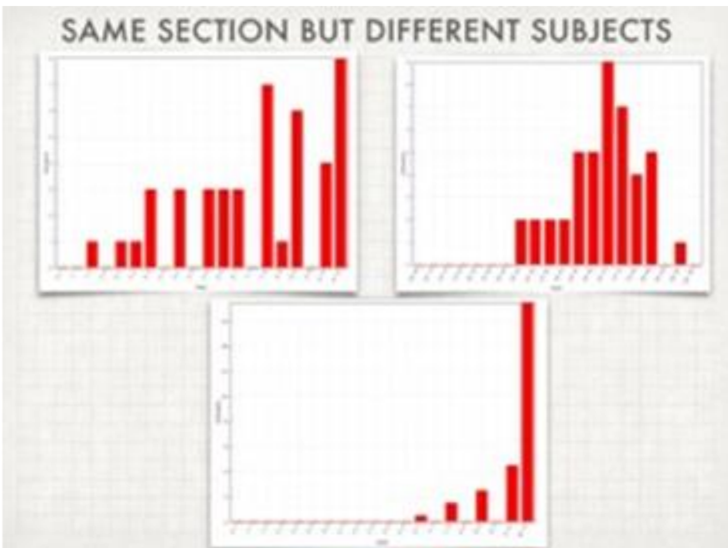

Performance in one part of the Quiz
Question 2: Data that are collected for some specific purpose and use are called
16
12
8
4
0
1
12
3
1
C
B
D
A
B,C

Topic 222

A Visit to the Doctor

Today we attempt to wrap up the course. I could not be with you last week since unfortunately I was suffering from sciatica pain and consequently immobile. Having visited with the physician I was prescribed quite a few tests. The reports of these tests were used for diagnosing the ailment. But my concern was greater; what corrective measures were needed, i.e. prescriptive and corrective. You must be wondering how this is related to information technology and our course? The parallel lies in when students come to us, faculty, or in my capacity as Dean, concerning educational issues. At our university the fees for one course amount to Rs.25,000, which is quite substantial. In a typical semester, consisting of four courses, the fees amount to Rs. 100,000.

Against these fees, the goal of these students is to acquire a bachelor's degree in computing with good grades; leading to well-paying jobs. During their course of studies they are assessed through quizzes, midterms, assignments, projects and naturally final exams. These examinations during their journey, especially the quizzes and midterms, since earlier, are good indicators of their performance. In most instances in all universities across our country; most of the quizzes undertaken by students are hardly graded. If graded, no feedback is provided in terms of their performance. B y the midterms arrive, where students stand in terms of performance, becomes quite clear. What knowledge he/she has acquired, what should he have acquired, what gap remains and how this can be filled? Little attention is paid to this diagnostic process. Especially in informing students of the situation and what final grades they can expect – A closed loop feedback. Each student should be able to take advantage of these diagnostic tests and provided individualized feedback. There is no need to take him through the lecture process again; rather underlying concepts where there is a problem need to be clarified. To do this, initially we thought of incorporating a weekly automated quiz for each semester. If we had resorted to manual methodology the tendency with faculty is that delay marking or retuning the quizzes to the students. This implies that students receive neither feedback nor the faculty where their class stands, i.e. has what was attempted to be taught - learned. This also allow for the appropriate prescriptive- corrective action. With an automated system we can even detect what underlying concepts require clarity.



