The Twelfth Annual Science and Math Educators Conference (SMEC 12)
April 10th and 11th, 2010

Science and Mathematics Education Center (SMEC)
Faculty of Arts and Sciences
American University of Beirut, Lebanon

SMEC 12 – CONFERENCE PROCEEDINGS

(ENGLISH AND FRENCH SECTION)

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SMEC 12 MISSION STATEMENT

The SMEC Conference is an annual event designed to promote the continued development of a professional community of mathematics and science educators across Lebanon and throughout the region. Specifically, the conference aims to:

- Provide an intellectual and professional forum for teachers to exchange theoretical and practical ideas regarding the teaching and learning of mathematics and science at the elementary, intermediate, and secondary levels

- Provide a forum for teacher educators and researchers to share their findings with science and mathematics teachers with a special emphasis on the practical classroom implications of their findings

- Provide an opportunity for science and mathematics teachers to interact with high-caliber science and mathematics education professionals from abroad

- Contribute to the ongoing development of a professional culture of science and mathematics teaching at the school level in Lebanon and in the region

- Raise awareness of science and mathematics teachers about the array of curriculum and supplemental classroom materials available to them through publishers and local distributors

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The Reproduction of Geometrical Plain Figures: a Complex Task
Naim El-Rouadi

Introduction

Continuous and appointed meetings with mathematics instructors of the three cycles in basic education which held discussions regarding geometric reasoning showed that instructors should not underestimate the importance of two main difficulties that students might face while learning geometry. The first difficulty is that geometry is very hard. Second, geometric reasoning should not be reduced to the learning of formal demonstration; learning requires learners to develop an important intellectual investment.

In addition, instructors expressed their convictions regarding geometric reasoning which is that reasoning is a major part of teaching geometry in which the ability to reason is an essential skill for learners to accomplish. Since geometric reasoning is rich in formal deduction, learning the skill of reasoning is the strongest argument in favor of geometry.

The instructors defined geometric reasoning in terms of Piaget's theory where reasoning begins at the operational level of a child's development, i.e. ages 7-8 or 10-11 years old. At this stage, the beginning of logic articulation takes place (logic linking). Thus, reasoning may be considered a domain that can be taught in early stages of development. Some added that reasoning is in fact a rich and diversified domain with a visual, static and even playful aspect.

For more than 15 years, I have adopted a custom to ask each instructor to explicitly state his point of view regarding the teaching-learning of geometry. The following quotes resume the majority of the points of views of the instructors regarding geometrical reasoning and required competencies, respectively:

> "Geometrical reasoning stresses the observation of figures before doing any real research work. Conjecture elaborations that are subjected to critical examination allow a convincing validation through demonstration. The key is to settle between intuition and the rigors when facing a complex problem and to think geometrically is to be able to perform a drawing. Hence, to think geometrically is also being able to rely on geometric intuition and rigors."

> "To think geometrically is to have a global vision when constructing a geometric figure. To effectuate a mental activity in the domain of geometry students should be enabled to:
> • Use different competencies of perception in deductions which are necessary to identify information in given figures (geometric information taken from definitions and theorems) and put the techniques of calculations into use.

• Use notions issued from different registers in the study of complex situations. The diagram helps visualize the object and allows identification of the conditions necessary for its realization which relies on its properties."

By referring to the Lebanese curriculum concerning plain geometry in the two cycles of basic education (II-III), we identified the recommended competencies which include: reproduce, construct, represent and describe. Some teachers of these cycles assured that the acquisition of the first competency (reproduce) remains far from the scope of students at the end of basic education. Therefore, empirical research was needed to clarify this point of view through further exploration.

Problem

This research aimed to study the knowledge (meaning and value) that first secondary school learners have with respect to plain geometry, taking into consideration that the reproduction of geometric figures is one of the specific objectives of teaching and learning geometry in the two cycles mentioned above. Consequently, the questions of this empirical research were:

1. Is a student of 14-16 years of age capable of accurately reproducing a given figure of plain geometry?
2. Is it sufficient to reason when it comes to geometric figures?
3. Is it enough to use certain necessary algebraic calculations to reproduce geometric figures especially when having an irrational number in this calculation?
4. Does it help to draw accurately a geometrical figure knowing that a ruler and compass are the only utensils used?
5. Are students able to draw the length of an irrational number ($\sqrt{2}$)?

Hypothesis

The geometric support of this study was a problem- situation that requires using: Euclidean geometry (to perceive plain geometric figures), reasoning (reason then demonstrate), algebraic calculations (to solve an equation of first or second degree and choose the acceptable root) and geometric representation of the length of a $\sqrt{2}$ segment (to trace this segment accurately). This was used to verify that Lebanese students have acquired competencies regarding the application of theorems and geometric concepts to solve complex problems (outcome learning). This research aimed to prove that formal reasoning is not enough to reproduce given geometric figures.

Theoretical Framework

This research was based on five theorists: Bernard Parzysz, Sophie Gobert, Eric Roditi, Alain Kuzniak, and Van Hiele.

Parzysz's proposal

Parzysz (1988), who worked specifically on graphic representations of space geometric objects, concluded some conflicts that occur with the drawer through (<le su>: understood and < le vu>: visual).

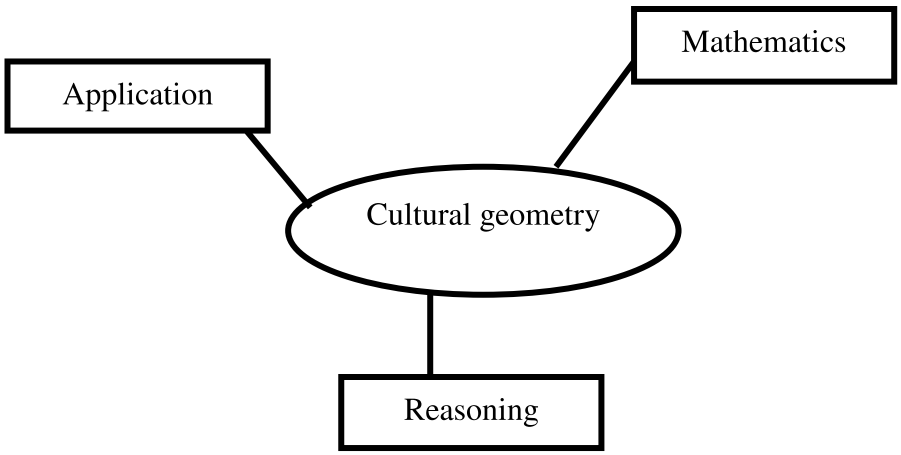


Figure 1

That is between the knowledge he knows about a geometrical object and visual given by his representations. Berthelot and Salin (2001) distinguished three problematics concerning the <le su> and < le vu> depending on the nature of the problem:

- A practical problematic where the objects are physical ones (in particular the drawing) in a way the solutions are practical and the validation remains in the sensational space. This problematic is categorized in the natural geometry according to Kuzniak.
- A geometric problematic where the objects are theoretical in which the process and validations depend on the geometrical knowledge. This problematic is categorized in the axiomatic geometry according to Kuzniak.
- Spatio geometry problematic (problematic of modeling) where we work on physical objects, the process gives an ideal model to physical objects and on the geometric knowledge, but its validation is done in physical space. This problematic has two links: with natural geometry that consists of the problem and solution, and natural axiomatic geometry which consists of the problem that is modeled and solved.(refer to figure 2)

S. Gobert's proposal

There are specific works to pass from physical space of drawing a figure, and vice versa. Sophie Gobert (2001) proposed in her thesis, that the micro space which belongs to physical space should not be assimilated like drawings. She proposes to name it "Representational Space" because it is not a geometrical space. The representation space exists in the middle space between the physical (sensible) and the geometrical space (abstract).

E. Roditi's proposal

Eric Roditi cited that in the case of drawing geometric figures, the implicit knowledge of construction is less important than the representation of properties that should be visible. But when constructing a geometric figure, this implicit knowledge of construction will be necessary for the correct representation. To construct two parallel segments, the method depends on the properties that are vital, and if this method requires additional drawings, it is not recommended to erase them.

A.Kuzniak's proposal

According to Alain Kuzniak (Kuzniak 1998), students' reasoning level in geometry is categorized into three levels:

-Natural Geometry (Geometry I), which has reality and the sensitive world for source of validation. In this Geometry, an assertion is justifiable by using arguments based upon experiment and deduction. The confusion between model and reality is great and all arguments are allowed to justify an assertion.
- Natural Axiomatic Geometry, based on the classic Euclidean Geometry. This Geometry (Geometry II) is built on one model close to reality. But once the axioms are fixed, the demonstrations have to be inside the system of axioms in order to be valid. For these two approaches, it is necessary to add Formal Axiomatic Geometry
- (Geometry III) which is little present in compulsory schooling, but which is the implicit reference of teachers' trainers. They are usually, mathematicians who have studied mathematics in university, which is very influenced by this formal and logical approach.

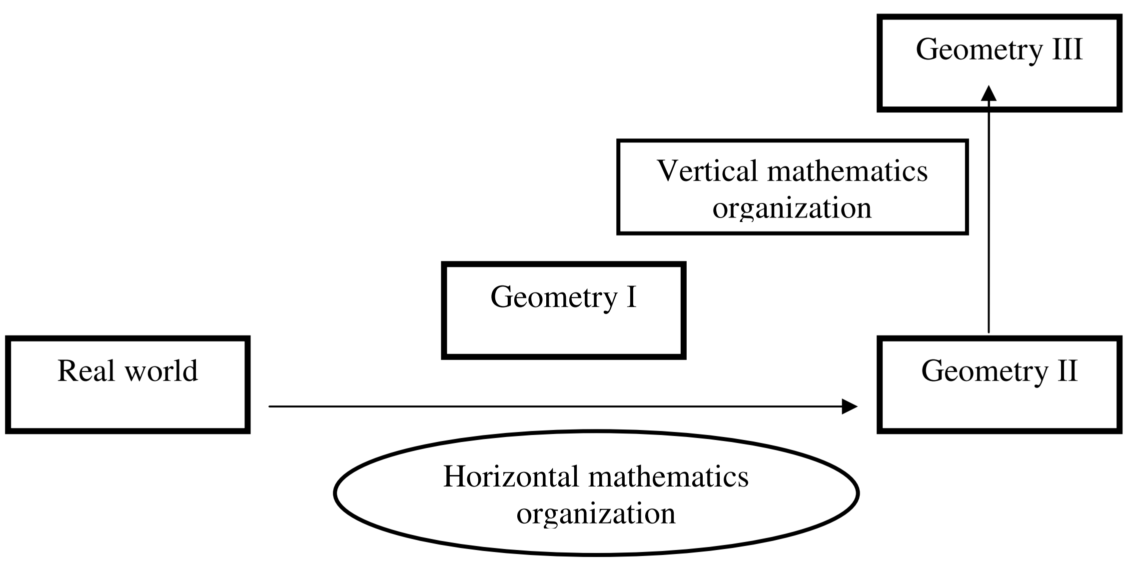


Figure 2

Parzysz (1988), in contrast to Kuzniak, divided geometry's reasoning into the following levels:

-Spatio-Graphic G1: the objects in play are physical (models, diagram, and computer images) and the proof are of natural perspectives (eyesight, comparison, measure).
-Pre-axiomatic geometry G2: in which the objects in play are theoretical using axioms and definitions. Also the proofs are theoretical (moving in fact from perceptive to hypothetico-deductive as the students' geometrical knowledge grows up).

He added that while solving a geometric problem, experts use diagrams in two ways and the cognitive path is made of series of moves between G1 and G2. Pupils use (G2) to draw diagrams, consider diagram as a physical object (G1) and make conjectures by mere eyesight or by using instruments (ruler, compass), use the data of the problem to guess the solution (G2) and if necessary refer to the diagram to select useful elements for the proof or use it to check the results(G1-G2).

In summary, Parzysz refers to the diagram or the figure as an important element in the process of solving a geometric problem, hence, it is considered as a physical and theoretical operation.

Van Hiele's proposal

According to Van- Hiele (1957), there are five distinct levels through which a student's reasoning progresses.

Level 0: (Visual): Students identify and reason shapes as a visual whole rather on geometric properties.

Level 1: (Descriptive/Analytic): Students categorize and identify geometric shapes according to properties.

Level 2: (Abstract/Relational): Students are capable of forming abstract definitions, differentiate sets of conditions for specific shapes and recognize that some properties are applied in other situations.

Students also first establish a network of logical properties and begin to engage in deductive reasoning, though more for organizing than for proving theorems.

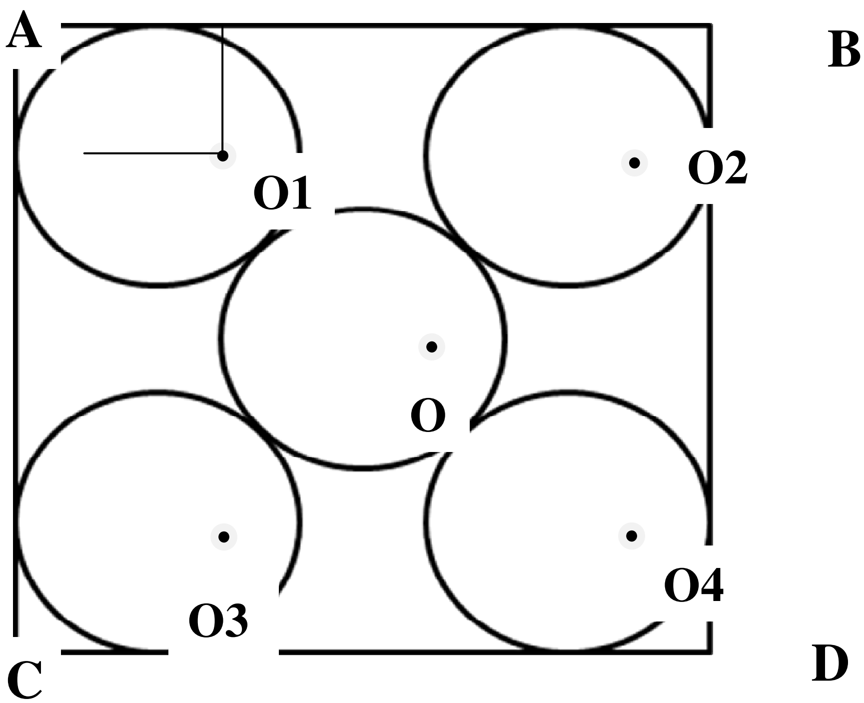
Level 3: (Formal Deduction and Proof): Students are able to prove theorems formally within the deductive system. They are able to understand the roles of postulates, definitions, and proofs in geometry, and besides they can make conjectures and try to verify them deductively.

Level 4: (Rigor) Mathematicians operate at this highest level**.**

Problem Situation

An instructor asked his student to draw the figure below on his copybook. The student encountered a problem because he could not figure out the radius of the circle. Could you kindly help him find the radius?

Problem: Given a square ACDB of side 10 cm and 5 equal circles. The sides of the square are tangent to the four circles and the middle circle is tangent to the other four circles. **Calculate the radius of one circle knowing that all the circles are equal.**



METHOD 1:

$AO_1= r\sqrt{2}$ $AO_1=O_4 D$ $AD=10\sqrt{2}$ $O_1O_4=10\sqrt{2} -2r\sqrt{2}$ $O_1O_4=2\sqrt{2}(5-r)$

$4r=2\sqrt{2}(5-r) \Rightarrow 2r=\sqrt{2}(5-r) \Rightarrow (2+\sqrt{2})r=5\sqrt{2}$

$r=5\sqrt{2}/2+\sqrt{2} \Rightarrow r=5\sqrt{2}(2-\sqrt{2})/4-2 \Rightarrow r=2.5(\sqrt{2}-1)/2$

$r=5(\sqrt{2}-1)$

Competencies:

1-Square: symmetry regarding the center O

2-Pythegorath theorem

3-Two circles tangent, the line joining the centers is equal to 2r.

4-Solve first degree equation.

5-Eliminate the irrational number from the denominator.

6- $(\sqrt{a})^2 = a$

METHOD 2:

$O_1 O_3=10-2r$

Triangle O_1OO_3 is the right isosceles triangle

$4r^2+4r^2=(10-2r)^2 \Rightarrow 8r^2=100+4r^2-40r \Rightarrow 4r^2+40r-100=0$

$r^2+10r-25=0 \Rightarrow r=-10(\pm)\sqrt{100+100}/2 \Rightarrow r=-10(\pm)10\sqrt{2}/2$

$r=-5(+-)5\sqrt{2}$ => $r'=-5+5\sqrt{2}$ not acceptable $r''=-5+5\sqrt{2}$
$r=5(\sqrt{2}-1)$
Competencies:
1-recognize parallel lines and their characteristics.
2-Square: Diagonals are perpendicular.
3-Use Pythagoras theorem.
4-Solve second degree equation.
5- Recognize that r is positive.

METHOD 3:
Consider the triangle $O_1\ O_3O_4$
$45°=\pi/4$ => $\sin \pi/4=\sqrt{2}/2=\cos \pi/4$
$\cos \pi/4=2r/10-2r$ => $\sqrt{2}/2=r/5-r$ => $1/\sqrt{2}=r/5-r$ => $5-r=r\sqrt{2}$ => $5=r(1+\sqrt{2})$
$r=5/1+\sqrt{2}$
Competencies:
1-Solve the unknown using cosine.
2-Two circles tangent, the line joining the centers are equal to 2r
3-Property of two parallel lines.

P.S: This method is applicable on the right isosceles triangle OO_1O_3

METHOD 4:
Consider triangle ODB, using Thales theory:
Where O_2O_4 is parallel to (BD)
Hence, $OO_4/OD= O_2O_4/BD$
$2r/5\sqrt{2}= (10-2r)/10$ => $(2r)(10)=(10-2r)(5\sqrt{2})$ => $20r=50\sqrt{2}-10r\sqrt{2}$
$20r+10r\sqrt{2}=50\sqrt{2}$ => $10r\ (10+\sqrt{2})=50\sqrt{2}$ => $r\ (10+\sqrt{2})=5\sqrt{2}$
$r=5\sqrt{2}/(10+\sqrt{2})$ => $r=5/1+\sqrt{2}$
Competencies:
-Use Thales theory
- Eliminate the irrational number from the denominator.

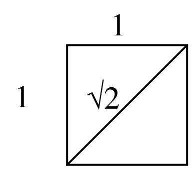
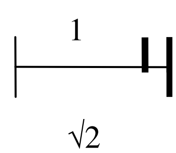
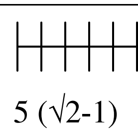
Practical part

We administrated in five secondary private schools of different languages (French and English) an exercise for 224 students but only 9 of them answered correctly. We chose one of them "Sami" to do our case study. Sami found $r= 5(\sqrt{2}-1)$ but he didn't know how to complete the figure.

Case Study 1

Sami, a grade 10 student, solved the first question concerning the calculation of the radius of five equal circles: $r = (\sqrt{2}-1)$
The second question was to reproduce the same given figure.
*S represents the student doing the experiment
*T represents the teacher doing the experiment

Teacher	Student	Teacher's Comments
-Draw the given figure using a ruler and a compass	-Tries to draw	-S began by drawing the square , and the 5 circles randomly without using a specific strategy
-What circle you should draw first?	-It doesn't matter ,I can start with anyone	
- Indicate the necessary elements for drawing a circle.	- Center and radius	
- You have the radius given which is r=5(√2-1) so find the other element	- The center of the circle	- He didn't specify which circle he will start with
- Can you find the element of symmetry? **(Hint1:draw the middle circle)**	- The center of the square	- He didn't specify the diagonals of the square because the diagonals are axes of symmetry in the square
-Draw the middle circle	- To Execute the intersection of the diagonals ,he put O the center of symmetry	- He didn't draw the circle
- Can you now draw the middle circle?	- Yes	
- Draw it	- Execution	- He calculated the radius of the circle separately and got the answer R =5(1.41-1) R =5(0.41) R =2.05
-Can you draw another circle?	-Yes	- He didn't specify the position of any center
-What characteristics do all the other circles have?	-Each circle is tangent to 2 sides and tangent of the middle circle	
-Specify a center of any circle except the middle one.	-No answer	-He didn't specify the access of symmetry (diagonal) -the point of tangency is included in the straight line of the centers
-Are the 3 centers included on the same diagonal segment?	-Yes	-He first took a length equals to the radius then, he drew a perpendicular. The intersection with the diagonal is the center of the circle. Then he drew the circle. He

		did the same for the 3 other circles. **P.S:** - The length of the radius used was 2cm (approximately)
-Do you think that you have drawn the correct figure?	-Yes	
-But the 5 circles are not exactly tangent	-Yes, because the radius is approximately 2cm	
-The problem proposed is to reproduce the figure so your figure is not correctly drawn what do you suggest to do?	-we can't define the exact value of R	
-Why?	√2 is an irrational number	
-Can you define geometrically the length of √2?	-No	-The student used the calculator to use the approximate value of the √2 which is 1.41
-How do you define the √2?	-If x^2 =2 then the positive value of X is √2	-This is the algebraic definition
Can you use the Pythagorean theorem to find a segment where its length is exactly √2?	No	His knowledge is only algebraic
I will give you a hint : -calculate the length of the diagonal of a square where its side is 1cm	-he drew a square and 1 diagonal then he used the theorem of Pythagoras and that's how he got the length of the diagonal	
Can you use this length to define exactly the same radius of the circles?	No answer	
You have now the exact length of (√2-1), can you draw the radius exactly?	Yes, I take 5 times this length	
Define the radius exactly which is R=5(√2-1)	On the straight line he drew the same length (√2-1)5 times in sequence	
In this case draw now a		The execution is valid

new figure		

Case Study 2

Mounir, a grade 10 student, whose average in Mathematics is above 70, had some difficulties in solving the exercise. After studying his worksheet, I found one of his gaps.

Mounir proved that: - the straight line O_1 O_3 is parallel to (AB)

- The distance (O1 $O_{3)}$=10-2r

He stopped his work at this point.

He missed drawing two diagonals.

In this case he can't solve the problem by applying Pythagoras theory in the right isosceles triangle which is O_1 O O_3

Knowing that O $O_{1=}$ O O_3 =2r

In this part, I gave him some hints to solve the problem.

Teacher	Student	Teacher's comments
Draw the 2 diagonals of the square	He executed	
What have you noticed?	The two diagonals of the square are perpendicular	
Can you now find the radii of the equal circles?	The right triangle OO_1 O_3 is also isosceles because O $O_{1=}$ OO_3 =2r knowing that the 2 circles are tangent.	
Calculate the radius now	He applied the formula of cos O $\hat{O}_1 O_3$ =2r/10-2r 1/√2=2r/10-2r He deduced r=5/1+√2	
What is the approximate value of r?	He used the calculator to calculate √2 and the final answer of r was r=2.06	He maximized the value
Can you reproduce the given figure by using the ruler and the compass now?	Yes	
Draw it		He repeated the same mistake that Sami had done.

Synthesis and Conclusion

Drawing a geometric figure is a part of the culture which is a basic factor in the process of teaching-learning geometry. Teaching geometry contains a large part of the esthetic. Hence, the given figure is not only an esthetical figure but also consists of variety of geometrical concepts. My analysis of the problem situation shows a relationship between the elementary algebra and the geometry concepts using a precise length of the irrational number.

- Characteristics of a square (perpendicular Diagonals, axis of symmetry, ….)
- Properties of tangent circles
- The possibility of applying Pythagoras theorem and Thales theorem.
- Using a trigonometric concept (cosine)
- Solve equation of first or second degree (choose the positive solution)
- The geometrical value of $\sqrt{2}$

Students' work sheets showed that the gaps are in one of the concepts above, which led to confusion in solving the problem. That's why they couldn't pass to the second step of the question that is reproducing the given figure. However, students who successfully solved the first part of the problem (calculating the radius) couldn't reproduce the figure due to the gaps in geometrically representing $\sqrt{2}$.

These gaps found in students' reasoning concerning the drawing of the figure were confirmed by E.Roditi who stated "In case of drawing geometric figures, the implicit knowledge of construction is less important than the representation of properties that should be visible". On the other hand, the proposed problem is placed between the second and the third level according to the taxonomy of Van Hiele and between the second and the third level of Kuzniaks' theory.

In conclusion, reproducing geometrical figures enhance the imagination of students to represent the implicit factors in the figures. According to the cognitive theory, the link between the students' memory and the geometric theories allows them to take suitable decisions which represent the critical thinking in mathematics.

Teaching geometry in basic education is not well taught due to two main reasons. First, it takes a lot of time and effort from both teachers and students. Second, the inductive method in reasoning is missing in the process of teaching were the instructors are concentrating on the deductive method. Also, they stress on students to memorize the definitions and theorems instead of giving it sense and value in the problem solving. Therefore, I am not surprised that among 224 students only 9 of them were able to find the radius but not reproducing the figure. Regarding the students who didn’t complete the first part of the problem, the major mistakes were the following:

- although the radius was drawn on the given figure (property of tangent circle), most of them were confused in discriminating the radius from the segment (O_1 A).
- some couldn’t progress in solving a first degree equation. Also, even though it was known that O is the center of symmetry of the square, they couldn’t know that (O_1 A) =(O_4 D).
- students couldn’t figure out that (O_1OO_4) are linear which composes the diagonal of the square.

Regarding the students who answered correctly the first part of the problem, and couldn't reproduce the figure correctly, they had some errors which were the following:
- They couldn't explore the geometric length of $\sqrt{2}$.
- They didn't draw the diagonals that the centers of circles are included on it.
- Some tried to enlarge the width between each circle and the sides in order to have a correct tangency.

Therefore, this study showed that teaching-learning plain geometry in basic education is very weak due to several reasons including time constraints, gaps in the curriculum and use of methodology which emphasizes on the implicit role given in figures such as properties and not always teaching the formal demonstration.

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The Double-Edged Sword: Highlighting the Misuse of Technological Tools

Haitham Solh

Abstract

The incorporation of information and communication technologies into mathematics classrooms is one of the most important themes in contemporary mathematics education. However, the power that technology has lies in its "appropriate" use that is, using its tools to promote conceptual understanding. In this paper, the author highlights the results of a study conducted on a computer-based mathematics curriculum. The study in question investigated the various teaching strategies implemented by teachers in a course design that included whole class instruction time in addition to time spent utilizing computer software to practice exercises, submit homework assignments, and take quizzes and tests.The study aimed to determine the proportion and methods of teachers using this approach that opted to support a conceptual agenda in their whole class instruction. The author concluded that the disadvantage of using a seemingly powerful and effective technological tool lies in the inability of the tool to enhance and promote students' conceptual knowledge.

Introduction

Interest in the use of technology in teaching mathematics has grown steadily over the last twenty years. From powerful computation tools such as graphical calculators and desktop computers, to software programs permitting numerical or formal computation and geometrical manipulation, to internet-based activities that found their way to many mathematics classrooms, it has become clear that the traditional assumptions on how mathematics should be taught in the classroom are changing substantially. The National Council of Teachers of Mathematics (NCTM) argued for the use of technology in their most prominent publication "Principles and Standards for School Mathematics" (2000). NCTM (2000) set a "technology principle," stating that "Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning" (p. 24). NCTM (2000) emphasized the positive role of technology in the classroom by affirming that "students can learn more mathematics more deeply with the appropriate and responsible use of technology. They can make and test conjectures. They can work at higher levels of generalization or abstraction"(p. 24). NCTM (2000) standards emphasized the use of technology at most levels, as they recommended that students "develop fluency in operations with real numbers, vectors, and matrices, using technology for complicated cases" (p. 222). Students should also develop the ability to "judge the meaning, utility, and reasonableness of the results of symbol manipulations, including those carried out by technology" (NCTM, 2000, p.296). Frederick Leung (2006) similarly reflects this emphasis in his claim that "the incorporation of information and communication technologies into mathematics classrooms is one of the most important themes in contemporary mathematics education" (p. 29).