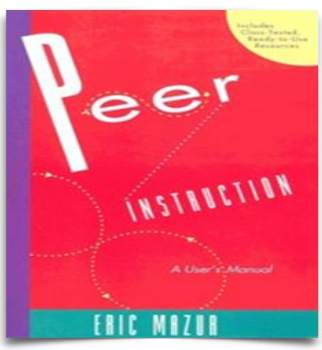
Topic 223

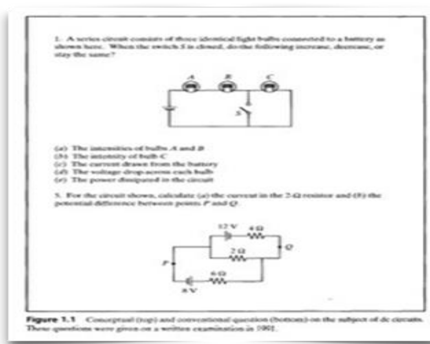
Automated Response System

As soon as a quiz takes place, I receive an email with analysis of the results, consolidated and for individual questions, including histograms. Here you see the results for one section in different subjects; different sections for the same subjects; and the results for sub problems in a quiz. The red line indicates the number of correct answers. If the line is too high or too low, it is a worrying fact. You can have a brilliant technological solution in the form of a classroom response system; yet the quality of the quiz is critical. Although a time consuming process yet needs to be undertaken initially with great care. Once correctly done all it requires is continual refinements and well worth the initial time investment. The system should be accessible to all the stakeholders in an educational system, and able to keep them in the loop of what is transpiring. Any gaps in technology and pedagogy need to be addressed as soon as they arise- diagnostic, prescriptive methodology which is evolutionary in nature.

In the slide here you see a histogram of our student results. The results reflect a summation and individual question, i.e. which student attempted what. What is the linkage here? The chain of logic which needs to be followed entails a linkage of entire quiz results to individual concepts and most importantly the underlying concepts. Usually, when forming a quiz and breaking it down into four component parts, you do not usually consider what concepts these are derived from. At time it can only be singular concept while at others multiple options. This diagnostic approach is critical as with a medical practitioner. As an illustrative example in class of forty students 10 choose option A, twenty B and five C. We begin our analysis from bottom up. In the first slide we try to determine the appropriate underlying concepts. We see that five question are linked to three underlying concepts. It easy to observe what questions are not answered correctly but harder to determine which underlying concept is not clear. Suppose we had designed the quiz with sole reliance upon concept A; only the people familiar with this concept would answer correctly, i.e. 10 in our example. About twenty went for option which relied upon concept B.

Thus at least thirty correct answers tell us that students are familiar with these concepts. We could further change the question to only rely on one concept and figure out what concepts needed to be clarified for students. Similarly, question relying upon multiple concepts can be analyzed for intersecting concept, sets and bottlenecks.





1. A series circuit consists of three identical light bulbs connected to a battery as shown here. When the switch S is closed, do the following increase, decrease, or stay the same?

(a) The intensities of bulbs A and B
(b) The intensity of bulb C
(c) The current drawn from the battery
(d) The voltage drop across each bulb
(e) The power dissipated in the circuit

5. For the circuit shown, calculate (a) the current in the 2-Ω resistor and (b) the potential difference between points P and Q.

Figure 1.1 Conceptual (top) and conventional question (bottom) on the subject of dc circuits. These questions were given on a written examination in 1991.

Topic 224

Peer Instructions

Here you can see the book by Eric Mazur, who was instrumental in popularity of classroom response systems. His experiments paved the way for improved learning for students in the classroom. In one of his experiments he presented a very innovative problem, presented here, to his students. The upper part you see, is conceptual, while the lower conventional.

The conventional problems are usually found in textbooks at the end of each topic. By attempting these most students feel that they have successfully mastered the topic; an assumption which is incorrect. Histograms for both types of problems are created. Next these are correlated. What were the results? You have a soft copy of this book in which you can discover this for yourself.

When I joined as Dean at my present university, in the introductory course on computing, offered in fall 2015, out 44 or so students in one section around 21 failed, 18 withdrew and only five passed. If you make a histogram of these results it would be entirely skewed towards failure. With these results and being an introductory course we manage to completely quash their interest or emphasize their inability in this subject. If you look at further results for other sections the results are as grim. In another course design and analysis of algorithms, which we had discussed earlier, out of 37 students, only three failed, thirty three withdrew, despite being taught by a very experienced and senior faculty. The course has acquired a reputation in which students fear to enroll since unlikely to pass. The course programming fundamentals was offered in spring 2016, in one section there were 36 students. Thirteen failed, three passed and the remainder withdrew; in all probability from the program too. This was the prevailing situation when I joined the university.

As narrated earlier the course design of algorithms was used as a test case. Four sections were made and we had trouble finding the fourth faculty member to teach. A female teacher with no experience was hired. She was told to follow certain pedagogical principles and asked to take the students on a journey of discovery, where the teacher would only act as facilitator. This created an interesting immersive experience for the students. And in comparison to the other sections where senior faculty was teaching, students started asking for transfer to the other section. The major comparative difference was the pedagogical tools which were provided to the fresh instructor.