The interest in the proper incorporation and use of technology in the classroom stems from the vast array of possibilities that technological tools seem to offer. Technology enables the exploitation of dynamic media like audio, video, and interactive software, allows students to collaborate in ways that were previously impossible, and provides tools to increase teacher productivity from lesson planning to record keeping. There are several pedagogical reasons given for the benefits of using technology in the classroom such as students' engagement, interactivity, and empowerment. Students using technology become active participants in the learning process instead of passive listeners. One-to-one technology enables the access, manipulation, and presentation of, and much more importantly, the creation of, multimedia rich descriptions and analyses. Technology can transform students from passive recipients of the teacher's knowledge to autonomous knowledge-constructors. Moreover, having students work in partnerships or small groups with a computer based problem as a guide allows students to work collaboratively. From a teacher's perspective, the advent of electronic technology can allow teachers and curriculum designers to focus more on mathematical ideas and devote less classroom time to the mastery of mechanical and computational skills. Calculators "reduce time spent on routine calculations and enrich students' understanding of deep ideas" (Alper et. al., 1996, p. 165). Technology also allows educators to capture the attention of students through interactive instructional activities.

Despite the huge potential of technology use in the classroom, NCTM (2000) warns that "technology cannot replace the mathematics teacher, nor can it be used as a replacement for basic understandings and intuitions. The teacher must make prudent decisions about when and how to use technology, and should ensure that the technology is enhancing students' mathematical thinking" (p. 24).

By highlighting the importance of the teacher's role, NCTM is responding to a frequent charge leveled against technological innovations in mathematics education which is that they exploit the capabilities of the technology rather than meet an instructional need. In other words, the use of technological tools is often technology-based rather than theory-based. Simply put, in the rush to jump on the technology bandwagon, teachers often fail to gear the mathematical activity that uses technology to achieve targeted learning objectives. For instance, Fey (2006) claimed that symbol manipulation tools (e.g. Derive, Matlab, Mathematica, etc.) used in math classrooms "are seldom used as aids in developing student understanding of symbolic forms and manipulations, or in solving problems that require such calculations" (p. 348). Earle (2002) summarized it best: "It is not about what technology by itself can do, but what teachers and learners may be able to accomplish using these tools" (p.10).

Procedural and Conceptual Knowledge

If one were to concede that the potential for technology in enhancing students' understanding and engagement can be realized only if it is used *appropriately*, it becomes crucial to define what the appropriate use of technology is. Several factors affect this determination, namely the quality of a technological tool, its mathematical goals, and the implementation process.

NCTM (2000) affirmed that "technology can help teachers connect the development of skills and procedures to the more general development of mathematical understanding" (p.26). This statement points to the overlap of the issue of technology use with another longstanding issue in mathematics education: the priority of *conceptual* and *procedural* emphases. Technology affects this discussion because technologies are designed to dramatically influence learning in both of these aspects. Hence, it is important to define these terms and determine how the interplay between them affects what is perceived as good instruction.

Hiebert and LeFevre (1986) defined conceptual knowledge to be knowledge “that is rich in relationships” and “can be thought of as a connected web” (p. 3). They claimed that the development of conceptual knowledge is achieved by the construction of relationships between pieces of information. In contrast, they defined procedural knowledge to be made up of two distinct parts: knowledge of the formal symbol representation system, i.e. knowledge of the symbols used to represent mathematical ideas and the acceptable form/order of writing such symbols, and knowledge of rules, algorithms, or procedures for completing mathematical tasks (Hiebert & Lefevre, 1986, p. 6). Star (2005) challenged both definitions, claiming that in both cases Hiebert and Lefevre (1986) departed from psychological perspectives on concepts and procedures by referring to only a particular subset of each type of knowledge. Only deep, richly connected knowledge is considered conceptual for Hiebert and Lefevre (1986), and only knowledge that is superficial and poor in connections is labeled procedural. A detailed analysis of these terms is discussed in the next chapter.

The “respective roles of procedural and conceptual knowledge in students’ learning of mathematics continue to be a topic of animated conversation in the mathematics education community” (Star, 2005, p. 404). Some argue against de-emphasizing procedures over concepts (Budd et. al. 2005; Klein, 2003), while others argue that procedural knowledge should play a secondary, supporting role to conceptual knowledge in students’ learning of mathematics (Pesek & Kirshner, 2000). Still, other researchers (Wu, 1999) labeled the conceptual-procedural dichotomy as “bogus,” since neither skills nor concepts can be taught or emphasized in complete isolation. From Hiebert and Lefevre’s (1986) perspective, the focal point of instruction needs to be conceptual knowledge, since “procedural knowledge that is informed by conceptual knowledge results in symbols that have meaning and procedures that can be remembered better” (p.16). This point of view is emphasized by Pesek and Kirshner (2000), who see that instruction “should involve students in reflecting, explaining, reasoning, connecting, and communicating” (p. 525). Thus, students should develop relational understanding, that is “understanding both what to do and why” (Skemp, 1987, p. 9). This point of view is not shared by Wu (1999), who boldly claimed that “deep understanding of mathematics ultimately lies within the skills” (p. 7). To add another dimension to the debate, the duality itself is now reconceptualized to attach a “quality” (superficial or deep) to the knowledge type (Baroody et. al., 2007). Star (2000) argued that the traditional usage of the terms procedural knowledge and conceptual knowledge obscures the myriad ways procedures and concepts can be known. He also added a depth dimension to Hiebert and LeFevre’s (1986) classification system to get levels of procedural knowledge.

In short, the conceptual and procedural distinction has received a great deal of discussion and debate in mathematics education through the years. Questions of how students learn mathematics – which precedes which, and what connections, if any, exist between the two types of knowledge – seem to be dominating the discussion on how to teach mathematics to serve the best interests of students. Simply put, the question is whether “developing skills with symbols leads to conceptual understanding, or whether the presence of basic understanding should precede symbolic representation and skill practice” (Sowder, 1998, p.5).

Background and Rationale of the Study

In 2005, Louisiana State University (LSU) redesigned its College Algebra (MATH 1021) class to become a computer-based course that requires students to attend only one lecture per week, doing the rest of the required course work on computer software. The course was tailored for advanced high school math classes, and is currently offered and implemented in several schools in Louisiana, with many schools offering dual enrollment. The design includes whole class instruction time (25% of class time) in addition to time spent utilizing computer software (MathXL) to practice exercises, submit homework assignments, and take quizzes and tests.

At a first glance, the redesign, named R2R (Roadmap to Redesign), has the feel of a methodology that it is geared mainly towards skills building, since many of its features seem to be promoting procedural learning. For example, the quizzes and homework exercises are very similar to the examples given in class and online; homework can be submitted and re-submitted until students "get it right," and help tools (like "help me solve it" or "view an example" buttons) walk the students through step by step procedures. The various ways in which teachers tackle instruction in the "margins" of R2R (lecture time and one-on-one interaction with students), however, play important roles in determining their goals. The whole-class instruction time provides a wide range of options for the teachers. They may use it effectively to promote higher order thinking skills and teach for conceptual understanding. They can use creative strategies to challenge students' thinking and engage them with problems, all while keeping up with the pace and demands of teaching the course, or they can use class time to support the procedural agenda already embedded in MathXL. It is not clear how many teachers, if any, actually teach to reach conceptual goals. Identifying those teachers, their strategies, and what common characteristics they share could prove to be a useful contribution to the growth and development of the R2R design. Identifying successful strategies that are deemed conceptually oriented can prove to be a substantial contribution to the debate of procedures versus concepts.

Purpose and Design Overview

To achieve a better picture of the learning impact of R2R, the study investigated the strategies and techniques R2R teachers implemented in their whole-class instruction as well as in their one-on-one engagement with the students. The first phase of the study aimed at providing a panoramic view of the various strategies that teachers use in their classes. Illustrating these techniques served to accomplish two goals: getting a rough count of the proportions of teachers that opt for conceptual and procedural agendas in response to software that is procedurally oriented and identifying the particular teachers who are adopting conceptual agendas as well as teachers who are procedurally oriented, for further, intensive study.

The second phase of the study focused on the latter group of teachers, and included the documentation and analysis of the varieties of methods these teachers used to support their teaching agendas, most importantly the strategies used to support conceptual understanding in the R2R environment. The research questions targeted were:

1.What proportion of teachers opt to support the procedural focus of R2R in their lectures, and what proportion use the lecture portion to insert a conceptual focus into the course?

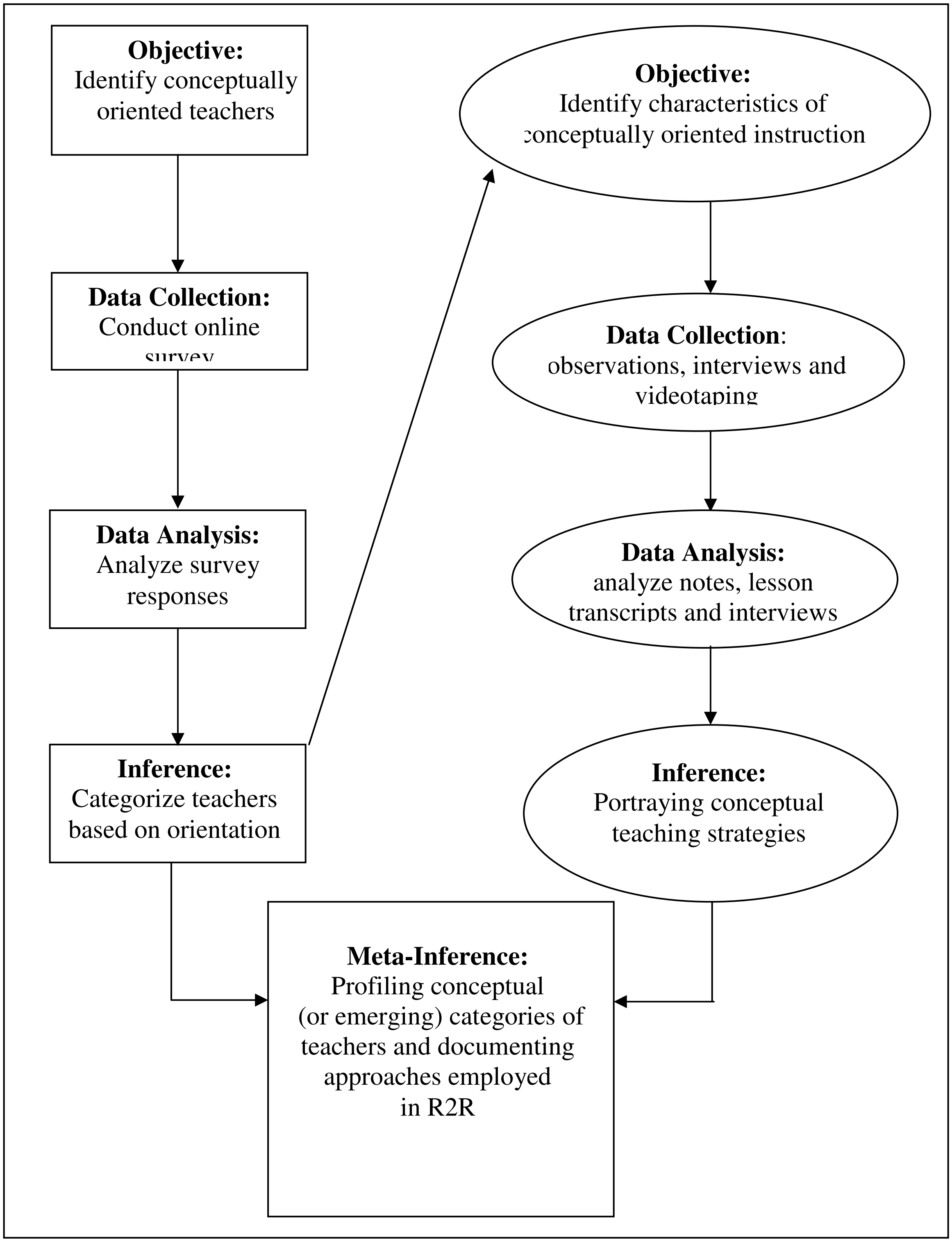
2. What are the varieties of approaches that R2R teachers use to enhance the students' conceptual understanding of the mathematical content?
3. If no teachers with a clear conceptual focus were found, then what characterizes the varieties of teaching techniques that the teachers employ in the margins of R2R?

To address the first question, a survey designed specifically for this study was set up for the teachers so they can elaborate on their teaching styles within R2R (describing a typical lecture, the perceived advantages they see in the approach, what problems they face, etc.). In addition to the survey, 9 classroom observations were conducted while taking extensive field notes that were analyzed later. The data obtained from the survey instrument served to answer the first question as well as isolate two groups of teachers for interviews and observations in the second phase. The interview and observation data served to answer the second question and alternatively the third one.

Study Design

This study employed a sequential mixed model design (Cresswell, 2002; Tashakkori & Teddlie, 2003). In this type of design, the first strand data was an online survey designed specifically for this study with the purpose of coding the answers to identifying teachers who have the highest percentage of answers that reveal conceptual tendencies. The second strand aimed at getting a better understanding of the approaches of the identified conceptual teachers. Class transcripts, notes, and teacher interviews form the bulk of the data in this strand. Finally, meta-inferences can be made based on the nature of inferences in the two strands of the study. If no conceptually oriented teachers are identified, in-depth analysis of the teaching strategies employed in the margins of R2R becomes the objective of the second strand. For the purposes of this study, the margins of R2R are defined as well as all the teacher-student interactions that take place in the lecture portion of the lesson and the one-to-one exchanges between the teacher and a student during a lab session. In that case, the analysis of the lessons transcripts and teacher interviews covers a sample of the teachers that includes conceptually-identified teachers, procedurally oriented teachers, and any emerging category in-between.

The figure below illustrates the sequential model design as it applies to this study.



Results and Data Analysis

The data showed that the majority of teachers who participated in the study were experienced where 70% had taught mathematics for 10 years or more. Their responses were collected and coded as either a "C" for Conceptual, a "QC" for Quasi-Conceptual, or "P" for Procedural. The coding was based on the extent to which the answers contained elements of conceptuality (soliciting students' ideas, discussing their strategies, linking current topic to previous knowledge). Once all the answers were coded, the codes were converted to scores for each individual respondent. Each teacher's score was calculated according to the following formula: Score = (# of "C" answers × 2) + (# of "QC" answers × 1) + (# of "P" answers × 0).

The following table summarizes the frequencies of the obtained scores:

Score	Frequency	Percent	Cumulative Percent
3	2	5.9	5.9
4	6	17.6	23.5
5	5	14.7	38.2
6	6	17.6	55.9
7	3	8.8	64.7
8	2	5.9	70.6
9	3	8.8	79.4
10	3	8.8	88.2
11	3	8.8	97.1
12	1	2.9	100.0
Total	34	100.0	

The findings in this section indicate that 20.6% of the teachers (7 out of 34) using the R2R design are oriented by conceptual goals, while 23.5 % of this sample (8 out of 34) have strong procedural tendencies. These data serve to answer the first research question, which required finding what portion of the teachers using the R2R design were oriented by conceptual goals.

The focus of the qualitative portion of the study was on the teachers who scored highest (conceptually identified) or lowest (procedurally identified). The teachers who showed aspects of both conceptual and procedural teaching agendas were not profiled in the study. A total of 7 observations (for three conceptually-identified teachers and three procedurally-identified teachers) and 6 interviews were conducted. For each category of teacher, individual teachers' data were carefully analyzed, and a teacher profile was created. Each profile included an analysis of the teacher's ideals gathered from his/her responses to the survey and interview questions. Then, analysis of the teacher's observed class was conducted to characterize his/her approach in the classroom. Finally, a cross-case analysis was done to enable the researcher to highlight the similarities and differences across the various teachers' approaches within a given category. The focus in this portion of data will be on conceptually-identified teachers and the compatibility, or lack thereof, of their instruction with their ideals.

Potentially-Conceptual Teachers' Questionnaire and Interview Data

The teachers' answers to the questionnaire reflected a conceptual orientation: All three answered that solving a problem correctly does not mean that the student understood the concept underlying the problem. Two of them maintained that skills should not be practiced until there is a sound conceptual foundation, and one of them stated that concepts can be taught regardless of the skill level. All three put an emphasis on soliciting students' ideas, however, only one of them answered that "students' ideas, right or wrong, form the focus of class discussions", while the other two stated that "students' ideas are solicited, but the teacher corrects their mistaken interpretations." In their interview answers, they stressed the importance of conceptual development. For instance, teacher C1 (the first of the conceptually-identified teachers) stressed that he highlights the conceptual basis of the problems in which he stated that "it's how the things go together, if you have a formula, where it came from, you know. It's showing them how a certain formula came about from something they know from before." Similarly, teacher C2 expressed her notion of conceptual development as "to show them the theory behind the problem that they're working, and why we are seeking to find a way to work these problems, and using this method, why it was developed, where it's relevant in real life to them." All three teachers objected to students' replication of procedures without understanding the underlying concepts and reflecting on the answers. They voiced their concerns in their interview responses: "There's always the aspect of connecting ideas and also anticipation. That's part of their conceptual development too, is anticipating what comes next" (Teacher C1); "the time I spend on concepts, it's valuable to them because they understand why we're doing it, and why the solutions are here and there" (Teacher C2); and "whether the answer is reasonable or not, that's where conceptual orientation comes in. If they understand the problem conceptually, when they get a strange looking answer, they can immediately question it" (Teacher C3).

However, those teachers' classroom practices had some common characteristics that deviated from their stated ideals. Generally, teachers in those classes often detailed some step-by-step procedures, and corrected students' misconceptions. The results show that the potentially-conceptual teachers following the R2R design had conceptually-oriented ideals which were detected in their responses to the survey and interview questions but were NOT reflected in their classroom practices. The common themes in the answers provided by this group of teachers were the focus on establishing meanings behind the problems and soliciting students' ideas. Surprisingly, neither theme was detected in their classroom instruction; the teachers were mainly providing solution steps, and students' ideas were not sought and discussed often.

Conclusions

One of the objectives of the study was to investigate the strategies teachers choose to adopt in response to procedurally oriented software. Given the procedural orientation of MathXL, finding teachers who were able to counter the tendencies of the software with conceptually oriented instruction was expected to be a challenge. The pool of potentially conceptual teachers consisted of 4 teachers who scored between 10 and 12 points (out of 16) on their questionnaire answers, so 3 of those teachers were observed and interviewed. It was concluded that the first two teachers (C1 and C2) followed a procedural approach in their classes, which contradicted the orientation they expressed in writing (questionnaire) and verbally (interview). The case of teacher C3 was specifically significant, since the teacher adopted a procedural approach in one of her classes, a regular R2R class, but was clearly oriented by a conceptual agenda in the other observed lesson, which was not bound by the same R2R constraints. The second observed lesson was done during a transition period between the Algebra portion (Math 1021) and the trigonometry portion (Math 1022) of R2R. The teacher was, according to her interview, developing the fundamental foundations for the trigonometry portion.

One of the challenges of teaching for conceptual understanding is the enormous effort that teachers need to make to orchestrate a conceptually oriented lesson properly. First, teachers need to probe students' current understanding of a concept and then design tasks that challenge their current conceptions, and attempt to lead them on a hypothetical learning path to refine their understanding. This is all done through questioning, reasoning, and justifying strategies. Incorrect student strategies play as important a role as their correct approaches, and teachers need to be able to let the students reach a decision on the soundness or incorrectness of an approach. This type of instruction is more difficult to implement with tight time constraints, since various ideas and unexpected issues emerge during classroom discussions. Moreover, given that all the conceptually identified teachers expressed a concern for the lack of time for whole class instruction, the study tentatively concluded that the conceptually-identified teachers'− those expressing a clear understanding of and orientation toward conceptual instruction in their questionnaire and interview responses−consistent failure to enact a conceptual agenda in the observed classes was due to the time constraints of instruction imposed by the R2R curriculum approach. The fact that the only conceptually oriented lesson observed in this study occurred for teacher C3 during a portion of the course after R2R obligations already had been met strengthens this conclusion.

The established procedural orientation of MathXL, the limited instruction time, and the observed difference in one teacher's orientation when the R2R constraints were removed present strong arguments for the incompatibility of R2R with conceptually oriented instruction. The current design of the program leaves little room for teachers to structure their instruction to attain conceptual goals.

Implications for Research and Practice

The study presents several opportunities to explore from both research and practice perspectives. From a theoretical perspective, the findings of this study can be extended to probe the current debate on procedural and conceptual knowledge. As discussed in the second chapter, proponents of procedural knowledge argue for investigating and promoting "deep procedures," that is procedures that are rich in connections, independent of concepts, and "associated with comprehension, flexibility and critical judgment" (Star, 2005, p.408). The R2R design presents a possible avenue to explore whether constructing meaning for the procedures would have a positive effect on the students' ability to choose the appropriate and effective procedure for solution without depending on visual clues or demonstrations. This could require some change in the software design to include various approaches for solving a problem.

Moreover, the study established that teachers who were identified as potentially conceptual did not have a conceptual agenda while teaching in the R2R design. This conclusion can spawn a number of related studies. For instance, a possible explanation for this result may be teachers' understanding, or lack thereof, of the subtleties of conceptual instruction. Further studies can investigate teachers' understanding of conceptual instruction through surveys, interviews, and observations. A possible avenue is to interview conceptually aspiring teachers prior to an observation, then follow up with further interviewing that probes the specific instances observed in their instruction.

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APPENDIX A
SURVEY INSTRUMENT

<u>Section I</u>

1. Age
   a) 25 or below
   b) 26 – 30 years
   c) 31 – 35 years
   d) 36 – 40 years
   e) 41 – 45 years
   f) 46 – 50 years
   g) 51 or above

2. Sex
   a) Male
   b) Female

3. Highest level of education attained
   a) Bachelor degree
   b) Masters degree
   c) Specialist degree
   d) Ph.D.
   e) Other (please specify) __________________________

4. Subjects in which you are certified
   a) Mathematics
   b) Science
   c) Other subjects (please specify)_____________________________
   d) I am not certified

5. Number of years teaching mathematics
   a) 1^{st} year
   b) 1 to 3 years
   c) 4 to 6 years
   d) 7 to 9 years
   e) 10 to 12 years
   f) More than 12 years

6. Number of years at current job
   a) 1^{st} year
   b) 1 to 3 years
   c) 4 to 6 years
   d) 7 to 9 years
   e) 10 to 12 years
   f) More than 12 years

Section II

1. Mathematics is about problem solving. If a student can solve a type of problem correctly every time, that indicates to me he/she has understood the content
   a) Strongly agree
   b) Agree
   c) Neither agree or disagree
   d) Disagree
   e) Strongly disagree

2. I believe that
   a) Skills need to be emphasized prior to introduction of concepts
   b) Concepts can be taught regardless of skill acquisition level
   c) Skills should not be practiced until there is a sound conceptual foundation

3. I believe that

   a) Comparing and contrasting different solution strategies is what helps students understand a problem.
   b) Multiple correct solution strategies may exist for a certain problem. This provides the teacher with the opportunity to have students appreciate the easiest, most efficient method.
   c) It's best to focus on the one approach that enables students to solve a problem efficiently and correctly. Introducing alternative methods is likely to confuse students.

4. Classroom dialogue is most effective for student learning if
   a) Students' ideas, correct or incorrect, form the focus of class discussions.
   b) Students' ideas are solicited, but the teacher corrects their mistaken interpretations
   c) The teacher presents the correct ideas in a clearly organized and deliberate fashion.

5. Prior to R2R, I would typically introduce new material by
   a) Illustrating/discussing a method or procedure and then have students practice it with several examples
   b) Posing a problem then paving the way for students to solve it by giving hints and suggesting possible starting points
   c) Allowing students to attempt a new problem type without showing them a routine method, and then having them discuss their solution approaches
   d) Other approach (please specify)

6. In addition to your typical introduction to new material (question 4 *i*), do you sometimes use other approaches? If so, indicate which methods (*a, b, c, or d)*, and the approximate percentage of time for each.

Section III

1. Is this your first semester teaching using the R2R approach?
    - *a)* Yes
    - *b)* No

2. How did you become involved in the R2R program?
    - *a)* Volunteered after hearing about it from a friend/coworker
    - *b)* Volunteered after I came across information about it online
    - *c)* It was mandated by the school/school district
    - *d)* Other (Please specify)_______________________________

3. When you signed up (or were assigned) for R2R (prior to adopting it), did you expect this approach to be________ (you may indicate more than one).
    - *a)* Helpful for students because it is engaging
    - *b)* Helpful for students because it is geared towards enhancing their content knowledge
    - *c)* Helpful at some level but not helpful on some others (please explain)
    - *d)* Not helpful because of its structure (class time vs. computer time)
    - *e)* Not helpful because of its content (topics, homework problems, quizzes…
4. What perceived benefits, if any, do you see for using the R2R approach?
    - *a)* Increases students' participation in learning
    - *b)* Increases students' enjoyment of learning
    - *c)* Better for students' understanding of the content
    - *d)* Better for students' mastery of skills
    - *e)* Less work for the teacher in preparation and planning
    - *f)* Other (please specify) _________________________________

5. What perceived disadvantages, if any, do you see for using the R2R approach? .
    - *a.* Decreases students' participation in learning
    - *b.* Decreases students' enjoyment of learning
    - *c.* Is not helpful in enabling students' understanding of the content
    - *d.* Is not helpful in enabling students' mastery of skills
    - *e.* More work for the teacher in preparation and planning
    - *f.* Other (please specify) _________________________________

6. The R2R approach requires students spending about 75% of the time working on their computers in class. Are you satisfied with the time allotted for the teacher within this approach? Why or why not?
    - *a)* Yes,____

b) No,____

7. Describe a typical lecture time in your class in terms of what you and the students regularly do.

____

8. What problems, if any, did you have with the way R2R is implemented?
   (You may check more than one)

   a) Software issues such as
   ____
   b) Teaching strategies issues such as
   ____
   c) Content issues such as
   ____
   d) Other (Please specify)
   ____

9. The R2R approach…
   a) did not meet my expectations
   b) met my expectations
   c) exceeded my expectations
   Comment (optional)

   ____

10. If you were the "R2R Czar", how would you organize the program to more effectively meet its objectives?

____

APPENDIX B
INTERVIEW GUIDE / INTERVIEW TRANSCRIPTS

1. Your responses to the questionnaire suggested an interest in students' conceptual development in math rather than just their skill with routine problems. Would you say this is a correct characterization of your teaching goals? What does conceptual development in math mean to you?

2. Teaching for concepts always is challenging, but perhaps this is especially true for R2R instruction. What sorts of special challenges related to conceptual goals do you find associated with the R2R model?