Despite, the criticality of content knowledge, these tools still allowed her to overcome this obstacle. Her major contribution, apart from the pedagogy, was the instilling of self-belief and self-discovery in the students. This in addition to regular quizzes with in-depth feedback will allow you to replicate this experience and compete with any highly qualified teacher. The interesting thing is that any new teacher without any preconceived notions can be trained to do this. Looking at some of the results the biggest surprise was the midterm. The same midterm was given to all four sections. It was designed by the senior faculty of the three sections and the new female teacher had no input. Since she did not know what was going to be in the midterm, she could not revise the topics which were to appear in the test. The results came in recently. As you can see the curve which was skewed towards failure has now become much more balanced. The 70% to 80% percentile tier now forms the largest component. Only two or three students fall in the minimum passing range. What a dramatic turnaround!

The email, after the midterms, which I sent to all the students, emphasized the fact that their job was not over. They had to carefully go through the results and understand what mistakes they made and what concepts still missing; while we too at our end would look at what conceptual misunderstanding still existed. If the students accomplish their assigned task seriously they would be given five extra marks in their midterms. Prior to this the methodology was that if a student challenged his grades and if the fault of the faculty his marks would be revised otherwise he would penalized, i.e. marks deducted. We have turned the entire concept on its head. Now those who will not discuss the paper with the instructor would be penalized. We have assigned two people to focus only on analysis of what mistakes were made and which concepts still require clarity. We are also looking at replication of mistakes in comparison to quizzes, i.e. were the same mistakes repeated. Apart from the requisite feedback from students you can see the favorable comments for the new instructor. Also as you can see here the classroom experience; students are having fun, there is little formality, no lectures are taking place, the students are engaged and involved in a "do" activity, they are "connecting" ideas, "reflecting" and "discovering." This is in marked contrast to what is transpiring in other classes: a situation which needs to be thought about.

Introduction to computing Fall 2015

Sections	students	Pass	Fail	withrawal	Teacher
D	44	5	21	18	Mr.Shafiq- ur - Rehman
E	43	11	22	10	
F	44	9	16	19	
G	45	8	29	8	
J	50	10	27	13	
Total	226	43	115	68	

Design and Analysis of Algorithms Fall 2015

Sections	students	Pass	Fail	withrawal	Teacher
A	37	1	3	33	Mr.Shafiq- ur - Rehman
E	49	17	11	21	Mr. M . Amjad Iqbal
C	49	31	6	12	Mr. M . Amjad Iqbal
D	53	22	11	20	Mr. kamran Shabbir
Total	188	71	31	86	

Programming Fundamentals Spring 2016

Sections	students	Pass	Fail	withrawal	Teacher
A	32	10	2	20	Mr.Shafiq- ur - Rehman
B	38	18	1	19	
C	36	13	2	21	
D	20	10	1	9	
Total	126	51	6	69	

Ashraf Iqbal
August 15 at 9:45am

My dear FOIT students
Your midterm examinations are over? But they will not be over unless you people - each one of you - look at your midterm answer sheet and find out the mistakes that you have committed? Then we need to know what concepts were weak because of which you committed those mistakes - so that we make corrective actions in making you understand and you people realize what is missing and do your final in a better way? I repeat each one of you should discuss your midterm with your respective instructor?

Ashraf Iqbal
22 hrs

My dear students of FOIT in the summer semester
Let us start with AA? I shall increase 5 marks in your midterm if you do the following to my complete satisfaction?

Tell me in writing - typed soft copy- the following?
1. What mistakes you have committed?
2. What concepts were necessary to attempt those problems that you did wrong?
3. Why you have committed this mistake - did you not understand the problem?
4. Did you commit the same mistakes in the quizzes conducted?
5. Now did you understand this problem?
6. We shall send you the question paper
7. Correctly solve the problem - underlying those parts which you have done wrong and understood after the midterm?
8. I need this write up to me mailed to Syeda Beenish by tomorrow before 10pm? After 10pm tomorrow you can not avail this facility?

Chaudhry Waleed mentioned you in a comment.

Chaudhry Waleed
August 14 at 11:27pm

Ma'am Samina Akram is one of the best teacher ever. Thankyou ma'am for being there for us and thank you sir Ashraf Iqbal for teachers like her. :)

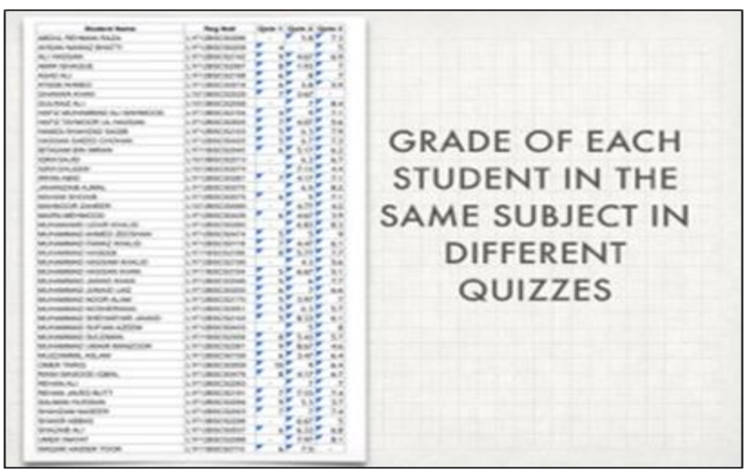
Topic 225

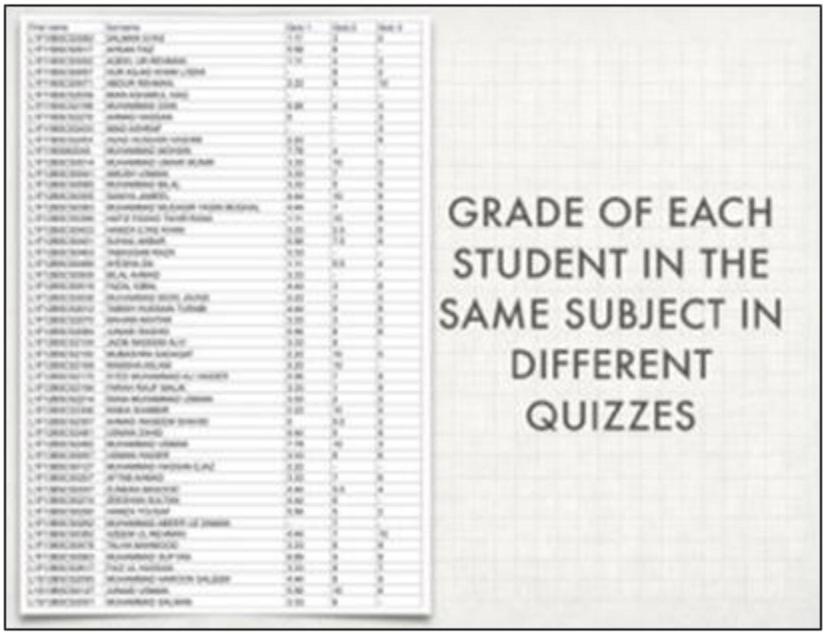
Learning Management System

We now look at the interface which is used in our quizzes. As you see from the slide different grades for each student for each individual quizzes provided as list. This allows us to compare various quizzes with the same subject or between courses. After logging into the program they are provided with the relevant question. Initially, the multiple choice answers are not provided rather we let them study the question and context. As they understanding the question is 60% of the answer. Next the options are presented. As soon as a student's selects an option in the prescribed time, they are provided with the right answer instantaneously, along with what mistake they had committed. This is formative assessment. Upon implementation we discovered a loophole, which was communicated by the students themselves and for which we did not penalize them.

Due to the instantaneous correct response being provided to each student, the class collectively selected one person to go through the entire quiz in the first ten second, the prescribed time for the first question. Upon receipt of the right answers these would be passed to remaining class. Based on this we have modified the system to only generate the right answers once the prescribed time is over for all students and they have provided the answer. A classroom response system is not static as with most things there is an evolutionary process involved. A teacher came to me the other day and enquired if I had looked at the data from the system. Once a student receives the answer options there are two variables which we can look at: the time involved in answering the question; and how many times does a student change his option during that time.