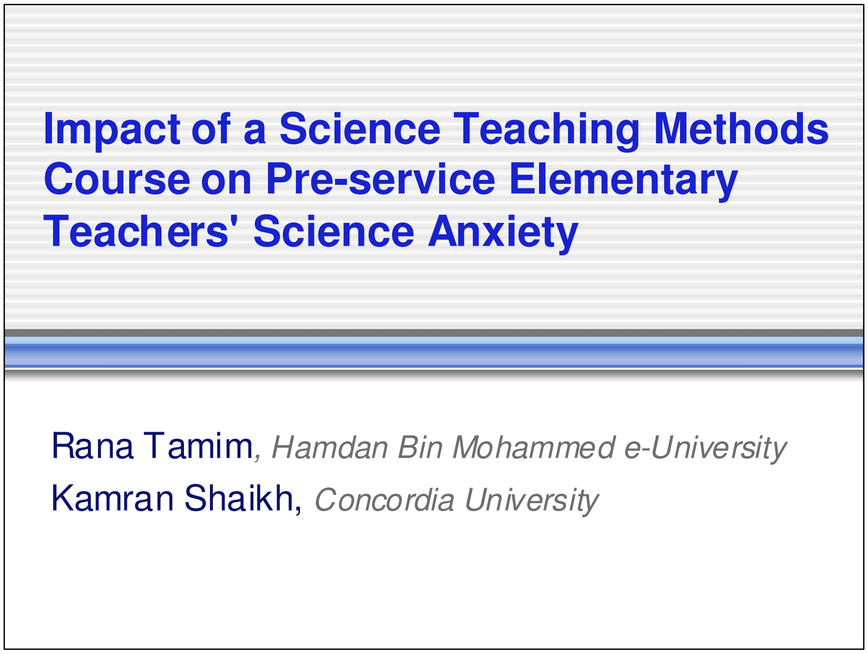
3. Please describe for me what is it that you do in a typical R2R class and how it links to your conceptual goals. Describe a lesson that you've given and addressed in it conceptual goals.

4. How do students interact with you and with each other during the class?
5. How do you verify that the students have understood a concept?

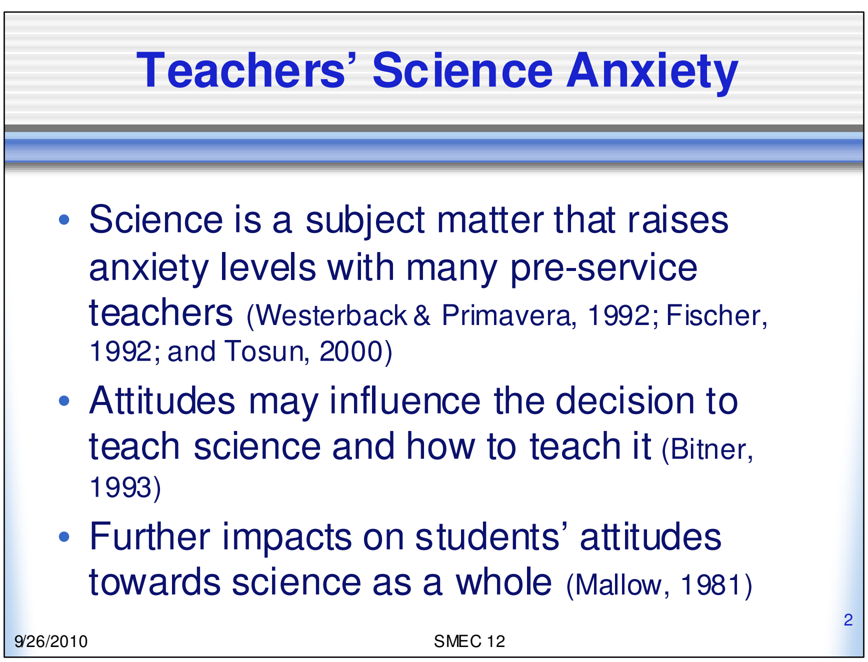
Impact of a Science Teaching Methods Course on Pre-service Elementary Teachers' Science Anxiety

Rana Tamim & Kamran Shaikh

SLIDE 1



SLIDE 2



SLIDE 3

Theoretical Framework

- Pre-service training is believed to have an influence on teachers' attitudes to science teaching (example Watters & Ginns, 1994)
- Constructivist oriented course design may have positive impact on pre-service teachers' attitudes to science (example Brown, 2000)

9/26/2010 SMEC 12 3

SLIDE 4

Research Objective

- Investigate pre-service teachers' perceptions about the impact of a constructivist hands-on minds-on science methods teaching course on their attitudes toward teaching science

9/26/2010 SMEC 12 4

SLIDE 5

Methodology

- Action research within context of undergraduate science teaching methods course in a Canadian University

9/26/2010 SMEC 12 5

SLIDE 6

Participants

- Undergraduate students in Early Childhood and Elementary Education program.

- A program that leads to a teaching certification in elementary grade levels

9/26/2010 SMEC 12 6

SLIDE 7

Participants

- 24 participants who offered consent to participate, with 7 completing interviews
- Age range: 20 to 48
- Average age= 26, SD= 6.5

9/26/2010 SMEC 12 7

SLIDE 8

Course Content

- Introduction and Overview (What is science, Value of teaching science)
- Teaching Science in Quebec (Teacher as scientist, QEP)
- Cognition and Learning (Theories of learning)
- Motivation (Teacher as Mediator and Motivator, Multicultural Classroom)
- Teaching strategies (Science inquiry, Cooperative learning , Explorations in Life Science, use of models and analogies, Exploration in earth Science, Learning cycle, Discrepant events, Explorations in physical science)
- Assessment (Formative and Summative Evaluation, Students' Misconception)
- Planning for Instruction (Planning the Lesson, Planning Assessment)
- Science Integration (Technology, Web-quests, Cross Curricular)

9/26/2010 SMEC 12 8

SLIDE 9

Course Design

- Teaching strategy based on constructivist approach (actual implementation of strategies than lecturing about it)
- Different teaching strategies were modeled with a hands-on minds-on approach (small-group learning activities, demonstrations, discussions, learning cycles, and cooperative learning techniques.
- Materials and resources from everyday life were used for most activities

9/26/2010 SMEC 12 9

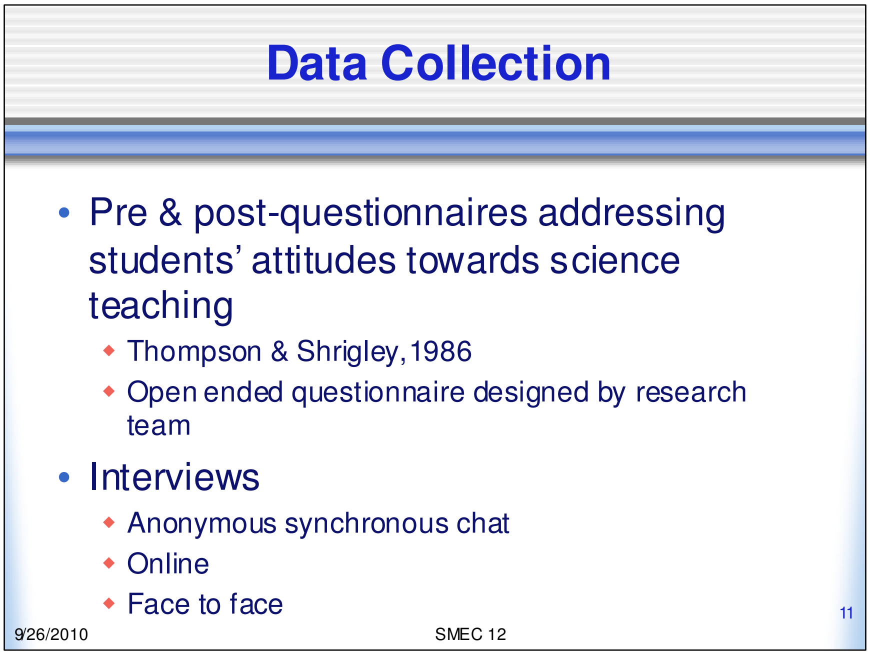
SLIDE 10

Ethical Considerations

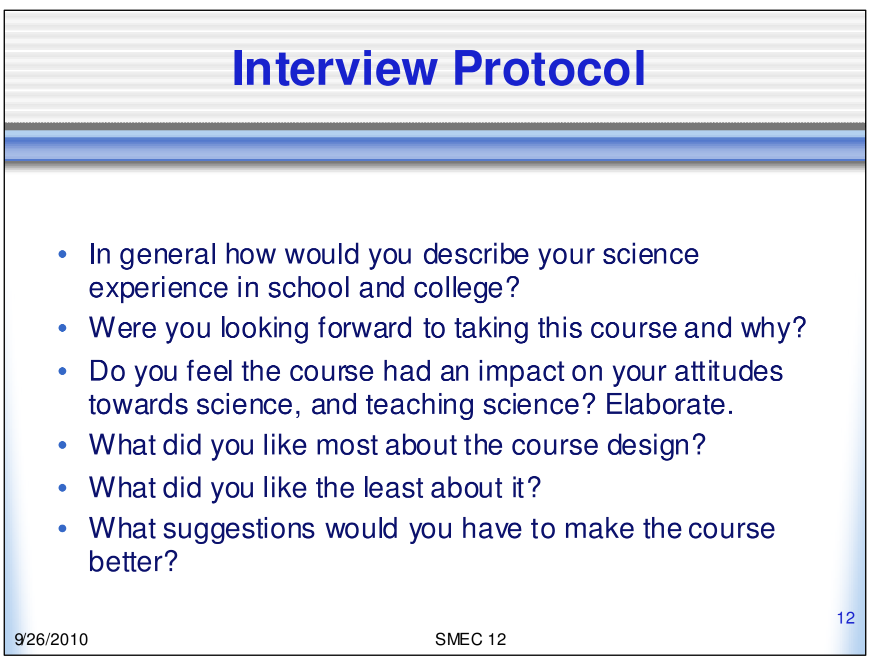
- Students informed of research objective
- Participation voluntary and confidential
- Freedom to withdraw with no -ve consequences
- Completed consent forms in absence of instructor and teaching assistant
- Consent forms placed in envelope and handed by a student to program coordinator for pick up after course grades were handed in

9/26/2010 SMEC 12 10

SLIDE 11



SLIDE 12



SLIDE 13

Results: Attitude to Science

- Results reflected overall negative attitude to science
  - “it was too difficult and i didn't understand so i stopped going to class”
- Students mostly disliked physics, numerical aspects, lecturing, complex concepts and theories and memorization

9/26/2010 SMEC 12 13

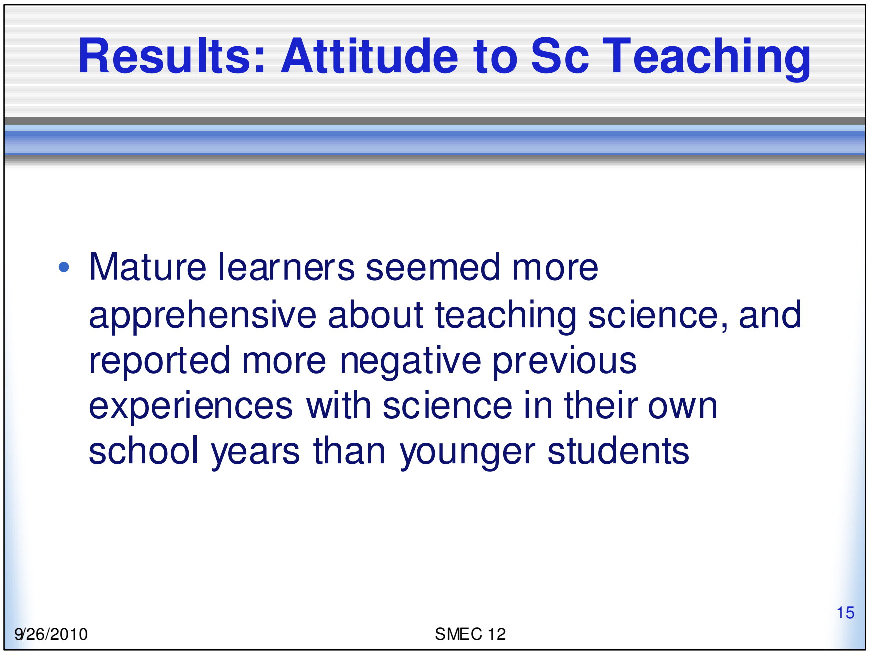
SLIDE 14

Results: Attitude to Sc Teaching

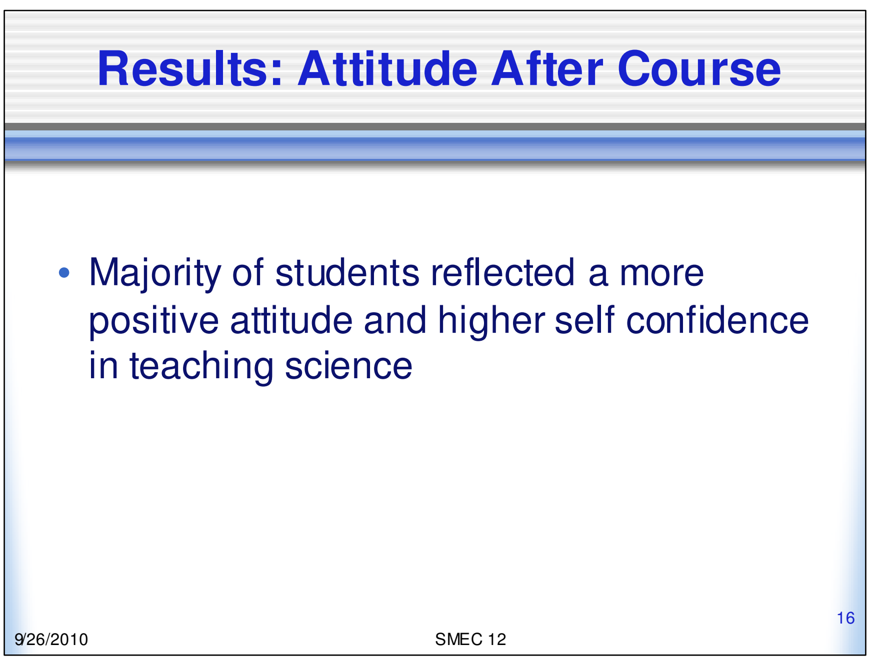
- Majority of students reflected insecurities about their ability to teach science
  - “*thought I had to be a lot smarter in science to teach it, I thought you needed to be a science whizir ability to teach science*”

9/26/2010 SMEC 12 14

SLIDE 15



SLIDE 16



SLIDE 17

Results: Attitude After Course

- *"I think I can do it. I feel I can do it and I can make it fun. I will enjoy it and the children will enjoy it. Because it is hands on, you don't have to sit there and read a book and understand it, you actually do activities and the kids can experience it. The hands on activities really made things clear for me, these were things we never had in school.."*

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SLIDE 18

Results: Attitude After Course

- *"I feel better prepared to manage the time and to use handy materials to explore our world and science interests"*
- *"I experienced bringing myself to the ideas THROUGH the activities instead of having the teacher tell us about them... the activity brings the child to see and understand the concept, not the teacher's words - quite difficult but essentially effective"*

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SLIDE 19

Results: Positive Design Aspects

- Hands on activities
  - *"explore the materials on our own, it was more helpful, when we can touch the materials, like the children do in our classrooms"*
  - *"Every class paralleled the teaching models that we could use in our own elementary school classrooms. we got to see lesson plans in action instead of decontextualized on paper"*

9/26/2010 SMEC 12 19

SLIDE 20

Results: Positive Design Aspects

- Positive atmosphere:
  - *"It was relaxed, insightful, fun and interesting. I wish I had this kind of class when I was in elementary school-who knows how that would have changed me now!"*

9/26/2010 SMEC 12 20

SLIDE 21

Results: Positive Design Aspects

- Group work
  - *"The group work really helped too because it allowed us to explore ideas and bounce them off of each other. We learnt from each other as well as from the professor."*

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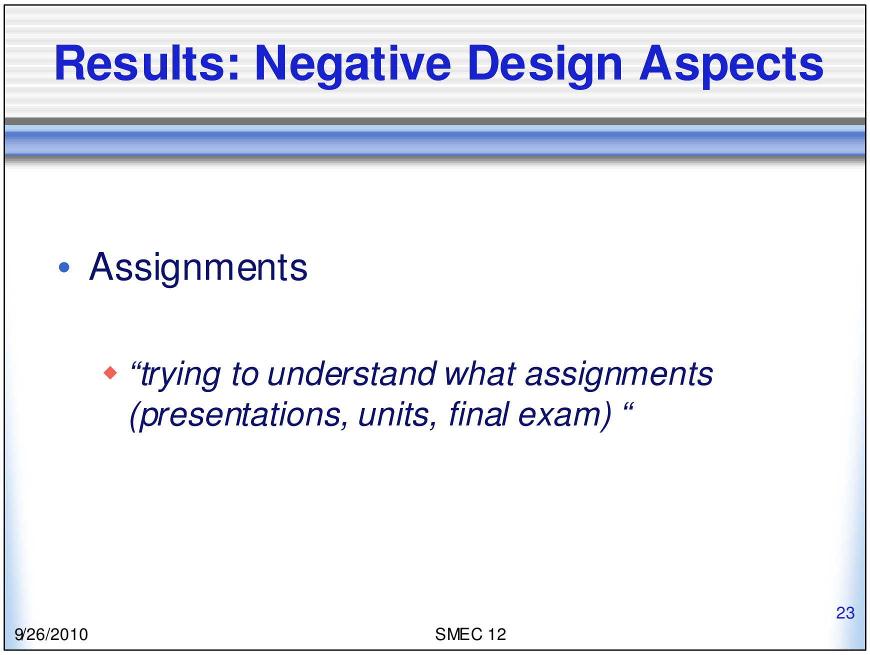
SLIDE 22

Results: Positive Design Aspects

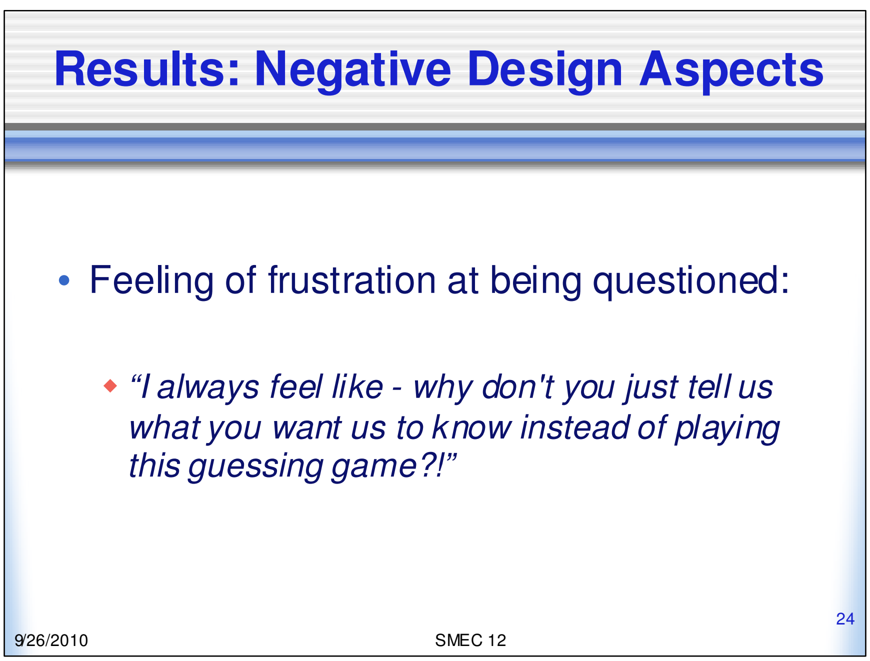
- Use of simple daily material
  - *"...doing experiments with simple and everyday materials in a fun and simple way"*

9/26/2010 SMEC 12 22

SLIDE 23



SLIDE 24



SLIDE 25

Implications

- Although it is perceptual, results offer an indication that methodology courses may positively help pre-service teachers and support their positive attitudes to teaching science, if properly designed and delivered

- Walk the walk and implement what you preach

9/26/2010 SMEC 12 25

SLIDE 26

Limitations

- Qualitative with perceptual data

- Limited scale, need for deeper investigation with larger sample sizes and more varied contexts

9/26/2010 SMEC 12 26

SLIDE 27

Future research

- Address quantitative with larger scale

- Although conceptual change with in-service teaching is harder, need to address the perceptions of in-service teachers pertaining to similar training within professional development contexts

9/26/2010 SMEC 12 27

SLIDE 28

Thank you ……………..

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9/26/2010 SMEC 12 28

Evaluating the Use of Assisted Software to Induce Conceptual Change as an Alternative Approach in the Teaching of Science Using Action Research

Randa Abu-Salman, Rana Haidar & Edward Khairallah

Abstract

Students come to science classes with alternative conceptions about many scientific principles and mechanisms. Research has recommended conceptual change - based learning environments using simulations for better understanding of these concepts. We have been using assisted software simulations to induce conceptual change in both physics and chemistry classes in all intermediate levels in our schools as an alternative approach to the teaching of science concepts. To evaluate the use of simulations, we conducted an action research at our school which was presented in this session. The participants were introduced to the steps involved in performing action research. Its results and actions intended to be taken as an evidence-based process. The participants were able to infer that by doing our own action research we could gain a better perspective into our own teaching and the students' learning and that the changes that we would make in our teaching would come out of our own work.

Introduction

The increasing availability of computer-related technologies in classrooms (Becker, 1991) has prompted the investigation of their influence on processes of conceptual development and conceptual change. The ability of simulations to portray phenomena and allow users to interact with the dynamics of a model system creates an arguably unique way of helping learners conceptualize (Windschitl, 1996). According to Vosniadou (2001), these models are dynamic and evolving and pupils can manipulate and change them particularly in situations where implicit physical knowledge needs to be applied in order to understand incoming information. Since all students enter classrooms with a wealth of knowledge about their physical, biological, and social worlds, they construct their own ideas about how the world works and explain scientific phenomena in light of these ideas. Scientific explanations of phenomena, with their characteristic rationality and generalizability, are often at odds with the informal explanations given by young learners. This discrepancy gives rise to the term *alternative conception* for the learner's explanation (alternative to the scientific conception). Alternative conceptions have the general characteristics of being poorly articulated, internally inconsistent, and highly dependent on context. Despite these qualities, informal ideas often have tremendous explanatory power in the mind of the student (Driver & Easley, 1978; Hewson & Hewson, 1983; Pines, 1985; Posner, Strike, Hewson, & Gertzog, 1982). In some cases, this explanatory power makes such informal ideas highly resistant to change. Gorsky and Finegold (1992) asserted that if naive conceptions are grounded in personal experience, then reexperience of the phenomena in an educational environment may be effective in precipitating conceptual change. Other than laboratory experiences for the students, this implies the use of simulations. Zietsman and Hewson (1986) used a computer simulation to diagnose and remediate alternative conceptions about velocity. Their results indicated that computer simulations can be credible representations of reality, and that remediation produced significant conceptual change in students holding alternative conceptions.

Conditions for Conceptual Change (Strike and Posner Model for conceptual change)

Educational conditions that promote conceptual change have been described as follows (Hewson, 1981; Hewson & Hewson, 1983; Hewson & Thorley, 1989; Posner et al., 1982):

1. The student must experience *dissatisfaction* with an existing conception. Without a sufficient level of dissatisfaction, students tend to assimilate conflicting information into a widening web of misconceptions rather than go through the process of conceptual change (Anderson & Smith, 1987; Perkins & Simmons, 1988). That is, dissatisfaction arises when, within the simulation, the learner is faced with results that conflict with what was predicted.

2. The new conception must be *intelligible.* If this condition is not met, the learner has no option but to internalize the conception through rote memorization, which means that there are no propositional linkages formed, and reconciliation with existing schema does not occur.

3. The new conception must be *plausible.* The new conception must also be congruent with personal standards of knowledge. Students, however, may be socialized to believe that the teacher is always right or that authors are infallible; thus, ideas directly transmitted from these sources may carry a predetermined level of plausibility.

4. The new conception must be *fruitful.* The candidate conception should have the power to solve problems or predict phenomena more decisively than the conception it will replace.

We have been using assisted soft-ware simulations to induce conceptual change in both physics and chemistry classes in all intermediate levels at our schools as an alternative approach to the teaching of science concepts.

The purpose of this action research study was to evaluate the use of assisted software in inducing conceptual change as an alternative approach to the teaching of science.

Research question: Does the use of soft-ware simulations in the teaching of science induce conceptual change?

Method

Sample and sampling procedures

The participants of this study consisted of 100 students of grade 8, grouped in sections and distributed in 3 schools. Three sections A, B, C in Saint Mary's Orthodox College (SMOC), one section in Beirut Annunciation College (BAC) and one section in Ecole Des Trois Docteurs (ETD) where simulations following their curriculum in physics were applied. All sections were equivalent in students' distribution, and had similar results in summative or cumulative tests done this year. Three sections at SMOC were taught by the same physics teacher, and the two sections at BAC and at ETD were taught by another physics teacher. Both teachers had similar backgrounds in education and in experience.

Data collection tools

We chose the concept of the “factors affecting the speed of a body during free fall”, which was scheduled to be given in the physics yearly plan for Grade 8 in March. We developed a two-tier questionnaire as the data collection tool. The first part was a 7 multiple choice set of questions. Each question had 4 choices (a, b, c, and d), in which one only choice was correct while the others incorporated possible misconceptions to the concept understudy noted from the experience of the teachers. The first three questions in the questionnaire were about prerequisites such as naming the forces acting on the body in free fall, type of motion and work performed. Question four specified which type of energy the body acquires while falling, and the rest of the questions tackled the concept under study. The second part consisted of open-ended questions which asked the students to explain in their own words their choice of answer. This questionnaire was sent to other physics teachers in other schools for suggestions or adjustments prior to delivery. We gave this same questionnaire as a pre-test and as a post–test for all participants. (Appendix 1)

Procedure

All five sections were given pre-requisite direct instructions on the concepts of mass, weight, kinetic energy and potential energy, as scheduled in their curriculum, as well as the definition of a free falling body, in February. No direct instructions were given on the concept of factors affecting the speed of a body during free fall.

All sections sat for the pre-test on the same day (March 17) and were given 30 minutes to finish. Only section C at SMOC and the section at ETD were asked to apply a virtual lab simulation on March 19, and fill in the corresponding work sheet (Appendix 2) using the schools’ computer labs and under the supervision of their physics teachers. No guided instructions were given to students; they were only asked to follow the “cook book” procedure in the work sheet and fill in the answers. The other sections at SMOC and the section at BAC were given direct instructions, on March 19 and 22, on the concept of the factors affecting the speed of a free falling body in class. All students sat for the post- test on March 23, and data was collected.

We would like to note here that as the teachers were correcting, they noticed that a large number of students still had a misconception regarding the concept of kinetic potential energy in a body in motion even though the concept was delivered as direct instruction to them. They chose to answer that a body in motion has kinetic energy only, (question 4 in the questionnaire). So, they showed section C at SMOC and the section at ETD another simulation pertaining to this concept where as a direct instruction was re-delivered one more time to the other sections.

Data analysis

The pre and post tests were corrected by different teachers and other science teachers in the department so that there was no bias or subjectivity in collection of data. We used qualitative and quantitative data analysis techniques in analyzing the data collected from the questionnaire.

For the qualitative analysis, we examined the students' explanations then

1. We compiled all responses in a comprehensive list.
2. We examined the responses until we could identify alternative misconceptions
3. We categorized four areas of misconceptions as follows:
   - Heavier object are pulled down faster by gravity.
   - Since P.E. and K.E. depend on mass therefore speed depends on mass.
   - Bodies closer to the ground will be pulled down faster.
   - Speed depends on mass; taking the example of the feather and the stone which do not fall at the same speed.

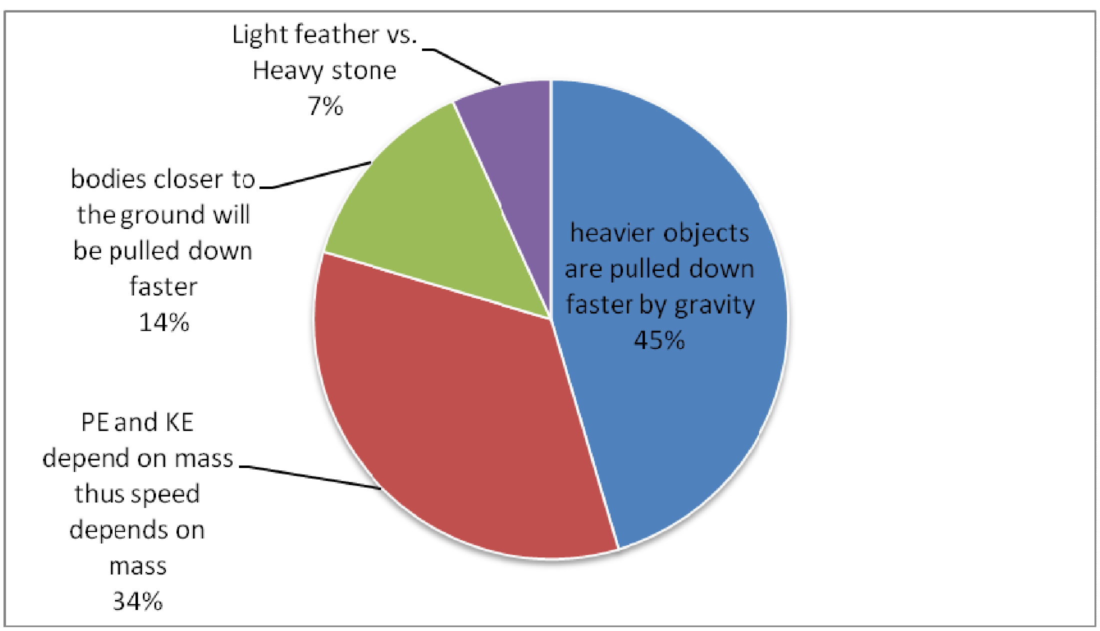
We presented our results in a pie chart using descriptive statistics as in percentages.

For the quantitative analysis, we also used percentages for the multiple choice questions. We collected the responses for each question for the learners who received direct instructions (control group) and for those who used simulations (experimental group), then we calculated the percent for each choice.

We used tables and graphs to represent our findings. We tabulated and graphed the results of questions 5, 6 and 7 which involved the factors affecting the speed (Appendix 1). Then we presented a comparison of results for question 4 for all learners who maintained the misconception (that during free fall a body has only kinetic energy) for both groups those who received direct instruction again (control group) and those who used simulation (experimental group).

Results

A. *For the qualitative analysis:* The pie chart below shows the percentages of learners who used the 4 categories of areas of misconceptions or alternative conceptions:

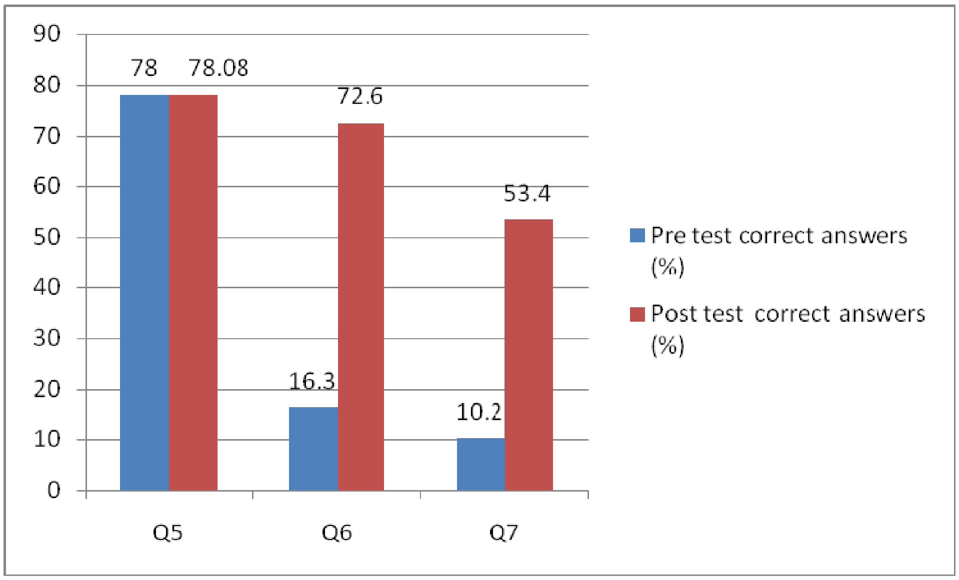


B. For the quantitative analysis:

<u>Section 1:</u> Percentages for questions 5, 6, 7 for the Control Group who received direct instructions.

a) Comparison between pretest and post test results for control group

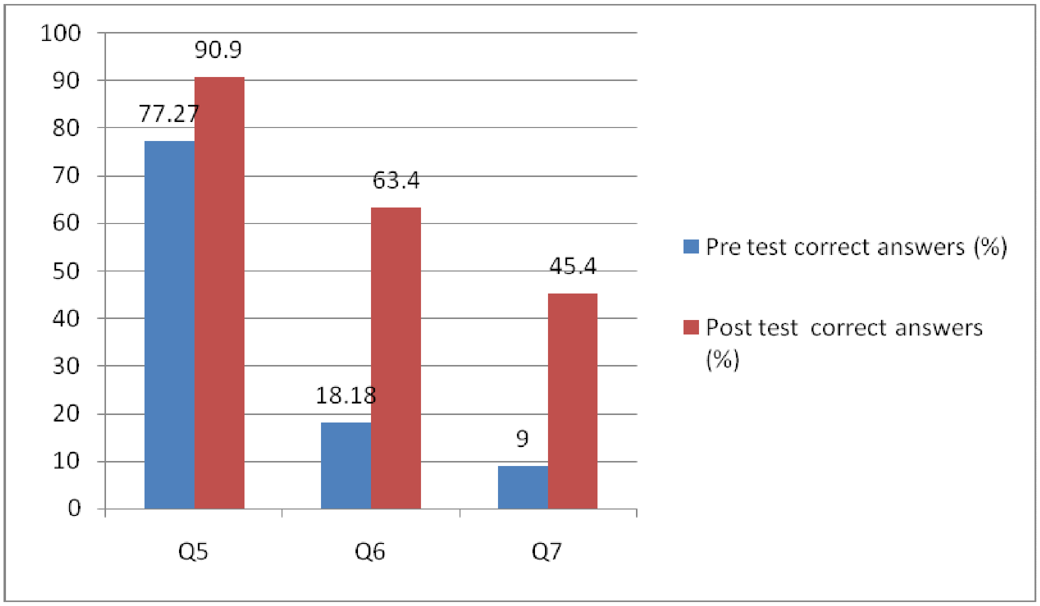
Without VL	Pre test correct answers (%)	Post test correct answers (%)
Q5	78	78.08
Q6	16.3	72.6
Q7	10.2	53.4



<u>Section 2:</u> Percentages for questions 5,6,7 for the Experimental Group who used simulation

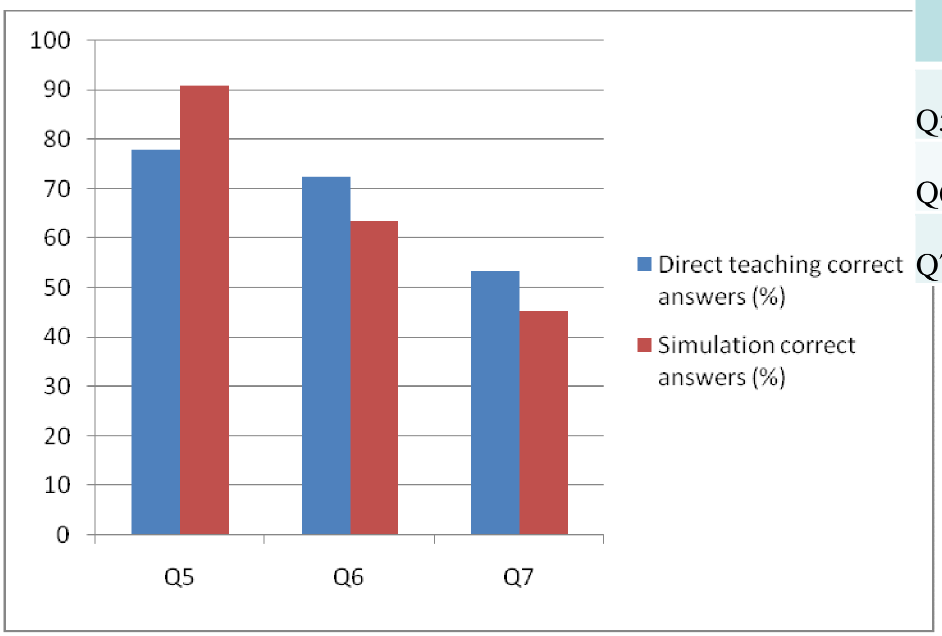
b) Comparison between pretest and post test for the experimental group

With VL	Pre test correct answers (%)	Post test correct answers (%)
Q5	77.27	90.9
Q6	18.18	63.4
Q7	9	45.4



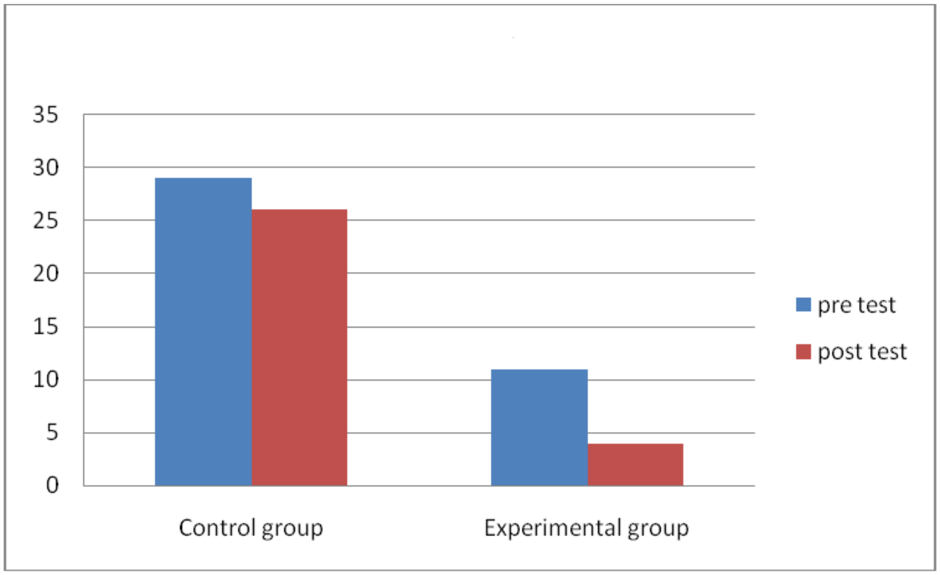
Section 3: Comparison between Control group (received direct instructions) and Experimental Group (used Simulation).

Statistical comparison using Chi square test



	X^2	p
Q5	35.283	P > 0.05
Q6	35.066	P > 0.05
Q7	33.209	P > 0.05

Section4: Question 4: Percentage of learners who maintained the misconception that during free fall the body has kinetic energy only.



	Control group	Experimental group
pre test	29%	26%
post test	11%	4%

Discussion

The primary purpose of this action research study was to evaluate the use of assisted software simulations to induce conceptual change as an alternative approach to science teaching specifically for areas that hold alternative conceptions to learners. To begin with, we found out that informal ideas do have a strong explanatory power in the minds of learners which make them resistant to change. In fact, the findings of the qualitative results indicated that 45% of learners with misconceptions have related that the speed of a free falling body depends on the mass because gravity pulls heavier objects faster, whereas 35% related speed to mass by concentrating on the formula K.E= ½ mv^2 where both are factors, to say that the speed depends on mass neglecting the fact that they are independent factors. On the other hand, when looking at section 1 findings, which were of the control group who received direct instructions on all related concepts, there was a big difference in their answers between the pretest and posttest specifically for Q6 (16% vs. 73%); they were able to eliminate the fact that speed depends on mass. But when many factors were involved (Q 7) they were confused and found it difficult to concentrate on height only as a factor of speed (53%) even though it was much higher than their achievement on the pretest (10%). Also it was not difficult for learners to say that objects fall from different heights with different speeds. Thus, the further away an object is, the higher its speed when reaching the ground during free fall (78%) in comparison to the findings in section 2 related to the experimental group, (who used simulations), which was 90% . The rest of the findings were very similar to those for the control group. In fact, in section 3 findings revealed that when comparing the results of direct instruction versus use of simulations there was no significant difference ($P > 0.05$) for all questions.

Moreover, when learners were exposed to a simulation about the variation of kinetic energy and potential energy on a body in motion, only 4% maintained the misconception (that the body during free fall has only kinetic energy), with respect to 11% for those receiving for a second time direct instruction. This result was unexpected and rather astonishing to their teachers. All this lead us to say that a re-experience of the phenomena in an educational environment may be effective in precipitating conceptual change and that remediation using simulations has produced some conceptual change in students holding alternative conceptions.

Furthermore, using Strike and Posner's model of conceptual change, the issues of *dissatisfaction* with a current conception, and the *intelligibility, plausibility,* and *fruitfulness* of the scientific conception can all be addressed in a learning environment. All our students have experienced dissatisfaction of their existing conception and actually some expressed themselves by exclaiming and shouting while working with the simulation as they faced a result that conflicted with their information. Asking students to explain these predictions activated prior knowledge and forced them to mindfully articulate explanations. For plausibility, a second criterion for conceptual change, the scientific conception seemed plausible for students due to the fact that the results indicated a large difference between the pre and post tests. As for intelligibility and fruitfulness, we can only assume, at this level, that these conditions were met, but we don't know for sure if the scientific conception was meaningful or understandable enough for them to be able to internalize it and form linkages, or if it really had the power to solve problems or predict phenomena more decisively than the one it replaced. Also, there was no time to measure the durability of this change, all of which will be the basis for future studies. Never the less, we propose to continue the use of simulations in our schools based on the evidence of our findings.

Implications of this research

This study supported the idea that computer-based simulations offer a suitable environment for altering learning misconceptions; intelligibility and fruitfulness can be established through the use of simulations prior to instruction where it can provide an introductory framework to direct classroom instruction, and can facilitate learning in the areas of knowledge and of application of knowledge. Not all simulation exercises necessarily engage the learner beyond following instructions, but using extended simulation exercises might add coherence and comprehensibility beyond the level of "information", predictions are quickly tested, and the fruitfulness in explaining results gives plausibility to these predictions. Furthermore, if within a simulation the learner is able to set up conditions that result in a confirmation of his predictions and can make sense of the scientific conception, therefore the learner can process his/her conceptual understanding of a phenomenon.

As for the use of action research as an evaluative tool, we infer that it is a process that provides the opportunity to work with others and to learn from the sharing of ideas. It can improve the teaching and learning process by reinforcing, modifying, or changing perceptions that are based only on informal data and nonsystematic observations Ferrance (2000).

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Internet Resources

These sites give a clear outline and summary of the steps involved in action research, highlight the benefits of the action research process, and give descriptions and diagrams of action research cycles and links to various action research sites.

_ http://ousd.k12.ca.us/netday/links/Action_Research/begin_guide_action_research
_ http://www.phy.nau.edu/~danmac/actionrsch.html
_ http://elmo.scu.edu.au/schools/sawd/arr/arr-home.html
_ http://educ.queensu.ca/~ar/
_ http://www.tiac.net/users/dfleming/resource/arwhatis.html

Appendix 1

Free fall

Name: **G 8**

Circle the best answer and explain your choice.

1- A body is released from a certain height. The forces acting on the body during its free fall are:

a- Friction

b- Tension

c- Weight

d- Reaction of support

Explain ---

2- What is the type of motion a body has during free fall?

a- Decelerating

b- Accelerating

c- Uniform

d- Accelerating then uniform

Explain: --

3- Is work performed during free fall?

a- Yes, because the body is displaced under the effect of gravity

b- Yes, because the body has a mass and weight

c- No, because the force is parallel to displacement

d- No, because the force is perpendicular to the displacement

Explain: --

4- During free fall, a body has

a- Kinetic energy only

b- Potential energy only

c- Potential and kinetic energy

d- No energy

Explain: --

5- A body is released from two different heights; will it reach the ground at the same speed?

a- Yes since the mass is the same in both cases

b- Yes since gravity is the same in both cases

c- No since the height has changed

d- No since the mass is the same in both cases.

Explain: --

6- Two bodies of mass 25g and 75g respectively are released from a height of 1m. Will they reach the ground at the same speed?

a- Yes since the height is the same

b- Yes since they are falling on the same surface.

c- No since heavier objects fall faster than lighter ones.

d- No since lighter objects fall faster than heavy ones.

Explain: --

7- The speed of a free falling body depends on

a- the mass of the body

b- the height from which the body is released

c- the weight of the body

d- all of the above

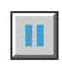
Explain: --

Appendix 2

Virtual Lab Activity
<u>Free Fall</u>

Name: -------------------------------
Class: --------------------------------

The purpose of this activity is the measure the speed of the ball at different heights from the ground using the virtual lab.
Read all the instructions below before working.

I- Click on **parts library** then **motion and forces** then **motion** and do the following steps:
   1. Drag **space** on the screen, click on it then enlarge its size to fill the screen.
   2. Click on **ground** then drag **ideal elastic ground** to the space already installed in 1 and put it at the bottom of that space.
   3. Click on **balls** then drag **ideal elastic ball** to the white space. If the ball starts to move, press the **pause button**  in the toolbar at the top of the screen.

II- Click on **presentation** in **parts library** then drag **number** to the scene. You will obtain the following: 

The number will serve to measure any physical quantity you'll choose from a previously defined list and related to the object you decide, in this case, the ball. You will need for this activity three **number boxes** that you will place at the extreme right side of the space and will set as follows:
   1. Mass
   2. Displacement y, which represents the height of the ball from the ground.
   3. Speed

<u>Note:</u> In order to set a number box to a specific quantity do the following:

- Click on  then drag it to link it to the ball.
- Click on 

- Choose from the list the required quantity.

III- Fix the mass of the ball to 1kg then press enter.
IV- Fix the speed <u>manually</u> to 0 ms^{-1} then press enter.

V- Click on the ball and put it by dragging on the highest position in the white space (*don't force the ball to move beyond the white space or the numbers will turn off automatically*). Note its height (displacement y) and write it down:
h= ____________ m

VI- Press the pause button again. The ball will fall, hit the ground and bounce back. This is the motion of the free fall. In order to measure the speed of the ball at different heights from the ground, do the following:

1. Press the pause button.
2. Drag the ball again to the highest position.
3. Set the speed to 0 and press enter.
4. In the menu toolbar, just at the right of the pause button, decrease the **time speed** to **×0.1**. This will help you to visualize the free fall in a slow motion, thereby noting the speed at various heights.

VII- You will have to do 5 measurements by making 5 successive pauses during the downwards motion of the ball before reaching the ground, where at every pause you will record the height of the ball and its corresponding speed.
Note: Take your measurements of the ball before it reaches the ground.

h (m)						
v (m/s)						

VIII-

1. Plot on the space provided on the annex sheet, the graph of variation of v in terms of h using the scales: 1cm → 0.1m and 1cm → 0.5m/s
2. Find from the graph the speed of the ball at the following heights: 0.2m, 0.4m, 0.6m, 0.8m and write them in the table of the annex sheet.

IX- Now, in order to know whether the speed of the ball varies with the mass of the ball, change the mass in the box to 10kg then repeat again steps IV till VIII by filling the table below:

h (m)						
v (m/s)						

X- What do you conclude concerning the speed of the ball in terms of its mass and of the height?

____

XI- In order to verify your results, do the following:

1- Go to scene 2 at the bottom of the screen.

2- Drag a space, a ground and 2 balls with 2 number boxes.

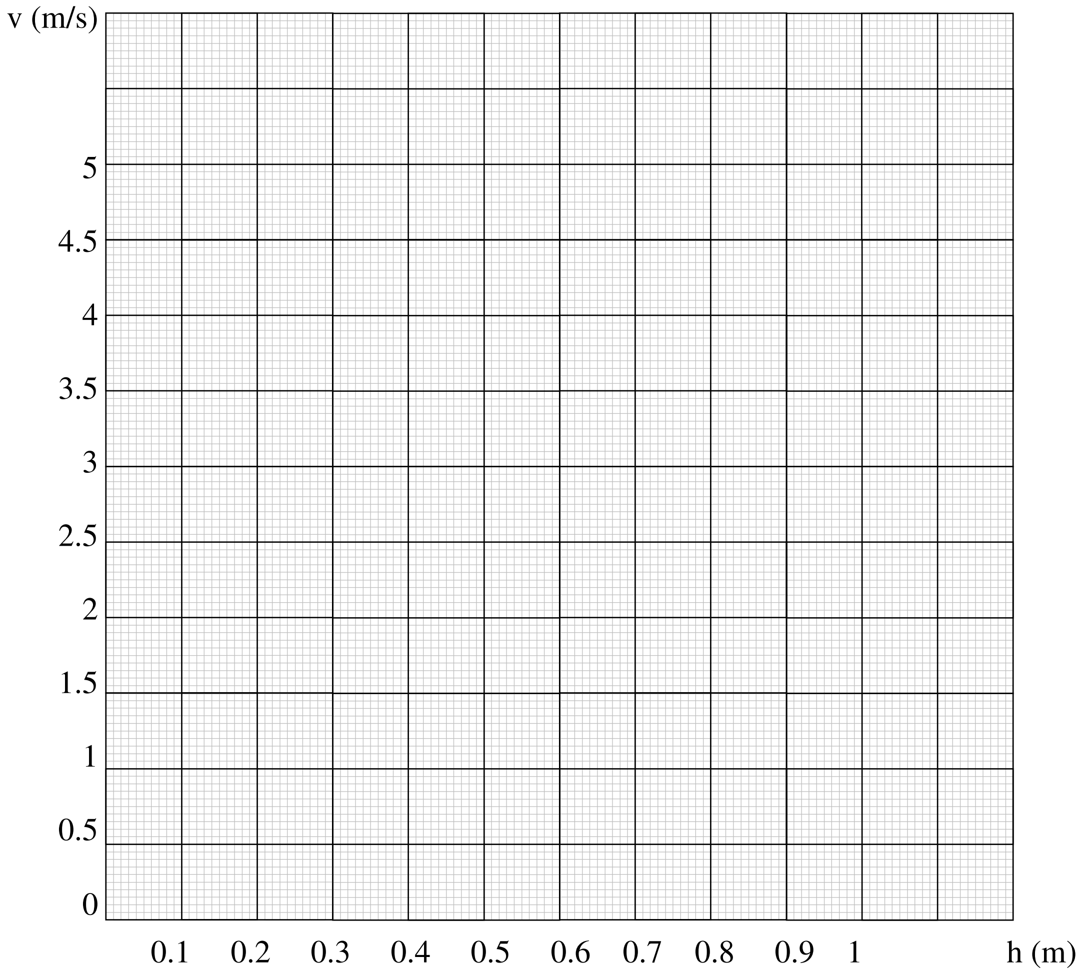
3- Set the mass of the first one to 1kg and the other to 10kg.

4- Put them on the highest position and release them by pressing the pause button and observe carefully their free fall, then answer the following questions:

Do they reach the ground at the same time?

Can you conclude that they reach the ground with the same speed? Why?

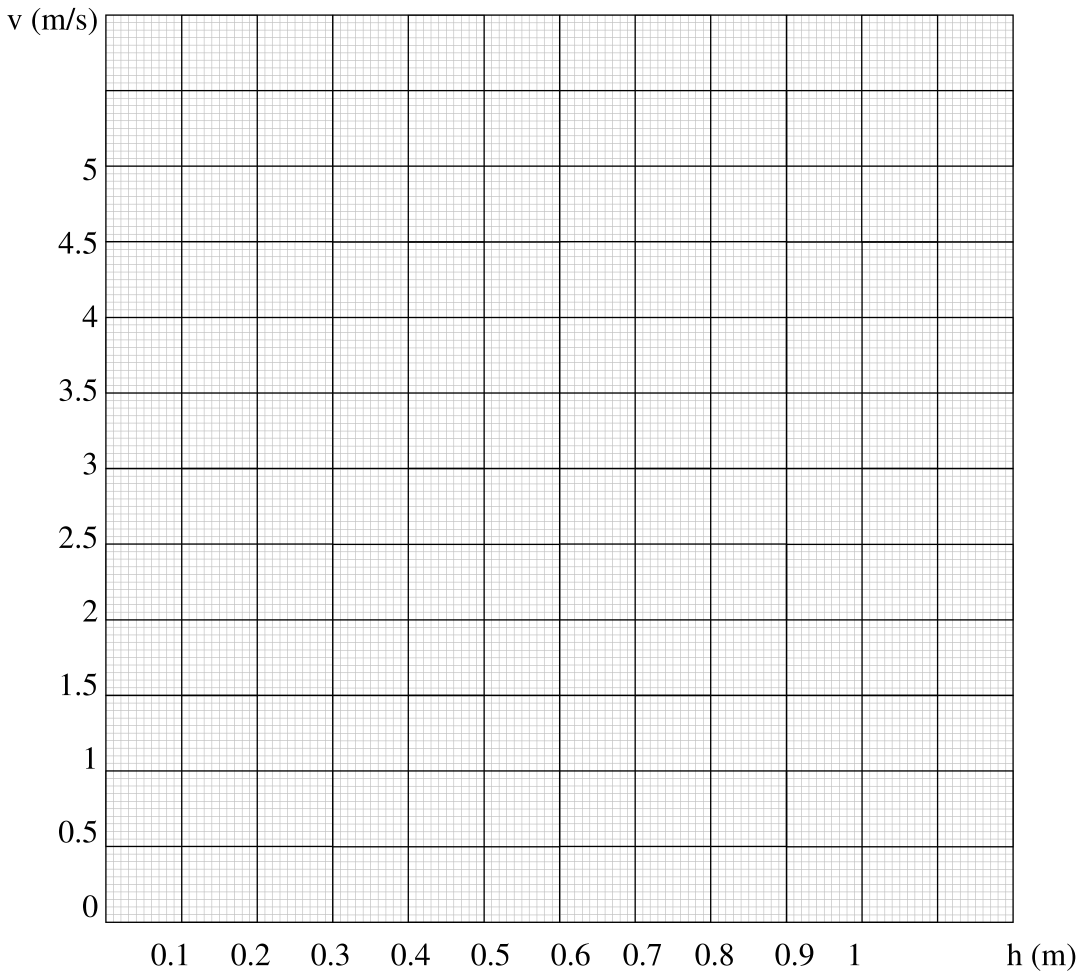
ANNEX SHEET



Graph of variation of v in terms of h
for a ball of mass 1kg

H(m)	0.2	0.4	0.6	0.8
V(m/s)				

Speed of the ball in terms of height for a mass of 1kg.