Suppose if the student answers immediately, what does this imply, was he confident of his answer or confused? If a student changes his answer multiple times, what does this imply? Looking at various research on response time it was discovered based on these principles for standardized tests like TOEFEL and SAT; the computer can discover in milliseconds in which centers globally there is some anomaly, in some cases cheating. This led to the computer blacklisting some exam centers and cancellation of exam for the students who were taking the exam. In our colleges is cheating occurs, the process is tedious. The case is put to a committee, which decides if the case has merit. The committee’s decision can be challenged in court. Conversely with technology the process is self-reliant. The entire decision is based upon student response time. If prior knowledge, response time are heavily skewed towards being very short. An amazing amount of data is available which can be analyzed creatively.




GRADE OF EACH STUDENT IN THE SAME SUBJECT IN DIFFERENT QUIZZES

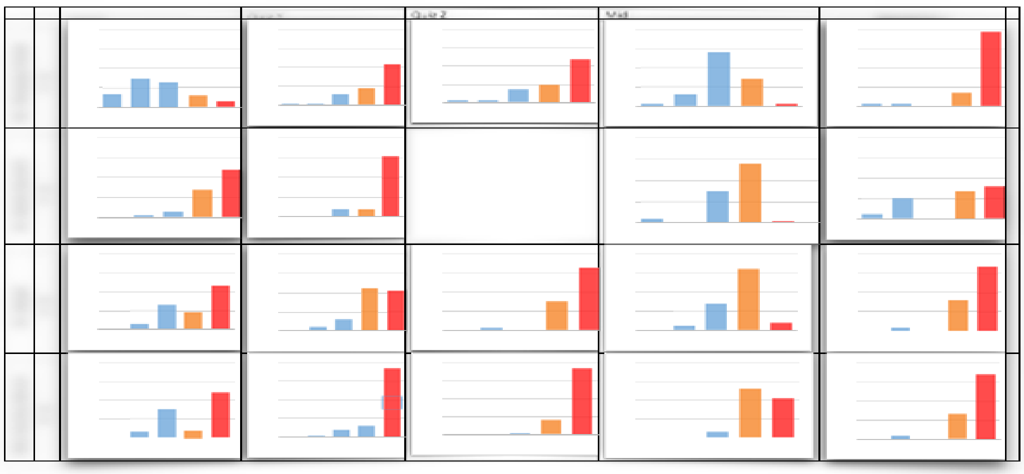
Topic 226

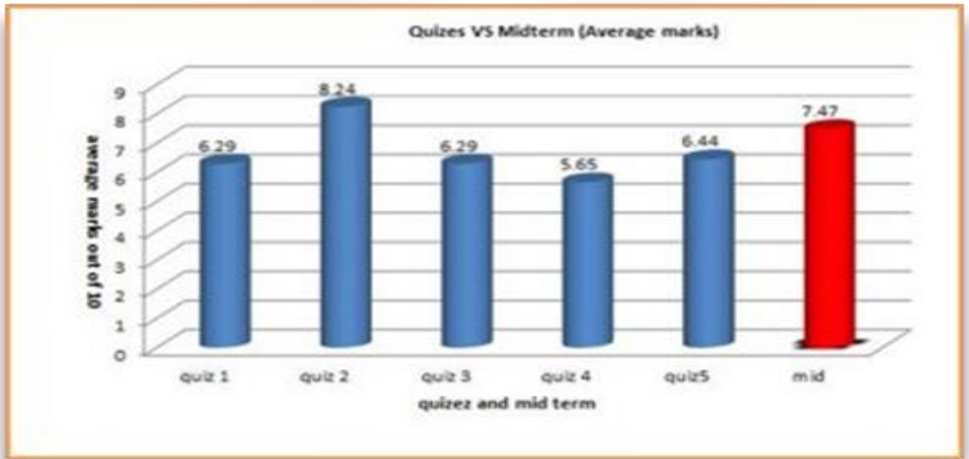
Formative Assessment &MCQs

How can we use a multiple choice format in assessing formative assessment? Teachers at our college, who taught programming and algorithms, were initially hesitant since a multiple choice format could not be applied for their discipline. I had to explain that conceptual knowledge could be broken down. A challenging task albeit one that can be done.