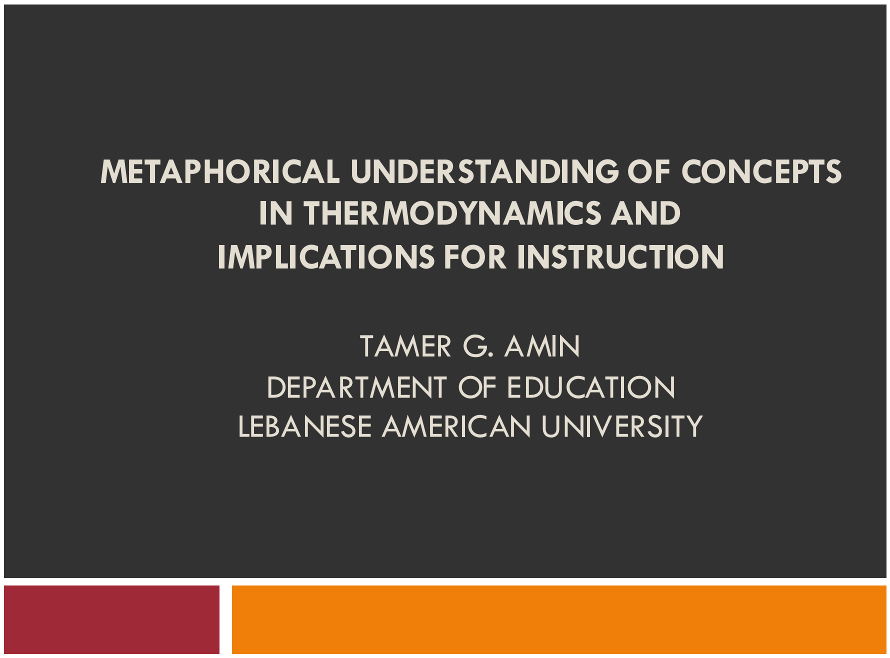
Graph of variation of v in terms of h
for a ball of mass 10kg

H(m)	0.2	0.4	0.6	0.8
V(m/s)				

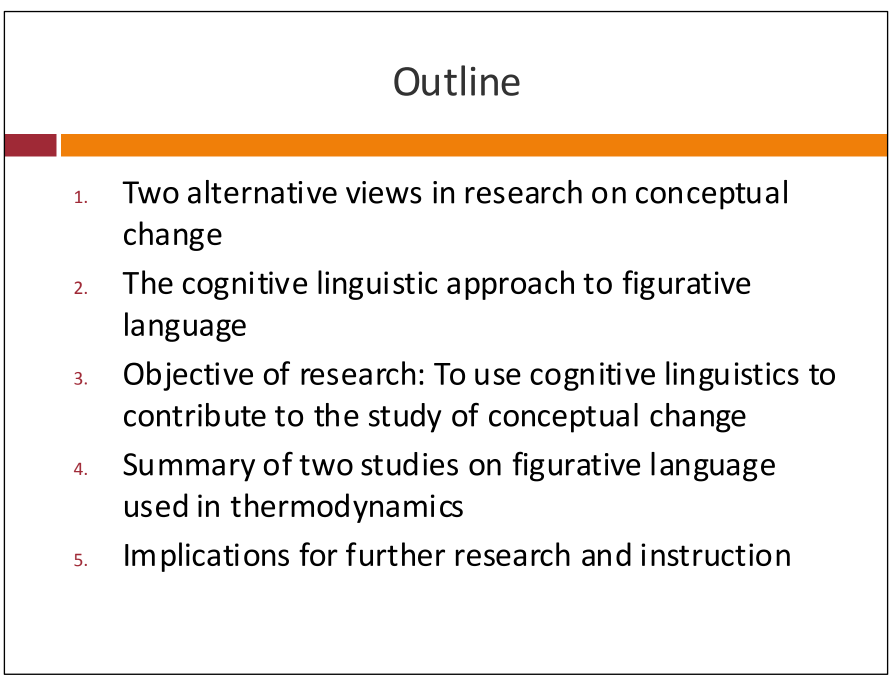
Speed of the ball in terms of height for a mass of 10kg.

Metaphorical Understanding of Concepts in Thermodynamics and Implications for Instruction
Tamer Amin

SLIDE 1



SLIDE 2



SLIDE 3

2. Two alternative views in research on conceptual change

a. General features of the conceptual change framework
b. Theory change/framework revision view
c. Naïve resource reorganization view (“knowledge-in-pieces”)

SLIDE 4

a. General features of the conceptual change framework

1. Identify pre-instruction conceptions
2. Contrast with scientific conception
3. Characterize the process of change
4. Draw implications for instruction and test them in instructional study

SLIDE 5

b. Theory change/framework revision view

Distinctive feature of this view is that pre-instruction concepts are characterized as having some coherence and broad application; concept change involves something like theory change.

(e.g. Carey, 1985; Chi, 1992, 2005; McCloskey, 1983; Vosniadou, 2002)

SLIDE 6

c. "Knowledge-in-pieces" view

- Distinctive feature is that pre-instruction conceptions not considered to be coherent and broadly applicable and conceptual change involves the reorganization of multiple experiential knowledge elements position.
- Importantly, even expert scientific knowledge is grounded in "experiential" or "intuitive" knowledge schemas

  (e.g. diSessa, 1983, 1993; diSessa & Sherin, 1998; diSessa & Wagner, 2005)

SLIDE 7

Contrasting the two views of conceptual change: Explaining the dynamics of a coin toss

- **Impetus theory** governs people's judgments about motion (McCloskey, 1983)

  "The act of setting an object in motion impresses in the object an internal force or impetus. This impetus is assumed to keep the object in motion after it no longer is in contact with the original mover. According to this view, moving objects eventually slow down and stop because their impetus gradually dissipates."

- **Multiple knowledge schemas** abstracted from experience (diSessa, 1993):
  - Force as a mover
  - Dying away
  - Dynamic balancing

SLIDE 8

2. The cognitive linguistic approach to figurative language

SLIDE 9

2. The cognitive linguistic approach to figurative language

Central claim: Systematic use of figurative language reflect "conceptual metaphors"

Many (if not all) abstract concepts are understood metaphorically in terms of experience-based knowledge gestalts with these metaphors reflected in systematic use of language – see e.g. Lakoff & Johnson, 1980; 1999)

SLIDE 10

2. The cognitive linguistic approach to figurative language (cont.)

Examples of conceptual metaphors from cognitive linguistics literature:

- Time Is A Resource

Stop wasting time.
Save time for some leisure.
Don't used up all the time you have.

- Force dynamic construals

Letting/removal of restraint:
Opening the tape *let* the water run.
Getting a babysitter let us have night off.
The animals were ***released*** into the wild.
With the onset of summer I felt ***released.***

- Object event structure metaphor

Attributes Are Possessions (e.g. I *have* a headache)
Changes Are Movements of Possessions (e.g. I *got* a headache; the headache *went away*)

- Location event structure metaphor

States Are Locations/Containers (e.g. I'm *in* love; he's *in* a depression)
Changes Are Movements (e.g. She *got out of* this mood she's been in; he *fell in* love.)
Causation Is Forced Movement (The victory *brought* the crowd to its feet.)

SLIDE 11

3. Objective of research:

To use cognitive linguistics to contribute to the study of conceptual change from a "knowledge-in-pieces" perspective – in particular, to identify intuitive knowledge that can be the basis for understanding abstract concepts in thermodynamics (e.g. energy, entropy)

SLIDE 12

4. Summary of two studies on figurative language used in thermodynamics

a. Study 1: Metaphorical construal of energy in *The Feynman Lectures on Physics*
b. Study 2: Metaphorical construal of entropy and second law of thermodynamics

SLIDE 13

a. Study 1
(see Amin, 2009)

Objective: What conceptual metaphors underlie figurative use of the noun *energy* in scientific usage?

Method:

Source: *The Feynman Lectures on Physics* Vols. 1 & 2

Database: All sentences containing the noun *energy* found in sections of the text containing energy in the title (479 from vol.1 & 390 vol. 2; Total = 869)

Identification of conceptual metaphors: Sentences were placed in construal categories through an iterative process of categorization and until no new categories or sub-categories were identified. The proposed categories were based on language-based construals identified in the cognitive linguistics literature.

SLIDE 14

a. Study 1 - Results (cont.)

Scientific construals of energy - i. transport

Object Event Structure Metaphor

Energetic State Is A Possession

… gravitational potential energy – the ENERGY which an object *has* because of its relationship in space, relative to the earth (I-4-4)

Change in Energetic State Is Movement of Possession

It either *gains* or *loses* ENERGY, depending upon whether the piston is moving one way or another when the atom strikes (I-39-7)

Caused Change In Energetic State Is Transfer of Possession

How much ENERGY will they have *given to* the material when they have stopped? (I-16-9)

Elaboration in terms of containment

… the potential ENERGY *in* an electric field … (I-14-9)

…when we *put* ENERGY *into* the gas its molecules move faster … (I-16-8)

SLIDE 15

a. Study 1 - Results (cont.)

Scientific construals of energy – ii. transformation

<u>Location Event Structure Metaphor</u>

Forms of Energy Are Locations/Containers

This much energy is *<u>left</u>* in the material *<u>in</u>* some form, as heat, potential **ENERGY**, or whatever. (I-16-5)

Changes in Form of Energy Is Movement Into (Out Of) Containers

...the elastic energy ... is converted to kinetic energy and it *<u>goes back and forth between</u>* compressing and stretching the spring and the kinetic **ENERGY** of motion (I-4-6)

SLIDE 16

a. Study 1 - Results (cont.)

Scientific construals of energy – iii. Conservation/ quantification

Energy State As Amount of Substance

... the *<u>amount of</u>* energy added to the gas ... (I-45-2)

Energy As Material Resource

...and energy is *<u>stored</u>* in the elastic bodies... (I-10-4)

...the energy *<u>needed to</u>* add one more proton... (II-8-4)

Energy As Part/Whole Schema

... so we *<u>put the two together</u>* and say that the *<u>total</u>* kinetic energy inside an object is <u>partly</u> heat, *<u>partly</u>* chemical energy and so (I-14-6)

SLIDE 17

a. Study 1 - Results (cont.)

Scientific construals of energy - iii. Conservation (cont.)

<u>Location Event Structure Metaphor</u>

Energy States Are Locations/Containers (On a Vertical Scale)

When the two oxygen atoms have settled down ... they *are* *<u>in the lowest</u>* energy state ... (I-14-5).

Energy State Changes Are Vertical Movements

Therefore the frequency of the light which is liberated in a *<u>transition from</u>* energy E3 *<u>to</u>* energy E1 (for example) is ...(I-38-7)

Causing Energy State Change Is Force Movement

... a machine for *<u>accelerating</u>* electrons *<u>to high</u>* energies – is based on this idea (II-17-4)

<u>More Energy Is Up; Less Energy is Down (Energy As Object)</u>

When we try to push the atoms very close together the energy *<u>goes up</u>* very rapidly, because they repel each other. (I-14-7)

SLIDE 18

b. Study 2
(see Amin, Jeppsson, Haglund & Strömdahl, under review)

Collaborators:

Fredrik Jeppsson, Jesper Haglund & Helge Strömdahl,

National Graduate School in Science and Technology Education, Linköping University, Sweden

Objective:

What conceptual metaphors (and metonymies) are used to conceptualize the concept of entropy and the second law of thermodynamics?

SLIDE 19

b. Study 2 (cont.)

Method:

Sources: The figurative language compiled from a range of textbooks and a popular science text:

- Introductory college physics (Young, Freedman & Sears, 2003),
- Introductory college chemistry (Zumdahl, 1998),
- Statistical mechanics (Bowley & Sánchez, 1999)
- A popular science treatment of the topic (Atkins, 2003)

Identification of conceptual metaphors: Iterative process of categorization inspired by findings from cognitive linguistic literature. Only those construals found in all four texts are reported.

SLIDE 20

b. Study 2 - Results

Macro level conceptual metaphors:

<u>Changes In A System is Object Movement Along A Path</u>

When system proceeds *from* initial state with entropy S1 *to* final state s2, the change in entropy…(Young, 774)

<u>Spontaneous Change Is Movement in A Particular Direction</u>

The natural direction of change is towards ever greater disorder. (Atkins, p. 124)

<u>Caused Change to the System Is Forced Movement</u>

The world *is driven forward* by this universal tendency to collapse into disorder. (Atkins, p. 130)

SLIDE 21

b. Study 2 – Results (cont.)

Macro level conceptual metaphors (cont.):

Spontaneous Changes in A System Is Sentient Goal-directed/Agentive Movement

The second law of thermodynamics… determines the *preferred* direction for such processes. (Young, p 755)

A Scientific Law/Principle/Equation Is A Social Law

There is no *prohibition* of the system or the surroundings individually undergoing a decrease in entropy provided that there is a compensating change elsewhere. (Atkins, p. 63)

Increasing Entropy Is A Preferred Path

…the signpost of spontaneous change points in the direction of increasing entropy. (Atkins, p. 123)

SLIDE 22

b. Study 2 – Results (cont.)

Other conceptual metaphors were identified for construing entropy and the second law when thermodynamic systems were conceptualized at the micro level as well as the link between levels.

SLIDE 23

4-Discussion (cont.)

- Implications for instruction:

i. Misconceptions can be anticipated and targeted during instruction. Overly literal interpretations of metaphors are likely.

ii. Explicit discussion of specific metaphorical expressions (and metaphorical language generally) can help avoid misconceptions.

iii. Instructional visual analogies can be designed based on metaphors identified in scientific usage.

SLIDE 24

4-Discussion (cont.)

- Implications for research

i. Confirmation of the role of conceptual metaphor in student and expert reasoning and problem-solving needed, but conceptual metaphor analysis can be seen as a useful starting point in protocol analysis. Debate regarding coherence or fragmentation of naïve understanding can be addressed.

ii. How conceptual metaphors implicit in scientific language are appropriated by students needs to be studied in tutoring studies and classroom-based research. Conceptual metaphor perspective provides a bridge between conceptual change and discourse perspectives.

SLIDE 25

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Do We Need Agricultural Literacy for Elementary Science Teachers? Why and How?

Mohammed Hendy

Abstract

The main purpose of this study was to determine the effect of teaching an agricultural and science integrated unit on Abu Dhabi University pre-service female teachers' agricultural literacy and attitudes towards integration. Two statistical hypotheses were set to guide this study concerning agricultural literacy and attitudes. The study adopted the one group pre - post test research design to examine these hypotheses. The research sample of this study was all of Abu Dhabi University's female pre-service elementary teachers (n= 33). The study results revealed that the proposed integrated unit had an impact on pre-service agricultural literacy and attitudes towards integration. According to these results, the study recommended conducting further studies to measure the changes in pre-service teachers' attitudes, to predict their behaviors towards integration, to identify barriers to integrating agricultural activities into the elementary curriculum, and to determine how in-service teachers use agriculture in teaching their school subjects.

Introduction

Curriculum reform has been attempted as a means of dealing with the problems faced by schools in several countries. Different approaches to curriculum development have been tried, including the integration among school subjects which can strengthen the links among the learning environments of school, home, and community. The long history of research on the ways by which students learn provides a strong rationale for the value of integrated instruction. In the 17^{th} and 18^{th} centuries, predecessors of modern Psychology speculated that meaningful learning involves the formulation of connections between concepts. More recent research in cognitive science strongly supports this view. The work of Ausubel (1968), Neisser (1976), and others in the 1960's and 1970's led to our current notion of schematic structures in the brain.

The current movement towards the integrated curriculum has its basis in learning theorists who advocated a constructivist view of learning. The work of Piaget, Dewey, Bruner, and other psychologists supported the holistic view of learning. Proponents of the progressive education movement of the 1930s advocated the integrated curriculum, sometimes identified as the "core curriculum" (Vars, 1987). The twenty-first century requirement for a flexible use of knowledge goes beyond a superficial understanding of multiple isolated events to insights developed by learning that is connected-or integrated (Office of Educational Research and Improvement [OERI], 1994). Integration adds meaning and relevancy to learning as students discover fascinating and compelling relationships between disciplines (Mathison & Mason, 1989).

Regarding integrating agricultural activities into the elementary school science curriculum, young children have a natural curiosity about plants, animals and environment and are excited when they have the opportunity to study them (Cronin-Jones, 2000). Several previous studies revealed the effectiveness of integration between science and agriculture. In 2004, Knobloch and Van conducted a study on the integration of an agroecology unit in elementary classrooms and found that agricultural and environmental literacy instruction created third and fifth graders' interest motivation and increased the fifth graders' comprehension and application of knowledge. Hendy (2002) explored that involving elementary pupils with special needs in an integrated unit between science and agriculture improved their achievement and ability to classify pictures and real samples of agricultural plants. Roegge and Russell (1990) explored that student performance increased when students were taught courses that integrate science and agriculture.

Acquainting teachers with how to integrate agricultural concepts and activities into the elementary school science can enhance their role and motivate them. Educational literature and research explained that elementary teachers who had more agricultural knowledge and more accurate perceptions of agriculture could teach effectively about agriculture and environment (Humphrey, Stewart & Linhardt, 1994). Knobloch and Ball (2003) as well as Knobloch and Martin (2002) found that elementary teachers' positive attitudes toward agriculture motivated them to integrate agriculture into their classroom instruction.

Regarding pre-service elementary teachers, Moss (1989) explained that tomorrow's teachers who will conduct some agricultural activities should be better prepared in instructional areas of agriculture and related sciences. Trexler and Suvedi (1998) found that teacher perceptions of agriculture and confidence toward integrating agriculture in science improved after a curriculum intervention program on science and agriculture.

Finally, and general speaking, there is a relationship between elementary teachers' thinking about integration of the curriculum and the amount of integration in their classrooms (Schmidt, 1983). Therefore, training programs are required to enable them to base strategies for teaching and learning on a process of integration (Taylor& Mullhal, 1997).

Purpose and Objectives/Hypotheses

The main purpose of this study was to determine the effect of teaching an agricultural and science integrated unit on Abu Dhabi University pre-service female teachers' agricultural literacy and attitudes towards integration. Taking the details of this purpose in account, two study hypotheses were formed as follow:

1- There is a statistically significant difference between the mean scores of pre-test and post-test regarding knowledge achievement test.
2- There is a statistically significant difference between the mean scores of pre-test and post-test regarding attitude scale.

Methodology and Procedures

The target population of this study was all female students who enrolled in the Department of Teacher Education, Abu Dhabi University. The research sample consisted of all female students enrolled for summer 2007 (N=33), they considered to be a random sample for this study.

Two research instruments were developed based on reviewing previous literature. The knowledge achievement test consisted of fifty multiple-choice questions regarding achieving some agricultural ideas and concept, the total mark of the test was 50 multiple choice items. Another research instrument was the attitude scale in which respondents were asked to respond to 45 statements regarding integration among subjects generally (15 items), integrating agriculture into the elementary school science (15 items), and the role of teacher preparation program towards integration (15 items). Their responses were measured using a five point Likert-type scale where 5=strongly agree, 4=agree, 3=undecided, 2=disagree, and 1=strongly disagree. Content and face validity of the instruments were determined by a panel of experts in education. The estimates of reliability, using Cronbach's alpha, were 0.81 for the knowledge achievement test, 0.77 for attitude scale.

Moreover, treatment instructional materials were developed within five modules concerned with integrating general elementary science topics with agricultural concepts and activities. Each module had a specific title, objectives, media and instructional resources, procedures, and assessment. The instruction of each module consisted of information related to the general concepts of the integrated topic (module topic). An outline for the proposed program was given to a panel of experts in education to determine the validity of the program. Some changes were done according to the panel's opinions.

The one group pre - post test research design was used to conduct the study experiment. After determining validity and reliability of research instruments, they were administered as a pre test to the research sample, and then the intervention and treatment were conducted for three weeks (15 hours through 10 workshops,). After studying the program, the research instruments were administered again as post test. Data were entered and analyzed using computerized data analysis software to examine the research hypotheses.

Results

Hypothesis 1: There is a statistically significant difference between the mean scores of pre-test and post- test regarding knowledge achievement test.

The hypothesis was tested at .05 alpha level, the mean scores of pre-test was compared to the mean scores of post-test (Table 1). It is shown that post-test mean scores of 32. 39 higher than pre-test mean scores of 17.33 regarding the knowledge achievement test. Moreover, table 1 shows that the T value is 13.099 which revealed that there was a significant difference between the two means in favor of the post-test. This means that pre-service teachers got more knowledge related to agriculture as a result of studying the proposed program. So hypothesis one was correct and acceptable.

Table: 1- Mean, Standard deviation, and T test value regarding research sample responses on knowledge achievement test

Test	Pre Test		Post Test		T
	M	SD	M	SD	
Knowledge Achievement test	17.33	5.17	32.39	6.53	13.099

Hypothesis 2: There is a statistically significant difference between the mean scores of pre-test and post- test regarding attitude scale.

The hypothesis was tested at .05 alpha level, the mean scores of pre test was compared to the mean scores of post test (Table 1). It is shown that post test mean scores of 136.55 higher than pre test mean scores of 97.09 regarding the total attitude scale. Moreover, table 2 shows that the T value is 21.83 which revealed that there was a significant difference between the two means concerning the attitude scale totally. It is also shown that there were significant differences between the pre-test mean scores and the post-test mean scores in favor of the post-test with respect to the first and second dimensions but the difference was not significant regarding the third dimension of the attitude scale. This means that pre-service teachers' attitudes were totally developed as a result of studying the proposed program. So, hypothesis two was correct and acceptable.

Table: 2- Means, Standard deviation, and T test values regarding research sample responses on the attitude scale (n=19)

Attitude scale dimensions	Pre Test		Post Test		T
	M	SD	M	SD	
A- Attitudes towards integration among school subjects	31.82	3.23	50.21	6.70	17.96
B**- Attitudes towards integrating some agricultural and environmental issues into the elementary school curricula**	37.76	3.52	57.82	6.71	19.46
C- Attitudes towards the role of teacher preparation program towards integrating	27.91	2.75	28.24	2.87	1.20
Total	97.09	7.85	136.55	13.39	21.83

Note: strongly agree= 5, agree= 4, undecided= 3, disagree= 2, strongly disagree= 1

Conclusions

Based on the findings of this study the following conclusions were made:

1- Pre-service teachers' agriculture knowledge was improved as a result of studying the proposed program. So, organized materials on integration and using varied teaching strategies/activities and active discussions through conducting the integrated modules may be represented the factor behind raising the pre-service teachers' knowledge about agriculture. These results support the writings of Moor (1989) regarding the effect of the Michigan State University training program on integration to elementary teachers. It also supports the results of other studies like Frick (1991) who concluded that individuals possessing such knowledge would be able to synthesize, analyze, and communicate basic information about agriculture. Herren and Oakley (1995) concluded that elementary teachers who were trained on how to integrate "Agriculture in the Classroom" resources reported higher student achievement of agricultural concepts. It also enhanced the recommendations of Moss (1989) and Humphrey, Stewart, and Linhardt (1994) with respect to elementary teacher preparation programs in which they argued that pre-service opportunities should be provided to prepare future teachers with necessary skills to use agriculture as a vehicle to plan and teach core subjects.

2- Pre-service elementary teachers in this study generally had positive attitudes towards integration, i.e. integrating agricultural and environmental activities into the elementary science curriculum. So, involving pre-service female teachers in the activities of the proposed unit which included integrated topics between science and agriculture may help them accept the positive attitudes towards integration. This result has come to be consistent with the results of other studies like Edgerton (1990) who explored that after one year of involving teachers in an integrated study, they preferred to continue with the integrated programs. This also concurs with Greene (1991) who found that improvements happened in elementary teacher attitudes after participation in an integrated program and Maciver (1990) who found that teachers felt they were able to teach more effectively when they integrated across subjects and courses. Furthermore, Trexler and Suvedi (1998) found improvement in teacher perceptions and confidence towards integrating agriculture in science after a curriculum intervention program on science and agriculture.

3- By providing knowledge of integration to the pre-service teachers, it is expected that they will help and motivate their pupils to achieve integrated concepts and ideas. This conclusion is outlined according to what was mentioned by Edgerton (1990), Greene (1991), and Humphrey, Stewart, & Linhardt (1994). Herren and Oakley (1995) concluded that elementary teachers who were trained on how to integrate "Agriculture in the Classroom" resources reported higher student achievement of agricultural concepts.

Recommendations

1- A follow up study should be conducted to measure the changes in attitudes and behaviors of pre-service teachers.
2- Research should be continued in the development of an instrument that would predict elementary pre-service teachers' behaviors towards integrating agricultural and environmental activities into their instruction based on their perceptions.

3- Future research studies should be conducted to identify barriers to integrating agricultural and environmental activities into the elementary curriculum and to describe student achievement associated with the integration of agriculture in the elementary curriculum.
4- Research should be conducted regarding teachers who have taken part in institutes to determine how they are using agricultural and environmental activities in teaching their school subjects.

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Mathematics

Conceptual and Integrated Math Instruction

Rola Hallak & Israa Fawaz

Introduction

The interactive activities that took place throughout this session focused on how authentic learning could be applied to reach deeper understanding by relating to students' real lives. The session started off with a challenging activity. The session then proceeded as follows: a diamond activity that dealt with the effective features of a Math class, a deductive exploration of the concept of fractions and a discussion of a variety of strategies that could be used. After concluding with mental calculations and new strategies to be taught, participants played some challenging games focusing on the concept of measurement. This occurred after asking a set of questions that reflected their prior knowledge about the concept. After each activity, participants were informed whether they were playing the role of the teacher or that of the student whereby in certain instances, they were put in their students' shoes. From time to time, attendees were asked to reflect on the activities by writing in their journals.

The workshop's central idea was Math being a subject that could be transdisciplinary and conceptual. As presenters, we planned to engage our attendees in a variety of learning engagements that either carried out a conceptual focus related to real-life or needed language skills for the sake of attaining deeper understanding of Math concepts. It was an active workshop for it included advanced strategies that could be implemented in any Math class and aimed at enhancing higher-order thinking skills. Individual reflections and group discussions took an important role in gaining new perspectives about Math instruction.

Description of the Session

The session was planned as follows (see slide show below):

(a) Presenter provided a brief introduction of what conceptual Math is. (5 mins)

(b) Participants warmed up their mental thinking with challenging computational mental operations. (5 mins)

(c) Participants showed different perspectives regarding the features of an effective Math class and presented their work through a one-minute speech. This activity was followed by a brief discussion, including mention of how students could make their thinking visible through language communication skills. (15 mins)

(d) Participants took on the roles of learners by going through a deductive exploration of the concept of fractions. Paper strips were used to recognize, identify, and apply equivalent fractions. Then, they the participants shared their experiences concerning the usage of fractions in daily life situation. Using fractions tags, participants moved to meet those that had their tags' equivalent fractions. (15 mins)

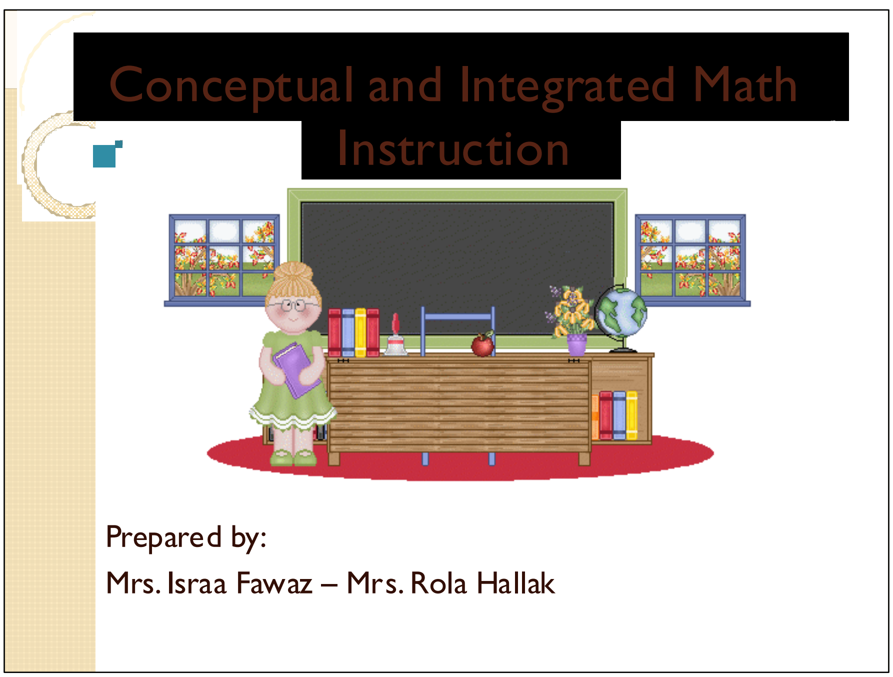
(e) Participants had a break to practice some mental calculations. (5 mins)

(f)Taking the role of the teacher, participants used a Math journal to reflect on their Math conceptual instruction. (5 mins)

(g) Participants were asked to set math questions inquiring into the concept of measurement. The participants' questions were focused on a set of concepts such as: form, function, causation, connection, responsibility, change…etc. This part ended with a submission of a Math portfolio activity entitled "My Personal Measurement". (15 mins)

(h) Finally, participants reflected on the journal regarding how what was learnt in this workshop could be used for other Math concepts. (5-10 mins)

SLIDE 1



SLIDE 2

The objectives of the workshop

- What conceptual Math instruction is
- How to plan for concept-based instruction
- How to integrate Math with language to attain better understanding
- Acquire strategies that enhance higher order mental Math skills

SLIDE 3

What conceptual understanding is

Instruction based on conceptual generalizations is an effective way for students to genuinely understand topics, but more importantly, it is an effective way to teach students to think in life and for life.

SLIDE 4

Multiply The same 2-Digit Numbers that end by 5

- Example 1: 35 ✖ 35 = 1,225

  3 × (3 + 1)

- Example 2: 65 ✖ 65 = 4,225

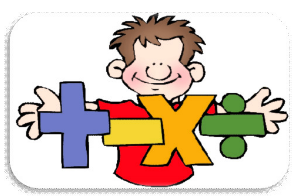
  6 × (6 + 1)

SLIDE 5

Multiply The same 2-Digit Numbers that end by 5

Use the same method to calculate the following products quickly:

- 15 × 15 = ________________
- 25 × 25 = ________________
- 45 × 45 = ________________
- 55 × 55 = ________________

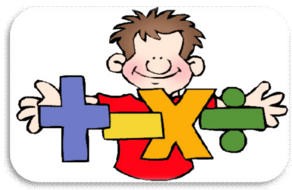


SLIDE 6

Multiply The same 2-Digit Numbers that end by 5

Use the same method to calculate the following products quickly:

- 15 × 15 = **225**
- 25 × 25 = **625**
- 45 × 45 = **2,025**
- 55 × 55 = **3,025**



SLIDE 7

Diamond Activity

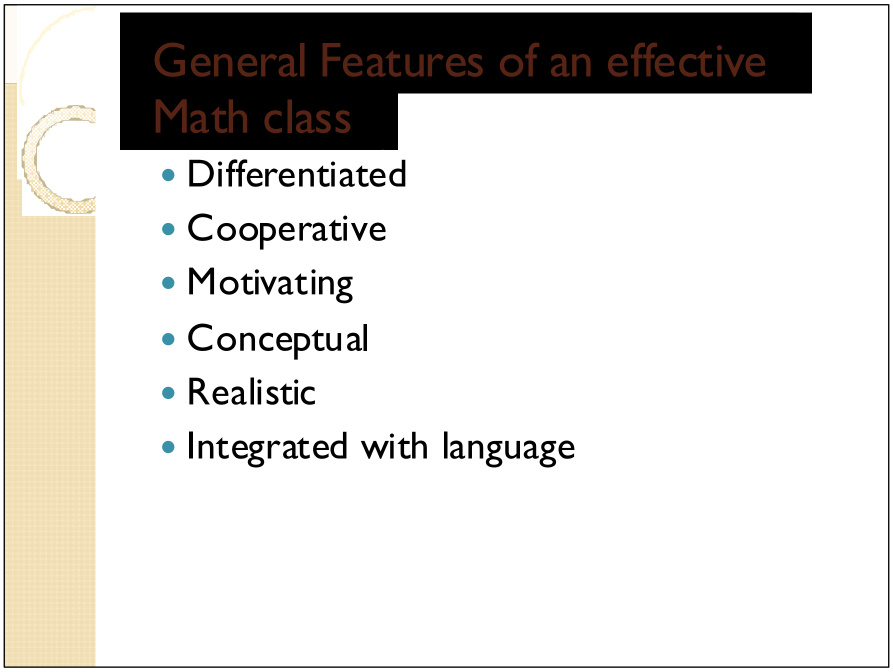
Group Work:

Read the features of an effective Math class, discuss them within your group, use the diamond grid to sort the features from the most important at the top to the least important at the bottom.

Concept Focus: Perspective

Timing: 7- 10 min

SLIDE 8



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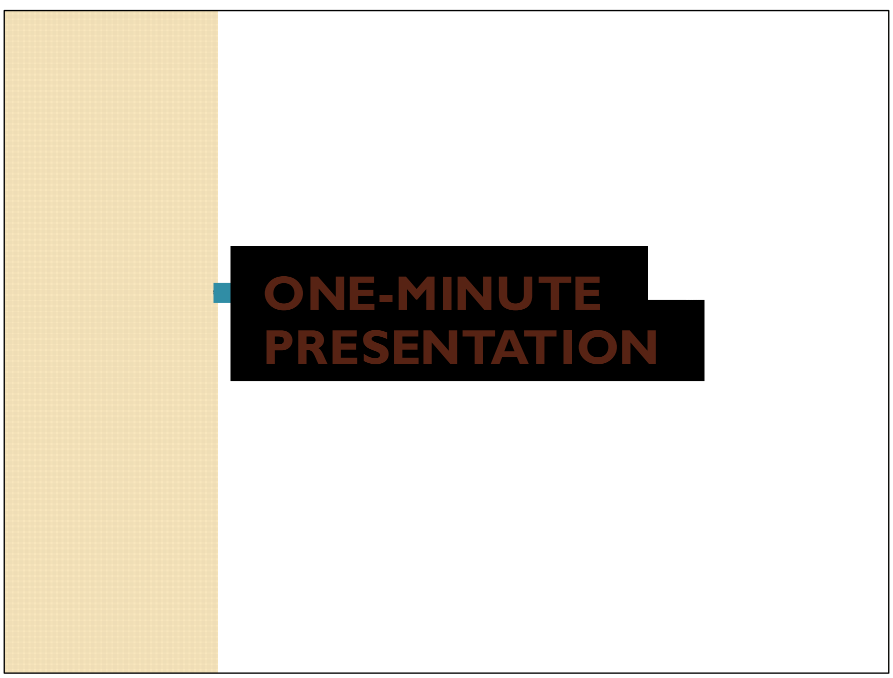
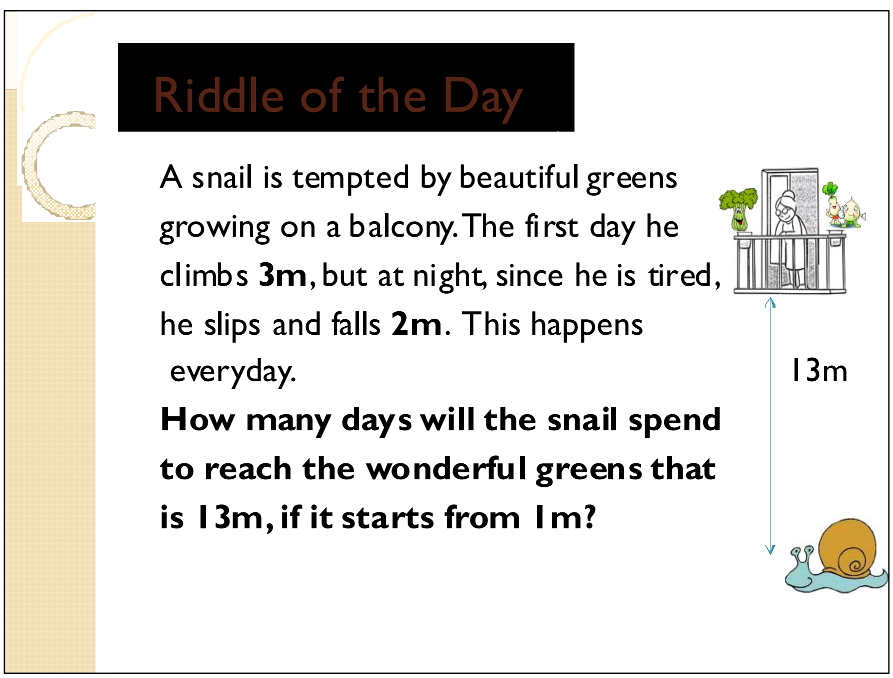


SLIDE 10

SLIDE 11



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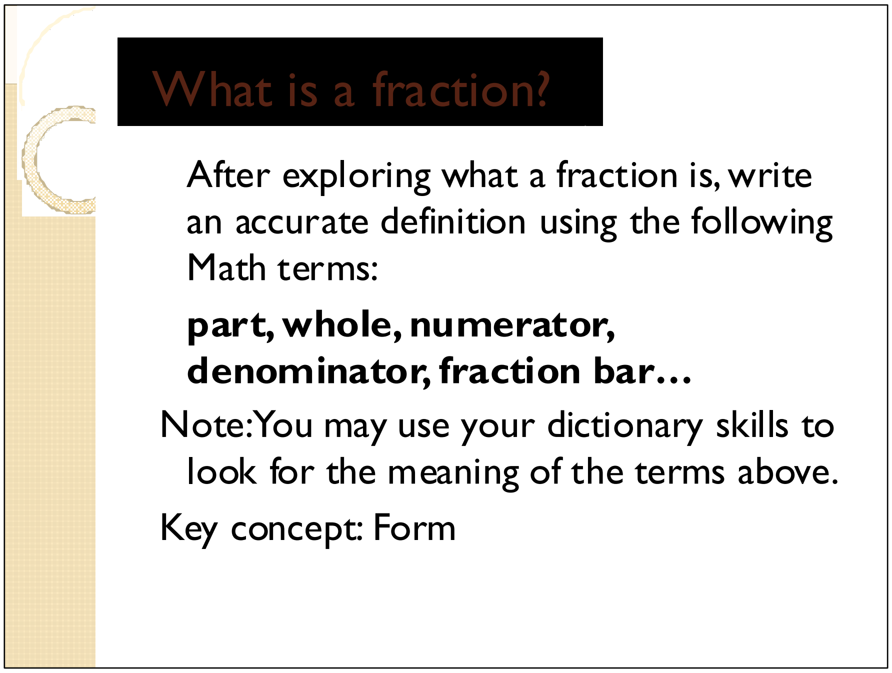

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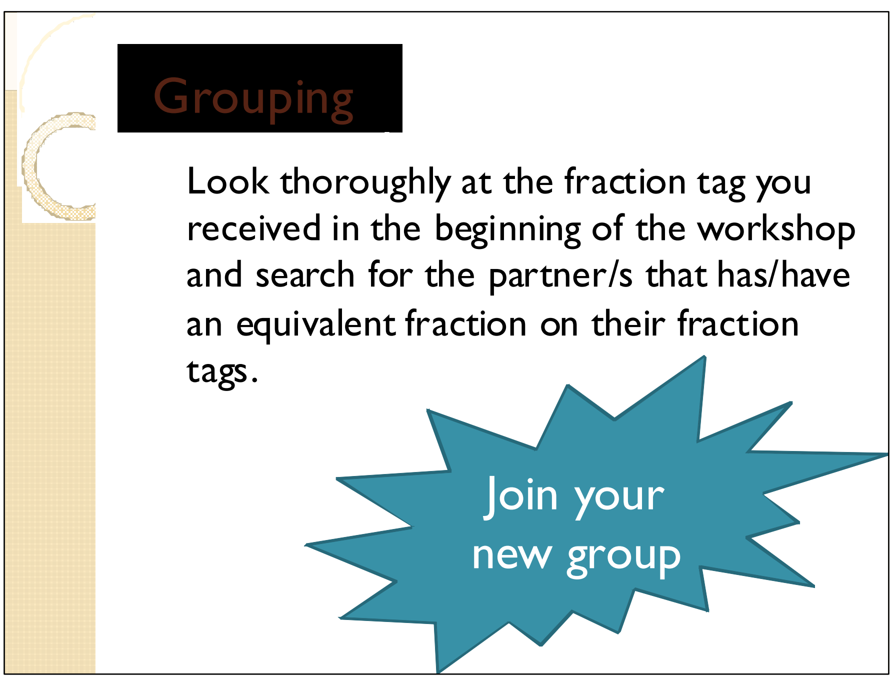


SLIDE 14

Learning Fractions in Life and for Life

In the journal, reflect recalling a learning experience or engagement your students passed through. Explain how you implemented a real-life concept and planned to engage them in real-life situation. To what extent were you preparing them to use it in their daily or future lives?

Then, group discussion will be held.

SLIDE 15

How to plan for a concept-based instruction

While planning, it's important to ask yourselves the following questions:

- What is the concept connected with our Math lesson?
- What are the difficult points of teaching the concept?
- What are the important points of teaching the concept?
- What are the errors and confusions that students tend to have while acquiring this Math competence?

SLIDE 16

Eight Hopscotch

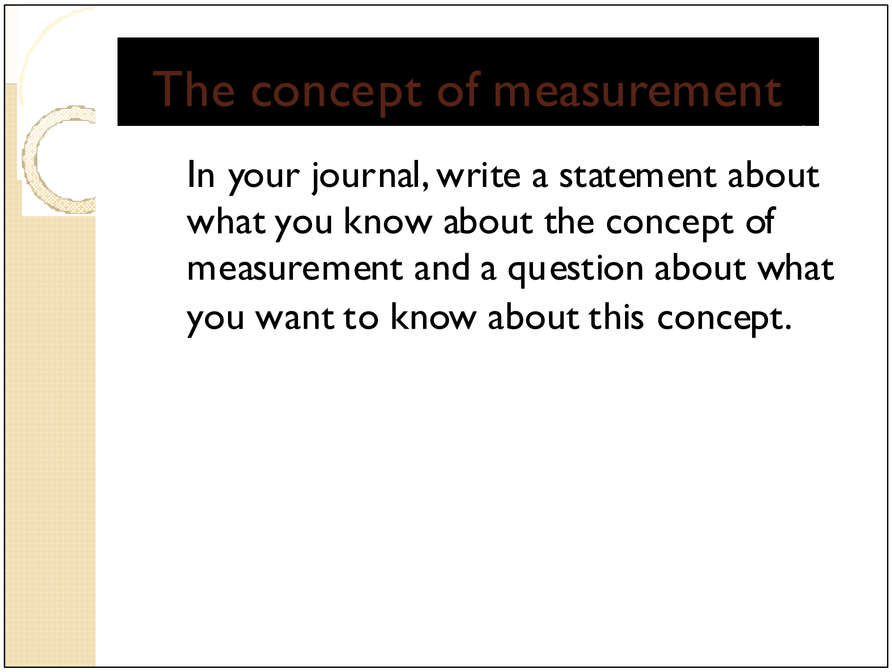
- Use a marker and solve the problems below to play a game of ***Eight Hopscotch***. Here are the rules.
  - If the answer to the problem is an **odd** number, move forward **2** spaces.
  - If the answer to the problem is an **even** number, move back **one** space.

SLIDE 17

Calculate

1. Hind adds 20 + 20 and divides by 8.____________
2. Haniya subtracts 28 from 100 and divides by 8. ________________
3. Hiba adds 5 + 8 + 3 and then divides the sum by 8. ________________
4. Hala multiplies 6 x 4 and then divides the product by 8. ______________
5. Nisrine adds 12 + 12 + 12 + 12. She divides the sum by 8. _____________
6. Narmine subtracts 36 from 100. She divides the difference by 8. ______
7. Salwa adds 25 + 31. She divides the sum by 8._____________
8. Racha multiplies 4 x 2. She then divides the product by 8.____________
9. Rola adds 36 + 36. Then she divides the sum by 8. ________________
10. **Did you get to the finish line?** _____________________

SLIDE 18



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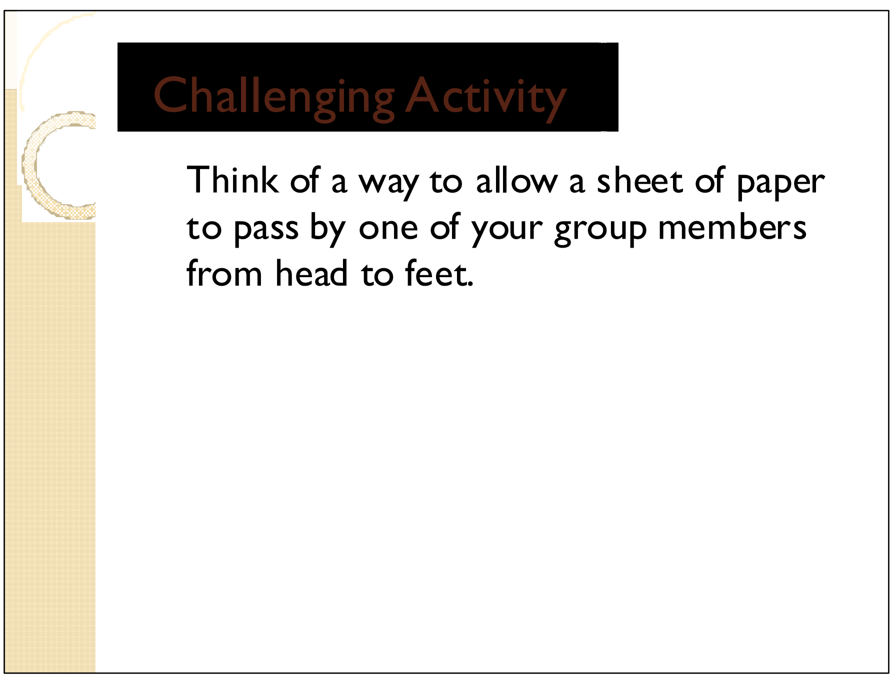
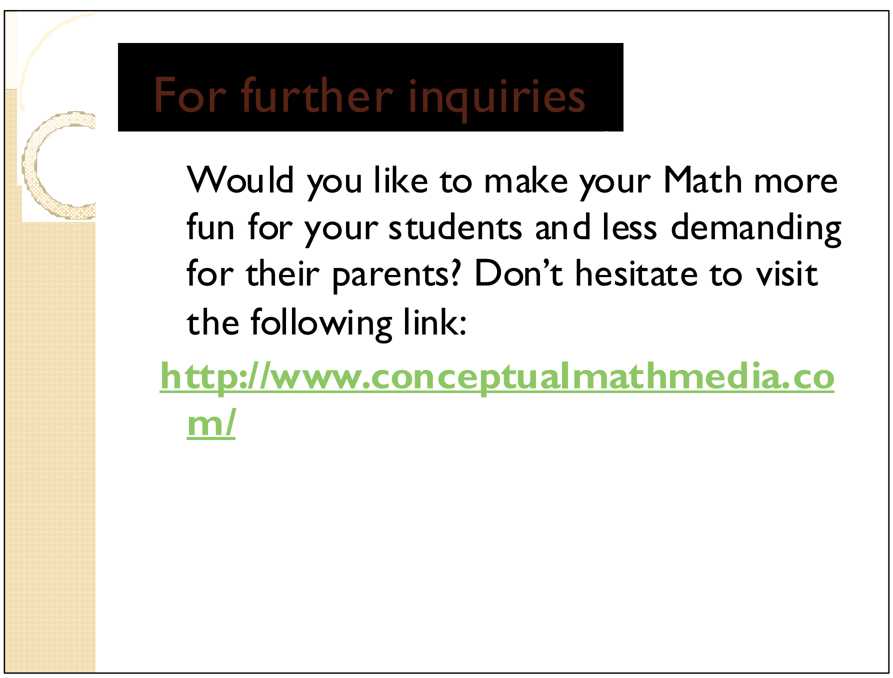


SLIDE 20

SLIDE 21



SLIDE 22

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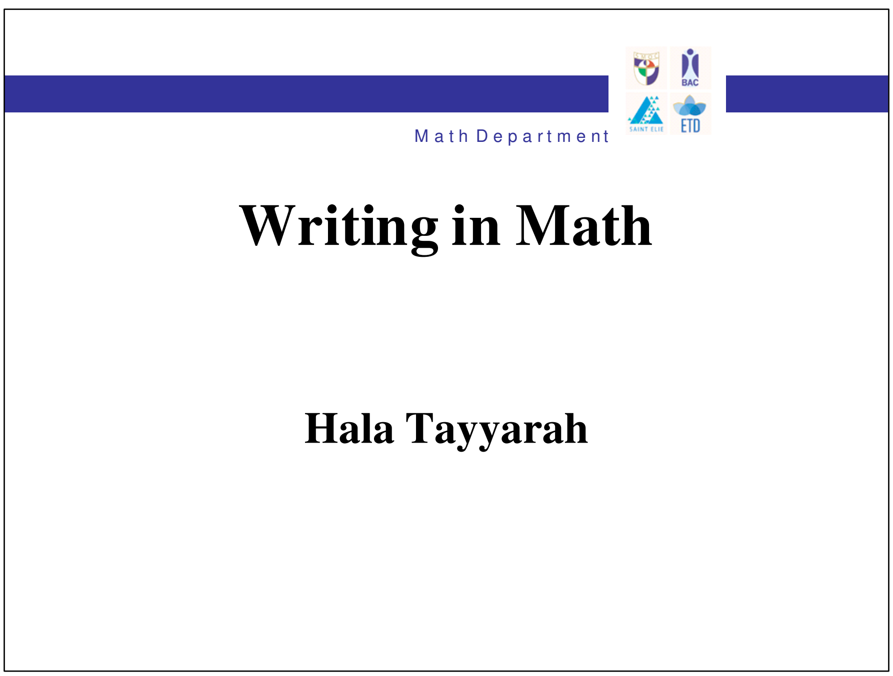
Internet resources

Writing in Mathematics: A Hidden Element of Learning
Hala Tayyarah

Solving word problems in Mathematics has continuously caused difficulties for learners throughout all the levels. This is mainly due to the students' inability to express their mathematical thoughts in writing. The purpose of this session was to emphasize the importance of writing in Mathematics and to exchange ideas where writing can be used in Mathematics classrooms. This workshop aimed to raise the participants' awareness for the necessity of integrating writing in almost all math topics by involving them in sharing previous incidents used in writing and by sharing recent findings in this domain. In the first part of the session, participants –who often or rarely use writing while teaching math- were asked to share with the group some of their experience in that domain. Next, the presenter shared with the audience some of the recent research, such as the latest NCTM findings on writing in math class, in order to emphasize its importance in teaching and learning math. Participants were then asked to sit in groups of three to four members in order to come up with two different examples of when and how to use writing in their math classes. At the end of the session, teachers were given a sample on previous writing examples and strategies used in different math classes.

SLIDE 1



SLIDE 2

Grade 8- Math

Unit Three

1) Expanding and factorizing algebraic expressions using remarkable identities.

2) Simplifying rational fractions.

SLIDE 3

A question taken from the unit test

Given [redacted] and [redacted]

a) Expand and reduce both expressions.

b) Factorize both algebraic expressions.

c) [redacted]

1. For what values of x is F(x) defined?
2. Simplify F(x).

SLIDE 4

Questions asked after finishing the unit

1) Explain in your own words what an algebraic expressions is. Provide real life examples.

2) Explain the difference between expanding and factorizing.

SLIDE 5

Results of question 1

- Out of 25 students, only 4 answered a reasonable answer such as: " An algebraic expression is a combination of numbers and variables that are added, subtracted, multiplied or divided.
- Ten students stated the following: " An algebraic expression is an equation where you have numbers and variables".
- The rest of the students' answers were very far from what was needed. For example , one stated that an algebraic expression is: "When you factorize or simplify numbers" another said:"when you have numeral values unidentified".
- All examples given were not real life but mathematical such as: x+4, 2a-3b and 4ac+4b-2m.
- Only one student provided the following example: " If we need to water 3 plants out of x plants, the expression is x-3".

SLIDE 6

Results of question 2

- Twelve students stated the following: " Expanding an expression is to make it bigger while factorizing makes it smaller."
- Two students said that factorizing is changing from a sum or a difference to parenthesis while expanding is the opposite.
- The rest of the students were not able to express the difference in their own words but rather provided an expression and expanded it once and then factorized it.

SLIDE 7

Research on writing in math

According to the **NCTM,**

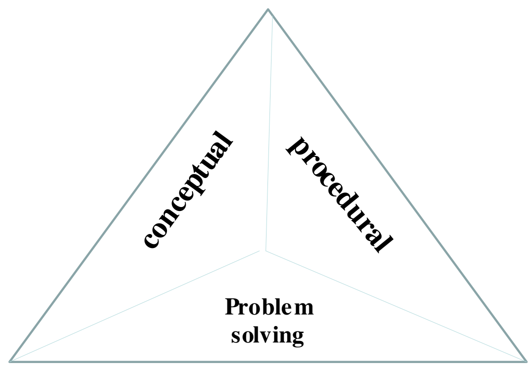
"Writing assignments and inventories are assessments that are produced by students, rather than teachers. They challenge students to think about their mathematical strengths and weaknesses, their attitudes, or their beliefs. They often take the form of student journals, students' reflections on their thinking and methods of working, and student-completed inventories."

"Student writing:

- Encourages students to think about how they solved a problem or performed a skill.
- Helps students view their accomplishments in terms of their own strengths and areas for improvement.
- Gives students way to think consciously about expanding their mathematical repertoire: types of strategies, use of representations and focus on content areas.
- Provides educators with evidence that students use concepts and problem-solving strategies."

SLIDE 8

Requirements for problem solving



SLIDE 9

Examples on writing used in problems taken from the Lebanese curriculum

- If the dimensions of a rectangle are 8 cm and 5 cm, find its area and perimeter . Write your answer in a full sentence.

- The hydrogen atom can be considered as a small sphere of diameter 10-10 meters. Supposing that we can pack hydrogen atoms in a straight line, how many atoms are needed to cover one centimeter?

SLIDE 10

Different ways for integrating writing in math

SLIDE 11

1) Introducing Units

SLIDE 12

Grade 5
Unit 6

Fractions, Decimals and Percents

Essential Questions:

What is the relationship between fractions, decimals and percents?

Under what circumstances is it best to use each of these three forms?

Vocabulary List:

Decimal
Denominator
Factor
Fraction
Multiple
Numerator
Percent
Percentage

This unit will be addressing the following sections of the text:
Chapters 6, and 7-1, 7-2, 7-3 and 7-4

SLIDE 13

2) Discussing concepts during class work

SLIDE 14

i)Open ended questions asked while working on a concept such as:

Why must we find a common denominator before adding or subtracting fractions? Use pictures and words to explain.

SLIDE 15

ii) **Math Journals.**

Math journals are a great way to begin class. Students can spend five to ten minutes writing on the daily topic. Math journals can also be used to assess background knowledge when beginning a unit, and then used as a means of assessing acquired learning at the end of the unit.