Interactive learning and formative assessment needs the classroom response system to be used several times in the classroom. Another issue is the quality of the quizzes. Naturally, this can be problematic for teachers in terms of assessment, based upon the large number of students. An automated solution is required. With technology the quality of the quizzes can be gauged. If all the students are getting good grades and are faring well or vice versa; technology would immediately point this out. Similarly, how do we quizzes for containing problems conceptually? Are these just capturing rote learning in a conventional framework? Also, do these into account any element of cheating? Along with us other people are also working at conceptual soundness of these quizzes. This is a problem which you too will face at the design stage. One method is to introduce a conceptual problems or a rote learning problem and asses their correlation to other answers. Depending on what is correlated, intelligent conceptual question or rote learning, you can discover how the quiz is skewed. Similarly, the time spent upon questions by students can be used to gauge the element of cheating. By looking at the performance of a specific student in three subjects, can we predict their performance in a fourth subject? If our grading system is correct then the answer is yes; if not the fault lies with our design. All these checks can be accomplished with the help of technology. Teachers cannot do this; they are overburdened as it is. Turning to correlation between different subjects: in our computer science department we are offering two seemingly unrelated courses; calligraphy and free hand drawing. How are these related to the sciences and other subjects? Unfortunately, especially in Pakistan, the nexus between arts, sciences and mathematics is little realized. As De Vinci and Omar Khayam pointed out this is a must. The left and right hemispheres of the brain need to be equally engaged. In the sciences and mathematics there lies great internal beauty, elegance and equilibrium. These aspects need to be illustrated to students.

Other considerations which need to be kept in mind include: learning styles and multiple ways to solve a problem; types of mistake with highest frequency; future database and intelligent data gathering. It is our desire that students make mistakes since this would provide us with the requisite data for future refinement of the classroom response system. How do quizzes predict outcome of major tests such as the midterm? If there is correlation between the two then there is utility to the quizzes, otherwise not. Feedback to each question individually is a key requirement. This can only be achieved with the help of an automated technological solution. The system should generate an individualized email for each student containing a summary and analysis of their results, in addition to one for instructors which allows them to take remedial steps for areas in which the student is lacking. Misconceptions have to be cleared at each step before moving on in a progressive manner. Apart from correlation to next levels of learning the present data also provides insights to many conceptual errors, answers and further questions. This feedback loop, which you see here, is essential since it allows for a continual upgrading, refinement and creation of an intelligent system. There is an essential utility for making intelligent mistakes and these need to be encouraged and not discouraged, as is usually the case in our context. We dealt with this subject in the book, “Running to nowhere.” The idea is assist a student, much like a doctor does to a patient, through prescriptive and remedial measures and not to penalize them. Without a proper feedback loop learning cannot be improved.




Quizes VS Midterm (Average marks)
average marks out of 10
0
1
2
3
4
5
6
7
8
9
6.29
8.24
6.29
5.65
6.44
7.47
quiz 1
quiz 2
quiz 3
quiz 4
quiz5
mid
quizez and mid term