Math Journal Topics

•Explain a formula.

•Write an explanation of a recently-learned concept, as if you were explaining it to a younger sibling or friend.

•Write everything you know about probability. (A great way to start a chapter! Have your students write a similar entry at the end of the chapter, and then have them compare this with their initial entry.)

SLIDE 16

iii)<u>Writing a Vocabulary Paragraph</u>:

Assign a list of math vocabulary words to your students, then have them write a paragraph that incorporates all of the words on the list. Your students will have fun generating some clever ideas for their paragraphs.

SLIDE 17

3) Working in groups on class activities

SLIDE 18

Activity on the use of powers
Dogs and Fleas

Five men were taking a walk one day in the early morning sun. Each man had with him 5 dogs. These dogs had only 5 hairs each on their heads. (Poor dogs!) Now, as these men were not diligent about keeping their dogs free of parasites, each hair on each dog was the home of 5 fleas. These fleas were each short one leg and therefore only had 5 legs each. What a sad sight!

How many men?
How many dogs?
How many hairs?
How many fleas?
How many fleas' legs?

Explain why you can use exponents to express these numbers. What if the fleas still had all 6 legs, would you still be able to use exponents to express the total? Why or why not?

SLIDE 19

4) Providing Research Assignments and Projects

SLIDE 20

Research Activities Ideas:

•**Write on Careers That Require the Use of Mathematics:**

Have small groups research various careers and write a report that they will present to class. Have students include specific examples of mathematics used in the career they research. Possible careers include: architect, chemist, physicist, engineer, statistician, chef, engineer, landscape designer, fashion designer, graphic designer, and football coach. Have students conduct interviews, research college courses required for applicable degrees.

•**Conduct a Survey:**

Your students will need to determine a survey topic, decide on an appropriate sampling technique and then write the survey questions. Along with appropriate statistical measures, have your students write a detailed summary of the process they undertook, as well as a summary of their findings. Make sure your students include at least one graph in their summary.

SLIDE 21

•Use the internet to explain certain concepts:

Multiplying two negative integers

There are many ways to explain why the product of two negative numbers is positive. Your assignment is to read some of these possibilities. The following website has 7 different explanations. Visit this website and read the 7 explanations thoroughly. Then decide which of these is best for helping you to make sense of multiplying two negative numbers. Finally, write a brief paragraph explaining which idea helped you most and why.

http://mathforum.org/dr.math/faq/faq.negxneg.html

SLIDE 22

5) Assessing Students' Understanding in Tests

SLIDE 23

Sample Test Question

Define each of the following terms in your own words: (2 points each)

y-coordinate

negative numbers

SLIDE 24

6) Detecting and Correcting Mistakes Done in Tests

SLIDE 25

Two mistakes were done while performing the following problem. Detect these mistakes and explain in writing why do you think they were done. Then, provide the correct solution.

$$[-3 (9+2)] \div -11 + (-2) =$$

$$[-3 (11)] \div -11 + (-2) =$$

$$-33 \div -11 + (-2) =$$

$$3 + (-13) = 10$$

SLIDE 26

7) Writing a Unit Reflection

SLIDE 27

Unit Reflection

Student Name: ____________________________________

Unit: _______________________

Answer with: ***Always, Usually, Sometimes, Never***

Were you prepared for class? __________________________
Did you participate in class discussions? __________________________
Did you complete your homework? __________________________
When did you begin studying for this test? ___________________________________
Approximate time you spent preparing for this test? ____________________________

Use complete sentences to answer the questions below; give clear, specific examples.

•How did you study for the unit test?

•Prior to the test, was there any area where you were not confident?

•What is one thing in the unit that you did well on?

•What is one area where you feel you still need to improve? What will you do to improve?

•What is your goal for the next unit?

SLIDE 28

General Tips for Proper Writing

• Help students develop their writing skills by giving very specific descriptive directions, but still giving them freedom to be creative.

•Use the words *how* and *why* often.

•Determine the time frame for the written assignment. This can range from fast and frequent—five minutes, everyday—to long assignments, given several times or once in a term.

•You may want to use study groups or cooperative learning groups for some assignments, which can further strengthen the learning.

•If your students are struggling with a writing activity, don't hesitate to model desirable strategies for completing the assignment and a sample final product.

•Let your students know ahead of time whether or not the writing activity will be evaluated.

SLIDE 29

Conclusion

• Do we have enough evidence that indicates the extent to which our students have acquired adequate conceptual understanding?

•Do you think it's important for them to know the conceptual part of a topic?

•If it's important and students don't know it, what changes should be done?

•Do you think "writing" should be graded?

Classroom Capsules for Meaningful Learning of Mathematics
Bilal Basha & Manal Malaeb

The aim of this session was to introduce a holistic approach to effective teaching and meaningful learning of mathematics. In the introduction, the presenters touched on the various practical aspects of the teaching-learning process (diagnosis, planning assessment…etc.). Afterwards a short presentation displayed the theoretical framework of various aspects that lead to innovation in teaching mathematics in the middle and secondary schools. The presenters stressed on teachers' challenges in approaching their goals. In this regard, the STAR (students as Strategists, Technicians, Accountants and Reporters) framework was suggested. On the other hand, the curriculum, time and learners' potentials remain as traditional constraints that have been facing teachers since the founding of structured schools. Although there is no one precise tool that teachers can use to overcome these obstacles, the classroom capsules that this presentation proposes is considered to be an effective teaching aid in this regard. Furthermore, the presenters displayed a framework that teachers ought to bear in mind while preparing any mathematics classroom (refer to presentation). This framework honors mathematical reasoning, problem solving, communication and the value of mathematics. In addition, it structures the ways teachers deal with learners, the curriculum, time and set essential indicators of effective teaching and meaningful learning. Most of the session time, afterwards, was highly interactive where participants got engaged in interactive activities where the notion of classroom capsules was elaborated. The participants were divided into groups of four and were provided with activities that involved innovative mathematical ideas. Upon the completion of every activity, every group presented their solution which was thoroughly discussed. The ideas of these activities were originally extracted from the research journals in mathematics and mathematics education, and then reformed and structured to fit the Lebanese curriculum on the one hand, and to be "motivating" and "interesting" on the other. The activities addressed various grade levels ranging from middle to secondary levels and covered a wide range of mathematical fields (algebra, geometry, calculus, probability…etc.). The activities involved the following ideas:

- *Promoting the various representations of the same mathematical idea.*

An activity in algebra addressing the middle school was used to elaborate this concept. The concept of solving a system of two equations in two unknowns was modeled through an activity that represented each equation by a balance including two unknown weights. Different paths to resolving this task were discussed

- *Expanding mathematical concepts and building connections among various fields of mathematics.*

On this concept, a mathematical formula on trigonometry which is usually taught in the secondary school (the sine formula of the sum of angles) was used to illustrate the fact that one way of enhancing meaningful learning is to make these formulas accessible to learners at lower classes (middle school), while pinpointing the importance of such formulas and their limitations

- *Training on deductive thinking for building concepts*

  An activity on leading questions to achieve a pre-assumed objective was used to illustrate this concept. The idea here was to promote the fact that the more deductive reasoning strategies were modeled to learners, the more learners acquire deductive reasoning more efficiently.

- *Training on thinking by contradiction for building induction reasoning.*

  A very elementary activity was used here which was using a contradiction to prove that the diagonals of trapezoids do not bisect each other. This task aimed at elaborating the importance of thinking by contradiction not only as an important mathematical problem solving strategy, but also as a habit of the mind of an inquirer.

- *Researching motivational activities.*

  The idea here was to motivate teachers to research the interests of their learners and accordingly plan activities that motivate them and capture their attention, in addition to pushing them to think and solve mathematics.

- *Promoting informality of assessment for building authentic judgments.*

  A task was assigned to the attendees to correct a sample exam in mathematics for middle school. Afterwards, the presenters modeled the behaviors of learners in approaching the problems of the exams, which showed a huge conceptual misunderstanding not being indicated in the exam paper itself!! The idea here is to promote the use of informal assessment (along with formal assessment) in mathematics as an essential tool of obtaining authentic results.

- *Promoting the sense of value and appreciation for original and interesting ideas.*

  The use of original and novel research ideas in classrooms can bring great motivation to learners, and accordingly promotes success, productivity and meaningfulness

The final part of the workshop was a reflection time-out on the applicability of these capsules in our classroom.

Jouons Avec Les Maths

Samia Hénaine

Abstract

Les élèves acquièrent mieux les concepts mathématiques par la manipulation du matériel concret. Cela les aide à construire une représentation mentale du concept. Les objets à manipuler, et surtout au cycle primaire, sont des introductions concrètes aux idées abstraites. Chaque élève doit avoir l'occasion de participer à des expériences concrètes, en utilisant les objets appropriés, avant de commencer à travailler les exercices d'application. Concernant les ressources imprimées, y compris le manuel scolaire et le cahier d'activités, celles-ci n'offrent que des représentations symboliques et picturales des concepts mathématiques. Cette session a offert aux participants des idées simples sur la façon d'utiliser un assortiment d'objets à manipuler (objets achetés, construits ou collectionnés auxquels les élèves ont accès à tout moment). Ces idées permettent d'expliquer, de motiver et même d'évaluer les apprenants. L'important c'est d'assurer la compréhension des concepts plutôt que la mémorisation machinale des règles et d'algorithmes. Les participants avaient également l'occasion de partager et de développer leurs idées sur la façon d'utiliser des objets simples.

Introduction

L'utilisation d'objets de manipulation est une composante importante dans l'enseignement et l'apprentissage des mathématiques. Chaque enseignant ou enseignante doit avoir en classe le matériel de manipulation comme ressources. Ce matériel est facilement accessible, il peut être acheté, construit ou même collectionné d'une façon très simple. L'objectif principal de cette session était d'approfondir la compréhension des participants de la façon d'utiliser ces objets.
Le matériel est composé d'une collection de nombreux objets à manipuler (jetons, pâtes colorés, attaches, céréales colorés), du matériel de base dix, des cubes emboîtables, des photos et des cadres plastifiés.

Stratégies

Au cours de la session, les participants ont découvert la façon d'utiliser ce matériel pour expliquer ou évaluer un concept mathématique. Ils se sont mis dans la peau d'un apprenant tout en utilisant effectivement les objets donnés et les stratégies suivantes :

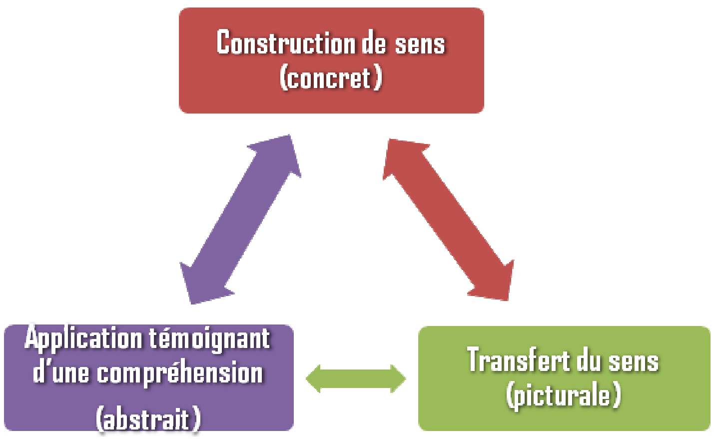
<u>KWLH :</u>
La stratégie KWLH permet aux apprenants de réactiver leurs connaissances antérieures. Les lettres de KWLH représentent :

- K : ce qu'ils savent (what they KNOW)
- W : ce qu'ils veulent apprendre ou savoir (what they WANT to know)
- L : ce qu'ils ont appris (what they LEARNED)
- H : Comment ils pourront apprendre d'avantage (HOW they can learn more)

Chacun des participants avait une carte à compléter durant la session.

Cycle d’apprentissage:

La construction d’un concept mathématique commence par le concret, puis par la phase picturale et jusqu'à arriver à l’abstrait où un nouveau concept est nait, et de nouveau recommencer le même cycle décrit (du concret à l’abstrait). Au cours du processus de planification, les enseignants doivent discuter des façons dont les élèves pourraient démontrer cette compréhension et planifier des activités adéquates à chaque phase.



Consolidation du Calcul mental:

La planification d’une séance mathématique doit être toujours introduite par une activité de calcul mental pour consolider les connaissances des élèves et pour les aider à construire leur propre stratégie.
Exemples d’activités : jeu du furet, plouf dans l’eau, jeu de bataille.

Comprendre les règles de fonctionnement de la numération décimale:

Cet apprentissage peut être acquis à partir des différentes stratégies, par exemple : les cartons Montessorri.

Les cartons Montessorri sont un jeu de neuf étiquettes pour chacune des classes de la numération décimale (ex. pour la classe des dizaines : 10; 20; 30; 40; 50; 60; 70; 80 et 90). Pour composer les nombres, il suffit de superposer les étiquettes en s’assurant que les bandes de couleur se retrouvent les unes sur les autres. Ce matériel permet de faire le lien entre l'écriture en chiffres du nombre et la lecture de ce nombre qui est basée sur une numération de type additive et multiplicative. De plus, il permet de mémoriser la décomposition canonique des nombres qui correspond aux mots nombres utilisés.

Gestion mentale:

Les lois qui précisent les différentes étapes de la démarche intellectuelle sont:
- la perception,
- l'évocation,
- les 4 types de gestes mentaux,

- la mémorisation.
La compréhension de ces lois aide l'enseignant à découvrir le style d'apprentissage de chacun de ses élèves et à utiliser ses connaissances pour supporter les élèves qui ont des difficultés.

L'évocation et la manipulation:

La manipulation est un élément essentiel dans l'acquisition des concepts mathématiques. Cependant, elle perd son efficacité si elle est utilisée seule comme un outil de l'évocation.
Pour cela, il est important d'activer l'évocation des élèves en leur demandant de se redonner mentalement ce qu'ils ont dit, vu et fait pendant cette manipulation.

Présentation physique:

Les élèves s'amusent en présentant physiquement les concepts mathématiques. C'est un facteur actif de motivation. Les élèves peuvent représenter la division, le diagramme en bâtons, le pattern et la valeur de position d'un nombre donné.

Description

Description du matériel utilisé :

- Le matériel de base dix commercial est formé de blocs (en plastique ou en bois) de différentes formes et dimensions pour représenter les unités, les dizaines, les centaines et les mille du système numérique. Les unités sont représentées par des blocs mesurant 1 cm x 1 cm x 1 cm ; les dizaines sont des blocs mesurant 1 cm x 1 cm x 10 cm ; les centaines sont des blocs mesurant 1 cm x 10 cm x 10 cm ; et les mille sont des blocs mesurant 10 cm x 10 cm x 10 cm. Ce matériel de base dix est utilisé dans plusieurs activités : le dénombrement, l'estimation, le regroupement, la valeur selon la position, l'addition, la soustraction, la multiplication, la division, les décimales, la longueur, l'aire, le volume et la masse.

- Les cubes emboîtables sont des cubes mesurant 2 cm x 2 cm x 2 cm. Ces cubes, disponibles dans une variété de couleurs, s'articulent. Ceux-ci s'avèrent utiles dans une multitude d'activités : le dénombrement, la classification, la correspondance des motifs, l'addition, la soustraction, la multiplication, la division, les fractions, les nombres décimaux, la valeur selon la position, l'estimation, les combinaisons de nombres, la gestion des données, les figures géométriques à trois dimensions, la symétrie et la mesure (la longueur, l'aire, le volume, la masse).

- Les photos, les cadres plastifiés, les pâtes et les céréales sont disponibles en plusieurs couleurs et formes, et peuvent être utilisés dans des activités d'addition, de soustraction, de multiplication, de division, de décomposition des nombres, de retrouvaille complément et de correspondance des motifs.

Déroulement de la session :

Le lien suivant conduit à la présentation « Power Point » qui montre le déroulement de la session avec la description détaillée des activités.

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Conclusion

Il est extrêmement utile aux élèves d'utiliser une variété d'objets de manipulation lorsqu'ils apprennent un concept mathématique important. Ceci aidera à s'assurer que les élèves n'acquièrent pas une compréhension limitée du concept en question. Les objets à manipuler sont des objets simples qui peuvent être simplement collectionnés par l'enseignant ou par l'élève. L'important est que l'enseignant connaisse comment transformer ces objets simples en outils d'apprentissage et comment choisir les stratégies convenables.

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Teaching Chemistry for Conceptual Understanding

Nizar El-Mehtar

Abstract

Conceptual understanding of a subject matter introduces an appreciable challenge for most students and teachers. The students' challenge may be attributed to new learning demands that compel them to think at a deeper level, overcome their misconceptions, make meaningful associations, and construct further knowledge. Moreover, many teachers might be de-motivated by a serious 'misconception' regarding 'Teaching for Conceptual Understanding' as an approach which brings about additional and overwhelming professional obligations. The aim of this workshop was to convince teachers that 'Teaching for Conceptual Understanding' is mostly plausible by implementing minor to moderate modifications on their routine teaching practices. Some classroom and experimental learning activities were suggested that help students to: (a) develop a better understanding of the microscopic, macroscopic, and symbolic realms of chemistry (b) appropriate intellectual tools to enhance meta-cognitive reflections and problem solving, and (c) acquire more learning gains from 'conceptual' laboratory experiences.

Introduction

Researches refer to an inherent complexity in chemistry that prevents many students from mastering the subject. Chemistry occurs on three levels: the macro, micro and symbolic levels. While conceptual understanding of the subject requires the learner to link between the three levels, teachers' instructional strategies are mostly restricted to the symbolic level, which is the most abstract one. Because teachers unwittingly move from one level to another, students fail to integrate the levels and consequently develop a fragmented view of chemistry (Gabel, 1999). Moreover, teachers do not facilitate students' understanding of the subject, since their prevailing teaching practices rely primarily on rote instructional methods and algorithmic problem-solving rather than conceptual understanding. Such practices deprive the students from active involvement in their learning process (Pickering, 1990; Sawrey, 1990; Mason et al., 1997; Gabel, 1999; Boujaoude & Barakat, 2000; Boujaoude & Tamim, 2000; Nakhleh, 1992; Francisco et al., 1998; Mestre, 2001; Chiu & Lin, 2004). According to Reif (1983) and Mestre (2001), current instructional trends rely predominantly on the following pattern: presenting scientific information, showing examples of solved problems presented in a linear sequence of detailed steps, and indulging the students in solving similar problems by following the same linear sequential model. Gabel (1998) argues that such patterns are dysfunctional and pernicious, since they emphasize formal knowledge and mathematical descriptions at the expense of qualitative reasoning skills that are essential for conceptual understanding. Even science laboratories, that are supposed to promote essential skills of inquiry and problem solving, seem to fail in developing the required conceptual understanding. Unlike authentic scientific research, most laboratory experiments are used to verify known phenomena and support the lecture portion of science courses (Mestre, 2001; Reid, 2002). Consequently, many students tend to apply the procedures provided by manuals without necessarily understanding the correlation between experimental observations and underlying concepts of the experiment (Zineddin, 2000). For learners to realize the long term payoffs of science education, teachers ought to teach for conceptual understanding. The rationale for this instructional approach is that acquisition of knowledge and routine skills does not ensure understanding of their basis (Perkins, 1993). Teaching for understanding dictates the engagement of students in a variety of performances in a culture of scientific inquiry and problem solving, where they learn to practice and develop processes leading to knowledge construction. In this culture, classrooms and laboratories transform into safe and collaborative environments for raising questions, taking risks, exchanging ideas, making/testing hypotheses, designing experiments, and exploring connections between school knowledge and personal experiences (Perkins, 1993; Cardellini, 2006; Germann & Odom, 1996; Baxter & Shavelson, 1996; Hofstein, 2004; Mestre, 2001; Zineddin, 2000). Many effective strategies have been found to enhance the conceptual learning of chemistry some of which include concept mapping, discrepant events, analogies, learning cycle approach, and real life situations. However, the outcome of any strategy does not seem to be thorough unless the meta-cognitive dimension is judiciously crafted within the learning experience associated with the adopted strategy. Meta-cognition enhances a deeper understanding of concepts, diminishes chances of misconceptions, and qualifies students to apply their knowledge in new situations. Furthermore, meta-cognitive monitoring and regulation of thinking mechanisms may have a positive impact on students' problem solving skills (Gabel, 2003; Rickey & Stacy, 2000; Cooper et al., 2008).

Strategies

Three approaches were adopted to convey the intended connotation of the session:

1. <u>Inductive approach to</u>:
   a. construct a common understanding of 'Teaching for Conceptual Understanding'(Frayer model was used as a scaffolding instrument)
   b. scrutinize authentic classroom scenarios to identify the origin of students' misconceptions (a list of classroom scenarios was distributed to participants)
   c. recognize the importance of addressing the micro-macro-symbolic levels of chemistry to enhance conceptual understanding of the subject
   d. acknowledge 'experimental design' as a conceptual dimension of laboratory experiences (carousel activity was used as an instrument for experiential and collaborative learning)

2. <u>Modeling to illustrate:</u>
   a. planning and implementing an 'explicit micro-macro-symbolic' instructional model (outcome of an intervention study)
   b. effective integration of 'discrepant events' within instructional plans (a video of a discrepant event was used to demonstrate the 'Observe-Reflect-Explain-Connect' model)
   c. adding the 'conclusion-evaluation' aspect as a conceptual dimension of traditional experiments

3. Deductive approach to
    a. present how traditional problems may be rendered more conceptual through: meaningful representations (graphs, concept maps, and schematics), qualitative reasoning, and authentic scenarios
    b. introduce the concept of 'Visible Thinking'

Throughout the whole session, reflection was a regular practice that accompanied all strategies. Participants were encouraged to think of all activities. Reflections and discussions taking place in this session served as potential learning experiences that are valid for classroom use.

Description of the Session

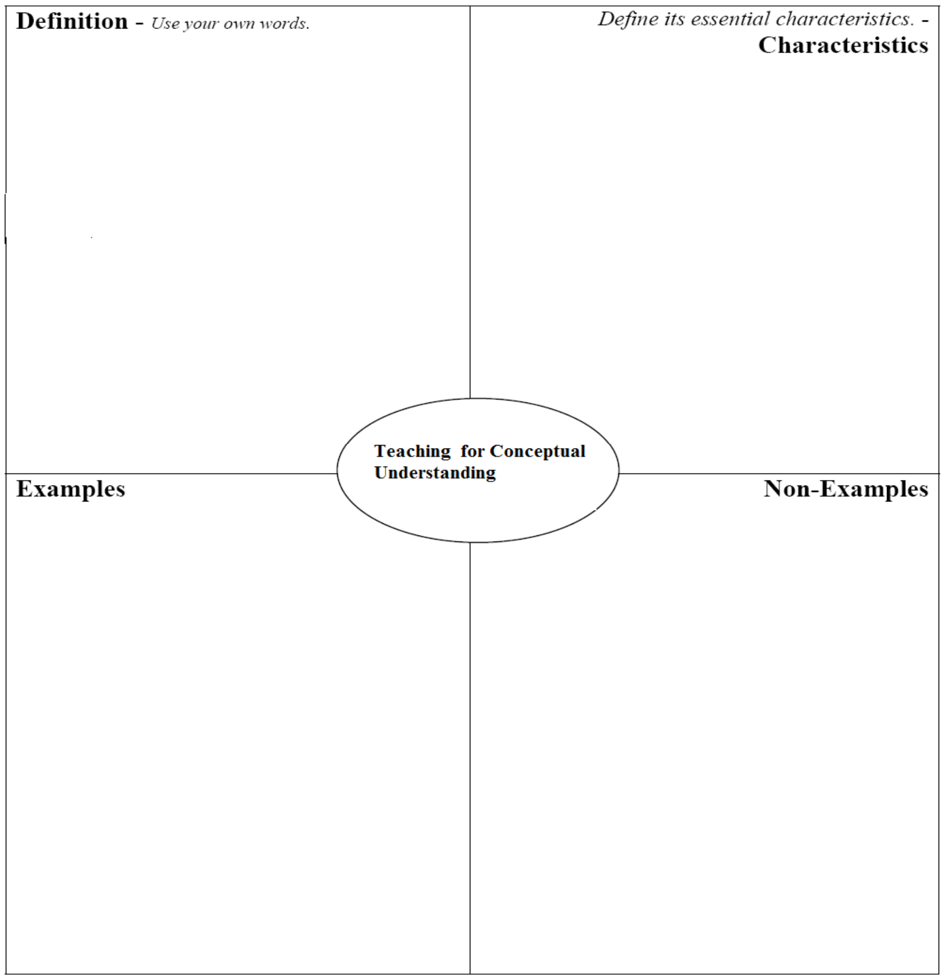
First Activity: What is 'Teaching for Conceptual Understanding'?

1. Phase 1 (individual work): The participants filled the Frayer's Model template based on their prior knowledge.

2. Phase 2 (individual Work): The participants read an article by Gabel (2003) about conceptual understanding, compared their prior knowledge to the expert's views, and modified/endorsed what they wrote in phase 1.

3. Phase 3 (whole group discussion): The presenter led a whole group reflective discussion centered around the following focus questions:
    - What learning gains may be attributed to this activity?
    - How, when, and for what objectives can this activity be applied in a chemistry class?
    - How can Frayer's Model be used in other learning scenarios?

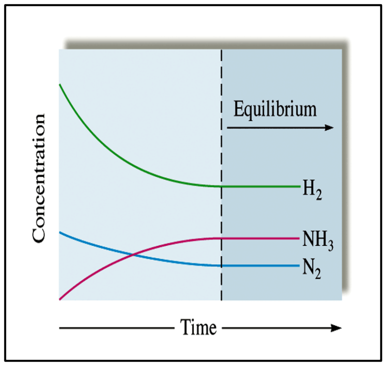
Frayer Model Template



Second Activity: The Macro- Micro- Symbolic Instructional Model

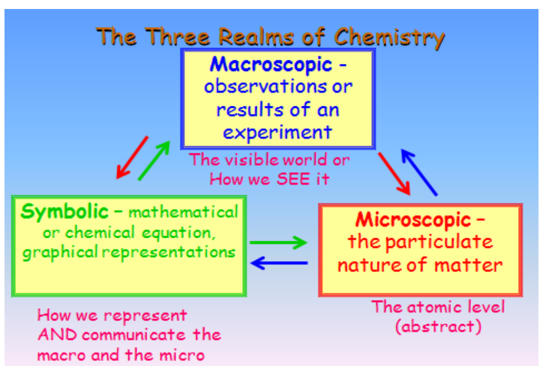
1. Phase 1 (group work): Participants, working in groups, examined and discussed a list of students' questions* derived from authentic classroom scenarios. Discussions were focused on the following questions :
   a. Do your students ask identical or similar questions? How do you address them?
   b. Do you feel that there is one common 'learning challenge' in the scenarios?

* All the questions were selected to address students' confusions regarding the micro, macro, symbolic realms of chemistry. Examples of these questions are:
"Is an atom of aluminum solid at room temperature?"
"Does one atom of sulfur look yellow?"
"How can this graph show dynamic equilibrium...The rate is zero at the end...I mean if we draw the tangent and find the slope...It is zero!"