Topic 227

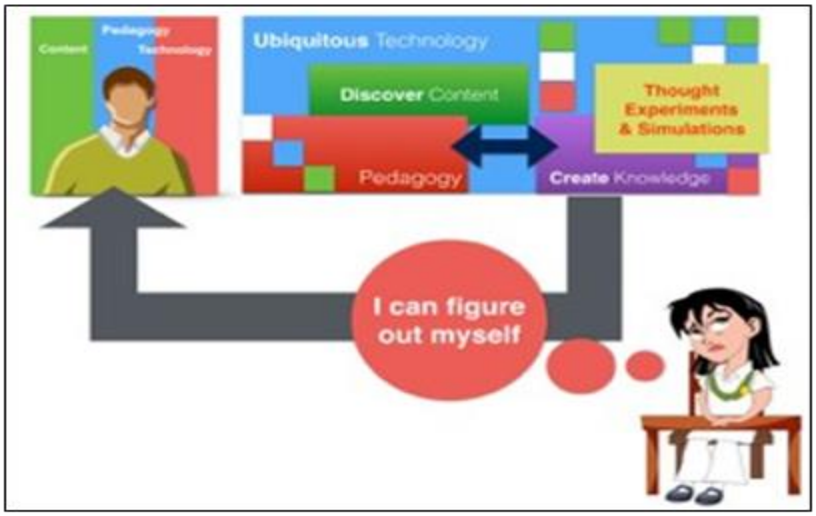
Roman English

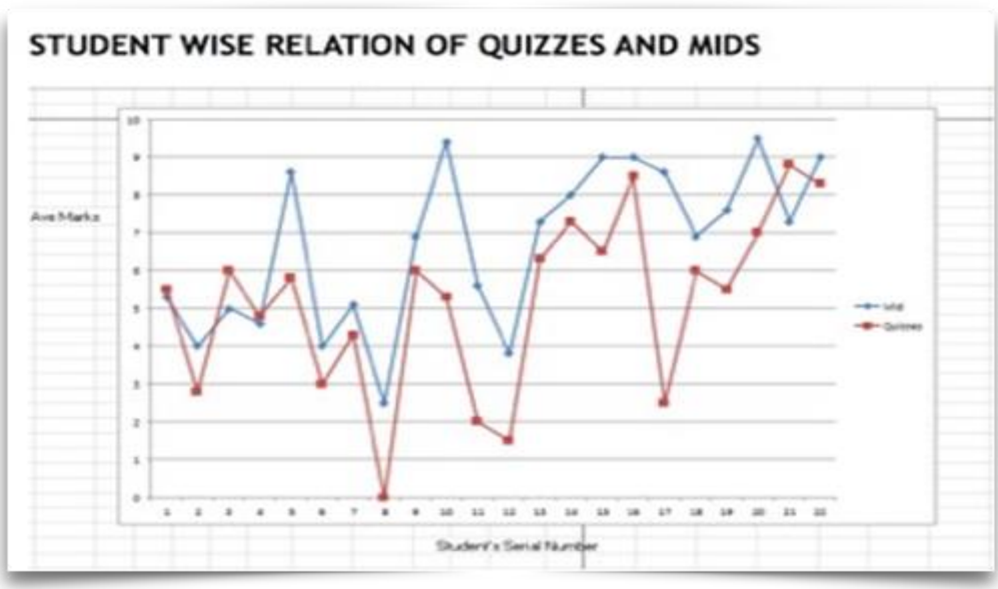
Another serious problem which I noted at our university was the lack of English skills among the students. A serious concern since the medium of curriculum being taught is naturally English. This led to many of our graduates not being looked at in a favorable light when in a working environment and a high rate of dropouts. In comparison to other major universities our student was body was very socio-economically diverse, which further exacerbated the language issue. The differing proficiencies created a great hurdle for teacher in terms of teaching. Despite introducing three English proficiency courses, which are segregated into short, simple sections; some of the text or email message I receive from students are mostly in roman Urdu. What was the solution? Our thought was that we are not the only university which sufferers from the same problem. If this disparity exists then a summative assessment system and lecture style teaching is not possible. Of all the main problems with language, speaking and writing are the main ones. Without these skills the students are unable to communicate. To alleviate this you would require a one tutor one learner model. A solution which is only possible with technology!

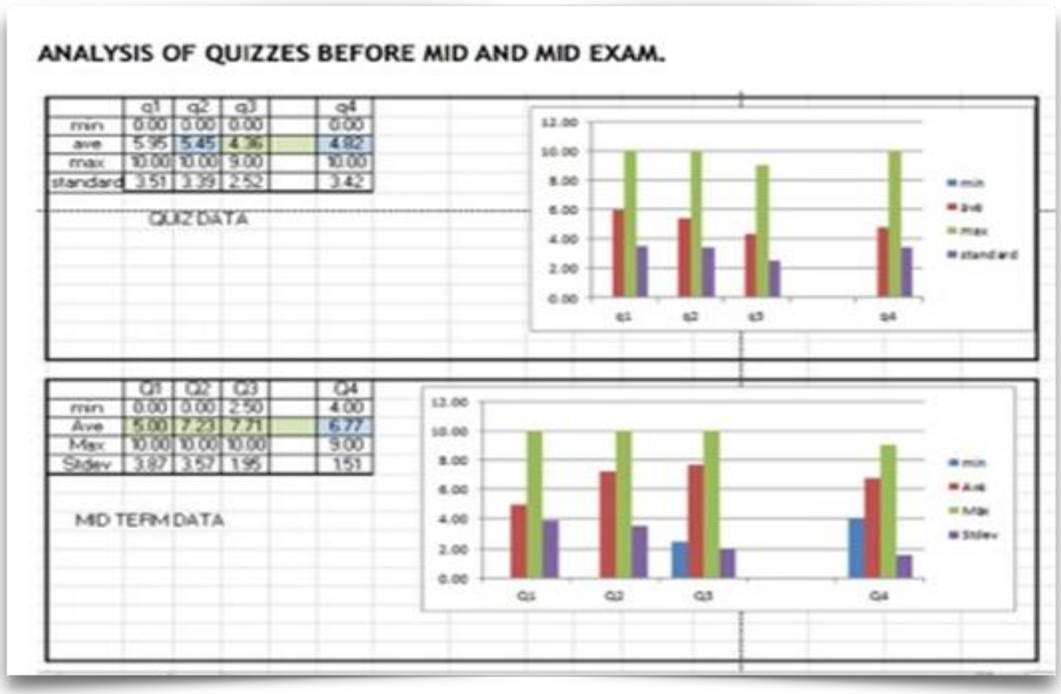
Looking around for solutions we looked at what MIT, in the States, which surprisingly were facing the same problem. How you may ask? About 30% to 40% of students are from China, who are brilliant in their fields but have issues with English. To make these students productive, a language software system was developed. Students registered on this system (Byki) showed remarkable results in terms of acquiring language proficiency. The system did not rely on traditional pedagogical methods. Seeing the system success we decided to purchase it. Apart from computers this system also has provision for mobile device connectivity. To test the system, I had my driver who is sixth standard dropout, to register on the system. The results based on declarative acceleration methodology were truly remarkable. From the slides presented here you can gauge what a right blend of technology and pedagogy can achieve? These illustrate the five principles entailed in the system design.

With an annual fee of ten to twelve thousand dollars, which comes to around a dollar per students annually, we can now register our entire student body and resolve our serious language problem. Without technology this is impossible. We do not have enough trained teachers in Pakistan to teach English to all students who require this. To handle this we are trying to develop an indigenous system by reverse engineering the imported software. We are not entirely conversant in all the background pedagogy involved; since based on input by numerous neuroscientists, psychologists, linguists, pedagogists and other experts. We might not be able to replicate the entire thing but can mirror most of the processes. This can be rolled out to all students in the country, even has utility for those not formally studying. In this illustration you can see my driver updating me about his progress without the help of an instructor.

Here you can see some of the interfaces; the questions and choices provided. The beauty of the system is that, instead of isolated elements of language, it focuses on development of all four areas simultaneously; listening, speaking, reading and writing. An example of formative assessment based on interactive learning and incorporating instant feedback. We hope you would also be part of our future designers who will develop these systems; so that no child is left behind in terms of learning. We hope this course has provided you with the insights to do exactly this. With the course there will also be accompanying book which will greatly assist you in playing a part in provision of quality education to each and every child in Pakistan.


Content
Pedagogy
Technology
Ubiquitous Technology
Discover Content
Thought Experiments & Simulations
Pedagogy
Create Knowledge
I can figure out myself


STUDENT WISE RELATION OF QUIZZES AND MIDS
Ave Marks
Student's Serial Number



ANALYSIS OF QUIZZES BEFORE MID AND MID EXAM.

	q1	q2	q3		q4
min	0.00	0.00	0.00		0.00
ave	5.95	5.45	4.36		4.82
max	10.00	10.00	9.00		10.00
standard	3.51	3.39	2.52		3.42

QUIZ DATA

	Q1	Q2	Q3		Q4
min	0.00	0.00	2.50		4.00
Ave	5.00	7.23	7.71		6.77
Max	10.00	10.00	10.00		9.00
Stdev	3.87	3.57	1.95		1.51

MID TERM DATA

Finished