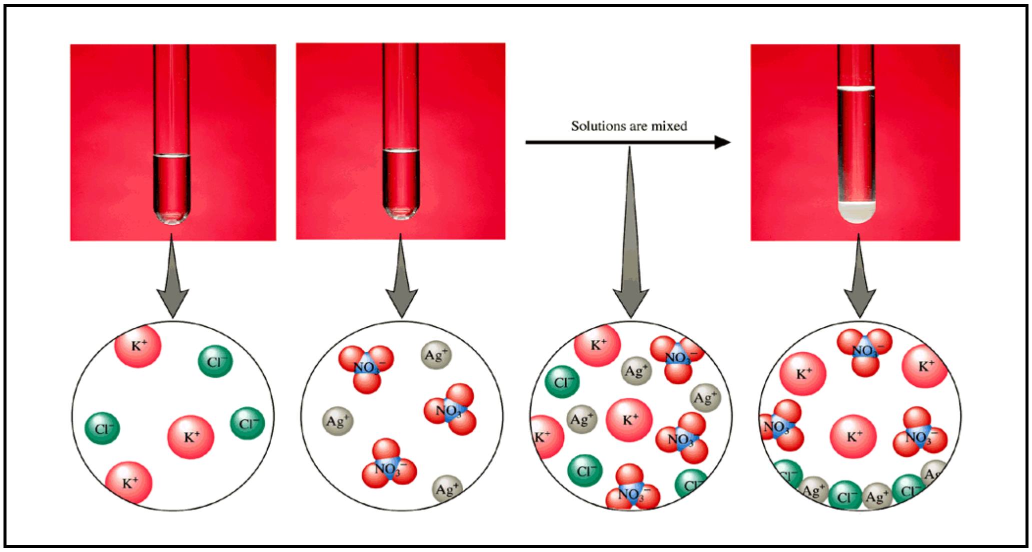


2. Phase 2 (whole group discussion): Each group representative communicated his/her group's reflections that emerged in phase 1.

3. Phase 3 (group work): The presenter distributed copies of the schematic 'The Three Realms of Chemistry' to the participants. Then the different groups were asked to respond to the following questions:
   a. How is the schematic relevant to the classroom scenarios presented in phase 1?
   b. How can the schematic be used as an instructional tool for teaching chemistry?



4. Phase 4 (whole group discussion): The presenter led a whole group discussion towards :
   a. Acknowledging chemistry as a 'world of representations'. A display of different forms of micro/macroscopic representations was presented to the participants and their routine uses in classrooms were assessed from the 'conceptual understanding' perspective. One example of the representations is:



b. Developing 'The Macro- Micro- Symbolic Instructional Model': (Jaber, 2009)

- Nature of the model: A meta-cognitive thinking model that enables students to integrate and shift between the levels of chemistry, addresses models and representations critically, and makes their mental models visible.
- Implementation of the model: Explicit integration within instructional (epistemology of models) and assessment plans.
- Advantages of the model: The micro-macro-symbolic approach helps students to acquire more control on their learning, and teachers to diversify assessment, where they evaluate scientific content, conceptual understanding, creativity, and organizational skills in one task.

<u>Third Activity: Experimental Demonstrations for Conceptual Understanding- Discrepant Events</u>

1. Phase 1: participants watched a video of the discrepant event 'How to Make Hot Ice' (crystallization of sodium acetate)

2. Phase 2 (group work): Participants in their groups engaged in the Observe- Reflect- Explain- Model
   - Observe: What did you observe?
   - Reflect: Use your prior knowledge to propose a preliminary understanding.
   - Explain: Use reliable resources to develop a scientifically sound explanation.
   - Connect: Investigate a daily life application.

3. Phase 3 (whole group discussion): The participants shared the outcomes of their engagements in phase 2. The presenter facilitated the overall exchange of reflections on the plausibility and challenges of discrepant events' implementation in chemistry classes.

Fourth Activity: Experimental Work for Conceptual Understanding- Experimental Design

1. Phase 1: The presenter introduced the elements of 'Experimental Design': Defining the problem and selecting variables (dependent, independent, and controlled), suggesting hypotheses, and developing a method for collecting data and controlling variables.

2. Phase 2 (group work): The participants in their groups engaged in responding to a simplified version of experimental design: 'Outline an experimental procedure to verify that that an aqueous solution of NaCl acquires a uniform composition'.

3. Phase 3 (inter- group carousel activity): Groups' procedures were shared and assessed through a carousel activity. For example, the procedure of group 1 was circulated to groups 2, 3, 4, and 5 who read the design and reflected on it. This procedure went back to group 1; the members read their colleagues' remarks and decided to endorse or reject them. A similar scenario took place with the other groups.

4. Phase 4 (whole group discussion): The presenter led a concluding reflective discussion that was based on the following focus questions:
   - How does this activity promote conceptual understanding?
   - How and when can such an activity be appropriate in the classroom?

5. Phase 5: the presenter shared with participants his experience with applying advanced versions of 'experimental designs' (challenges, conditions of applicability, scheduling, and learning gains). He suggested a scoring rubric for assessing such an activity.

6. Phase 6: The presenter suggested adding the aspect 'conclusion and evaluation' as a conceptual component of traditional experiments. He suggested a generic rubric for assessing this aspect.

   Segments of the proposed rubrics are given below:

   Research Question

	Appropriate	***Partially appropriate***	***Needs major improvement***
	3 points	***2 points***	***1 point***
Identification of focused problem			
Clarity of the relationships or patterns investigated			
Feasibility of the investigation using local resources			
Accuracy of terminology and wording			

Conclusion and Evaluation (International Baccalaureate Chemistry Guide, 2009)

Levels/marks	Aspect 1	Aspect 2	Aspect 3
	Concluding	Evaluating procedure(s)	Improving the investigation
Complete/2	States a conclusion, with justification, based on a reasonable interpretation of the data.	Evaluates weaknesses and limitations.	Suggests realistic improvements in respect of identified weaknesses and limitations.
Partial/1	States a conclusion based on a reasonable interpretation of the data.	Identifies some weaknesses and limitations, but the evaluation is weak or missing.	Suggests only superficial improvements.
Not at all/0	States no conclusion **or** the conclusion is based on an unreasonable interpretation of the data.	Identifies irrelevant weaknesses and limitations.	Suggests unrealistic improvements.

Fifth Activity: Adding a Conceptual Dimension to Traditional Problem Solving

The presenter displayed, while interacting with the participants, a variety of simple ideas to promote the conceptual dimension of traditional problem solving. The following example about the Haber process is a typical real life situation that demonstrates the authentic discrepancies between theoretical and industrial conditions: (www.chemguide.co.uk)

The Haber process combines nitrogen from the air with hydrogen derived mainly from natural gas (methane) into ammonia. The reaction is reversible and the production of ammonia is exothermic. $N_2 + 3H_2 \leftrightarrow 2NH_3$, $\Delta H < 0$. ***The typical industrial conditions of the process are: (a) The catalyst: Fe (b) The temperature: 500*** ^0C ***(c) The pressure: 200 atm.***

1. ***Theoretically, what temperature & pressure conditions favour higher yields of ammonia? Why?***
2. ***Are your predicted conditions consistent with the industrial ones? If yes, state how. If not, identify the inconsistency and suggest a valid reason for it.***

Concluding Remarks: Visible Thinking (Ritchhart & Perkins, 2008)

The presenter concluded the session by the following remarks:
1. To assess conceptual understanding we need to make our students' thinking visible.
2. Thinking happens mostly in our heads, invisible to others and even to ourselves. Effective thinkers make their thinking visible, meaning they externalize their thoughts through speaking, writing, drawing, or some other method. They can then direct and improve those thoughts. 'Visible Thinking' also emphasizes documenting thinking for later reflection.

Conclusion

This session was meant to convey one substantial message: 'Teaching for conceptual Understanding' is doable even under restricted professional conditions. In most cases, what separates a purely traditional instructional practice form a more conceptual one is a relatively simple modification. However, unless teachers acquire a solid will to make this modification, the teaching and learning of chemistry would remain less and less rewarding. Teachers do not have to simultaneously appropriate all the strategies suggested in the session. Gradual and selective adoption of the techniques are always recommended so that teachers take a sufficient amount of time to develop a deeper understanding of the conceptual approach and a stronger competency to implement it in a way that primarily serves their students' learning progression.
The Macro- Micro- Symbolic Instructional Model proposed in this workshop is a foundation for any conceptual approach since it addresses the spirit of chemistry as a discipline and subject matter. If we don't make our students aware of the nature of chemistry, how do we expect them to learn it? Future workshops in the domain of conceptual understanding ought to emphasize the three realms of chemistry with further explanations, a wider spectrum of applications, and more associations with students' misconceptions.

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www.Chemguide.co.uk

Enseignement Scientifique Vivant et Motivant "Attention! Au Cours
Andree Chaoui

Introduction

La session comprend l'enseignement des sciences aux cycles primaire et moyen.Elle décrit un enseignement vivant et motivant à partir de EB1 jusqu'à EB9. L'apprentissage des sciences commence à partir de EB1. L'approche pédagogique doit être convenable pour l'élève quant à son âge et à ses capacités. Cet apprentissage est fondé sur la démarche expérimentale:. Les enfants **observent** un objet ou un phénomène du monde réel qui leur est proche.
Ils **expérimentent**, analysent, raisonnent, mettent en commun et discutent leurs idées et leurs résultats. L'expérimentation va permettre de développer l'autonomie et l'esprit critique des élèves. Par ailleurs il faut donner à l'élève des activités organisées d'une manière progressive, allant du simple au complexe.

Stratégies et Description

La méthode suivie pour rendre le cours vivant,motivant comprend les étapes suivantes :

► De EB1jusqu'à EB9,
l'élève part des connaissances acquises et les met en application
en faisant des **affiches , du bricolage (herbier , pantin articulé, album…).**

►De EB3 jusqu'à EB9, l'élève apprend à faire des **recherches :**
Il réalise un tableau en inscrivant ce qu,il sait déjà et cequ'il aimerait connaître puis il cherche des réponses àses questions.
Dautre part L'élève apprend à distinguer entre la réalité et les schémas dans les:

- Observatisons microscopiques,
- dissections,
- et lesphotographies

La séquence suivante comprend la présentation d'une leçon:

➢ **Comment introduire une leçon?**

- En EB1et EB2, faire des introductions poétiques et artistiques pour inspirer et motiver l'enfant. Je cite deux exemples d'introduction poétique en EB1 et en EB2

En EB1
Chin, Pan et Zé
crient toute la journée.
Ils veulent de l'eau,
des noix de coco et faire dodo.

En EB2
Au printemps gai, vers avril et mai,
les tulipes sont de toute beauté.
Quand arrive l'été, tout ensoleillé,
c'est le tour des cerisiers.

- À partir de EB3 et jusqu'en EB9, on peut introduire une leçon par un conte ou une histoire variée.

➢ **Quelles sont les étapes qui suivent l'introduction?**

Ce sont certainement les étapes d'une démarche scientifique dont la première consiste à **observer et découvrir.** Ceci permet aux élèves d'être devant des documents variés (photos,dessins,schémas), accompagnés de questions qui leur permettent de les **découvrir activement :**

- en cherchant eux-mêmes les explications ,
- en confrontant leurs points de vue collectivement .

Pour approfondir ce qui vient d'être découvert et pour aborder les autres points de la leçon, des activités complémentaires variées et vivantes sont proposées à la classe:

- J'expérimente,
- je me documente,
- j'enquête,
- je compare,
- je classe,
- je réalise une affiche,
- un peu de bricolage,
- je cherche…et je trouve

Ces activités privilégient une démarche active, où l'élève **participe**, **expérimente** à chaque fois que cela est possible, **propose**, **imagine**, **observe**, **compare**, **déduit**… apprenant ainsi à développer les caractéristiques d'une véritable **attitude scientifique .**

Les points essentiels de la leçon sont résumés en quelques phrases et exprimés dans un vocabulaire simple et précis dans une rubrique intitulée « **J'ai appris».**

Deux ou trois exercices variés permettent à l'élève d'évaluer ses connaissances à la fin de chaque leçon. C'est la rubrique « **Je fais le point».** Ces exercices permettent à l'enseignant de connaître les points qui posent éventuellement problème et sur lesquels il faut revenir.

La dernière séquence de la session présente l'interdisciplinarité qui signifie que deux disciplines se joignent pour discuter le même thème.

- **L'enseignement scientifique peut intégrer l'interdisciplinarité**

Des dossiers parlent des milieu de vie au Liban.
D'autres dossiers introduisent les bons plats libanais.
La géographie a sa place également et évoque des plantes sauvages au Liban:
«Du Nord au Sud, le Liban est riche en végétaux divers. Faisons un petit tour pour voir ce qui pousse à la montagne, en plaine et sur le littoral ».
Sans oublier la matière de l'histoire qui explique l'évolution de l'alimentation chez l'homme.

Je présente le dossier sur les bons plats libanais qui a intéréssé les enseignantes. Il tourne autour d'une histoire de trois enfants:
« *Pour les vacances, Nada et Sami accueillent Kim un ami étranger. Lors des différents repas de la journée, ils veulent lui faire découvrir toute sortes de plats Libanais.*
Au petit déjeuner:
Que proposent Nada et sami àleur ami pour le petit déjeuner?
«Du foul moudamas» ,de la «kariché au miel», mais attention à la «mankouché», il ne faut pas en mangez trop souvent .Elle fait grossir et ne contient pas beaucoup de vitamines!
Au déjeuner : Kim choisit un repas varié comme le «laban emmo» ou la «siyadiyé». Quand au dîner pour dormir léger Kim prend une soupe aux lentilles.
La présentation de ce dossier relève du patrimoine Libanais tout en présentant les différents aliments bons pour la santé.

Conclusion

À partir du 1er niveau (EB1, EB2) l'élève s'initie aux premières étapes de la démarche scientifique.

de EB3 jusqu'à EB9, la démarche sera plus développée et l'apprenant suivra des étapes avancées (observer, expérimenter, analyser les résultats et conclure). Il sera ainsi mieux préparé au cyclesuivant.

1,2,3-Rotate: Biology Learning Centers

Amina Harbali

Abstract

The successful implementation of differentiated instruction in middle and high school Biology is one of the challenges that confront any Biology teacher. In this workshop participants will experience learning centers, which is one form of differentiated instruction. The concept of "blood types" (Grade 8) will be the core of what teachers will be exploring during this session. Additional examples will be provided including "Plants" (Grade 10) and "DNA" (Grade 11). Participants will engage in four different learning centers in which each center includes different skills that students must acquire. These learning centers include a variety of instructional strategies that address diverse student learning needs. Each center places the students at the center of teaching and learning. Learning centers are a way to enhance learning for all students by engaging them in activities that respond to particular learning needs, strengths, and preferences. Learning centers cater for students' readiness, interests, and learning styles.

Introduction

First, a brief introduction of the lesson to be discussed was provided to the participants. It was mentioned to them that prior to the learning centers activity students had attended a session that explained the blood types, blood antigens, antibodies and the successful rule of blood transfusion. Then, the participants were asked to form groups in which each group joined a center. Each learning center included detailed instructions, required materials and worksheets to be answered.

Strategy

Participants were first asked to have an idea about each center where each center had a specific title. They were informed that they only had 10 minutes to spend at each center and that they had to make sure that they got a good idea about each center. In other words, the activity part of this section took 40 minutes; 10 minutes for each of the four learning centers. Participants were asked to pay attention to the sound of the whistle which indicated that the time spent on one center had finished. It was also explained to the participants that the presenter was taking on the role of an observer and time evaluator. Participants' work during their practice in each center was evaluated by the presenter.

Description of session

Four centers were demonstrated in which each center had a title: **Center 1** (Test your Blood), **Center2** (The Nurse Problem), **Center 3** (Explore Rhesus Antigen) and **Center 4** (Food Diet & Blood types). *(Refer **to the attachment** at the end of the report for the four different activities.)*

In center 1: Participants had to test their blood type which was accomplished with the help of a nurse to avoid any contamination. Then, participants had to fill in their own identity blood type card.

In center 2: Participants had to solve the problem presented on the computer where all the detailed steps needed to solve this problem were given. As it is an educational game, participants enjoyed leaning through the computer.

In center 3: Participants made use of the prepared materials to make models of both blood "agglutination" and "no agglutination" processes; they explored the idea of schematizing and understanding the types of antigens, antibodies and the Rhesus factor.

In center 4: Participants acquired the skill of reading, picking out information from the text by designing their own food diet.

Each participant had the opportunity to **master different skills** in each center. All participants were expected to be involved in all the activities and ultimately present their worksheets and share their ideas to their partners and to the rest of the groups. Participants also had the chance to ask questions. Even though the presenter acted as a catalyst, she/he was also a facilitator where she /he observed and evaluated participants' work.

After the 40 minutes were over, the presenter clarified the importance of such a strategy and enriched the participants with further similar activities related to grades 10 and 11. These activities aimed to confirm that this teaching strategy could easily be practiced at any grade level (elementary, middle and secondary). Moreover, the presenter encouraged the practicability of such a strategy in any subject matter.

Conclusion

In conclusion, learning centers as a teaching strategy enables students of different potentials to understand major concepts with excitement and motivation. Throughout my presentation, I highlighted other teaching strategies that catered for differentiated instruction which could be applicable for improving students' performances, learning styles and achievements. Such strategies included Web quest, Interest Centers or Interest, Learning Contracts and others. Finally, I supported the applicability of learning centers by providing participants with prepared activities that may be used for grades 10 and 11.

Reflection:
It was a great pleasure to me when I shared with SMEC my presentation.

With my Best Regards
20/5/2010

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Discovery Lab
File Format: PDF/Adobe Acrobat - View as HTML
simulation of **blood** testing for your. family or class. **Blood type**. Antigen **...** Another way

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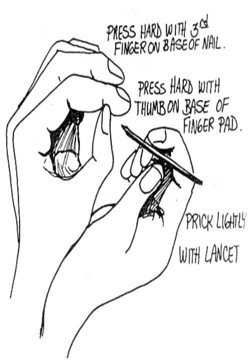
http://teachers.net/projects/centers/

Center (1) Test your blood

10 min  /5

Name: ______________________________
Partners: ______________________________



- Be courageous and test your blood

- List the materials used:____

- Draw your results using the given key:

A	B	Rhesus
◯	◯	◯

Agglutination   No Agglutination

- With which antibody did your blood clump?________

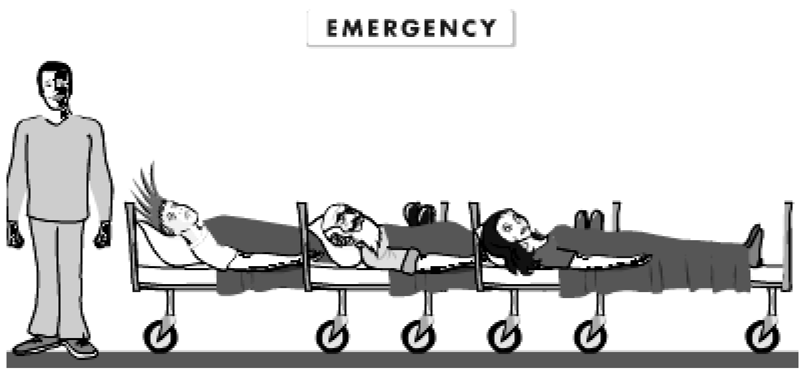
Center (2) The ' Nurse Problem

10 min /5

Name: _______________

Partners:______________________________

- Read the problem of the nurse provided on your table.



- What is the blood type of the patient 'Sabrina'?Why?

____

____

____

- What are the blood types that the nurse should not

  transfer into patient 'Sabrina'? Explain.

____

____

____

____

____

____

____

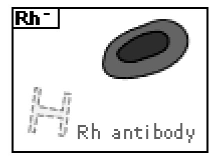
Center (3) Explore 'Rhesus Antigen'

Parteners: ______________________________

Name: __________

- Read the Rhesus passage provided on your table.

- What do Rh (+) people have?___________________
- What do Rh (-) people have?___________________
- Why can't 'Farawla' donate to 'Tarzan'?



____

____

____

- Why can 'Darina' donate to 'Tarzan' and 'Nimo'?

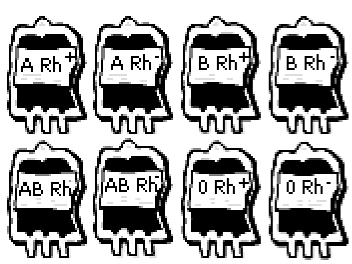
____

____

____

- Loulwa is blood type AB(-).
  Which of these blood types can she receive from?

____



Center (4) Food Diet & Blood types!

Partners: ______________________________ **Name:** _______________

- Read the passage provided on the table.

- What is the book title: ____________________

- What is the name of the researcher? __________________

- According to the researcher: How are blood types related the food?

____

____

____

- What is your blood type?____________

- According to the passage: what food is useful to eat?

____

- According to the passage: what is the food you have to avoid?

____

Use the given information to fill your blood type card.

Color your blood type card then <u>cover</u> it **AT HOME**

Documenting Children's Theories: Evidence of Deep Understanding

Jennifer Le Varge & Rasha Fakhreddine

Abstract

Children are constantly trying to figure out how the world around them works. In fact, when adults observe them closely they discover that children's actions can be explained in light of their theories about how the world works. Children's ongoing quest for knowledge and their deep understanding, however, must be documented in order for educators to fully recognize the scope of their theories. Documenting children's theories is an important tool for showing evidence of deep understanding, and for classroom evaluation and assessment. The question thus arises: how can we document children's theories? General guidelines and suggestions for using documentation to uncover theories and strategies for digging deeper with children through scientific activities, experiments and discussions were shared with the participants. In addition, participants took on the role of the learner by reviewing and discussing examples of documentation and theories from a real preschool classroom. Participants also had the opportunity to brainstorm ideas on how they can use documentation and deep understanding strategies in their own classrooms.

Introduction

Children are constantly trying to figure out how the world around them works. In fact, when adults observe them closely they discover that children's actions can be explained in light of their theories about how the world works. The ongoing quest they have to uncover and rearrange the world in order to understand it can be a source of great motivation for deeper learning. When one taps into children's thirst for understanding by helping them uncover their theories and making them visible through documentation, the work becomes fascinating for both teachers and children. Children can be asked to explain their theories, materials can be offered to help children tell the story of their theories, or they can use media to represent a theory in order to expand their thinking. As teachers work with children to help them pursue their theories, they will gain new insight into their unique perspectives. It is important for teachers to understand how documentation is a "living document."

The primary purpose of this session was to increase participants' understanding of documenting children's theories, and engaging educators in the documentation process; i.e. recording anecdotes or experiences, and reviewing them later on for evidence of understanding and assessment. Participants had the opportunity to take on both the role of a learner by engaging in the exploration of materials, and the role of a teacher by analyzing their experiences and documenting them.

Strategy

We introduced participants to observation techniques, questioning strategies, and ways to create lessons that allow children to show their 'deep thinking.'

Description of session

The session was planned as follows: (a) Brief introduction about deep understanding and the many forms of documentation (15 minutes); (b) Participants will engage with scientific materials and will document their experiences (20 minutes); (c) A discussion will ensue regarding the documentation of the participants' work (20 minutes); (d) Evidence of documentation from real classroom will be analyzed, and participants will extract evidence of scientific theories in groups (20 min minutes); (e) Discussion of findings (15 min); and (f) Discussion of strategies for using documentation and deep understanding strategies in the participants' classrooms (15 min).

(N.B. This was the schedule we were supposed to follow, however since only one person showed up, we couldn't even present our presentation, since that person just stood up and left in the middle of our session.)

Conclusion

Our session/presentation was very disappointing, since only one person showed up. The usher that day informed us that she heard a lot of people said that they were going to attend our session; however they felt that the session was too late and they wanted to go home. We felt very disappointed because we worked so hard for it, and were looking forward to presenting our topic! If we were chosen to present at SMEC again, we ask that the organizers find a way *not* to schedule sessions at the end of the day in future.

The Use of Data Logging in Science Investigations

Suheir Suleiman & Vivian Khoury Saab

Abstract

Data logging is the process of using a computer to collect data through an interface and sensors. The data collected could be displayed in a table as well as on a graph and statistically analyzed. The collection of data can be controlled by the experimenter. Data logging is commonly used in scientific experiments and in monitoring systems where there is the need to collect information faster than classical equipment can and where accuracy is essential. Examples of the types of information a data logging system can collect include: analyzing motion, temperatures, sound frequencies, pressure, CO_2 concentration and O_2 concentration. During the session, the use of some sensors and probes in physics and biology were demonstrated. The participants were involved in performing experiments using the Vernier Software.

Introduction

The purpose of this session was to add a flavor to experimental work in science by introducing the participants to the use of data logging. Data logging is the collection of quantitative data through the use of special sensors connected directly to a computer or a calculator. Some experiments require a lot of time and accuracy that cannot be achieved with regular equipment. Computer software and interfaces enable the students to collect, display, print, graph and analyze data accurately with minimal amount of time. It is important to note that the sophisticated sensors will not eliminate the use of regular equipment through which students build their manipulative skills.

Strategy

During the session, the use of some sensors and probes in biology and physics were demonstrated. The participants were divided into groups and be actively involved in performing experiments using the Vernier Software.

Description of session

During the session the following activities were performed:

a. Brief introduction to data logging.
b. Experimental demonstrations using the motion detector and the temperature probe.
c. Participants were divided into groups. Each group was actively involved in performing data logging experiments.

<u>Biology</u>: respiration in yeast cells using the CO_2 sensor, limitation on cell size using the conductivity probe, the effect of temperature on cell membrane permeability using the colorimeter.

Physics: graphing motion using the motion detector, Newton's law of cooling using the temperature probe, predicting the landing of a projectile using photogates, determining the acceleration of free fall using a photogate.

Conclusion

Laptops, probes and sensors with the compatible software were checked ahead of time and there were enough stations available for the participants.

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www.vernier.com

Using Language Switching to Support Foreign Language Learners in Science Classrooms
Tamer Amin

Abstract

Teaching science in Lebanon is conducted in a complicated linguistic environment. Many students at the elementary level and all students at upper levels are learning science in a language that is not their native language. Increasingly, recent developments in science curricula and recommendations regarding more effective teaching practices place great demands on communication and, therefore, students' linguistic abilities. Schools often have policies that prohibit the use of Arabic in the classroom when the language of instruction of a subject like science is officially a foreign language like English or French. However, research has shown that the strategic use of students' native language in such situations can be an effective teaching strategy. This developmental workshop introduced participants to a variety of ways in which language or as it is often referred "code" switching can occur in classroom settings examining the advantages and disadvantages of each.

Introduction

Teaching science in Lebanon is conducted in a complicated linguistic environment. French and English are widely used to teach science at all levels. Therefore, many students at the elementary level and all students at upper levels are learning science in a language that is not their native language. Current visions of science curricula, both in Lebanon and internationally, have emphasized various objectives including developing deep conceptual understanding and developing sophisticated scientific inquiry and reasoning skills (CERD, 1997; Millar & Osborne, 1998; National Research Council, 1996). To achieve such objectives, research has shown that students need to be actively involved in collaborative learning activities and self-reflective oral and written communication (Yerrick & Roth, 2005). Such practices place great demands on communication and, therefore, students' linguistic abilities.

Schools in Lebanon often have policies that prohibit the use of Arabic in the classroom when the language of instruction of a subject like science is officially a foreign language like English or French. This is usually based on the assumption that students will not learn the foreign language adequately unless they are immersed in that language and forced to use it as much as possible. While there is some justification of such an approach as an approach to language instruction, this assumption has been questioned by research and the effects on learning in various academic domains, such as science, that such policies have on students with limited foreign language proficiency can be serious (Cummins, 2000). In practice in the Lebanese context, many teachers feel that they are themselves forced to use Arabic or allow students to use Arabic in the classroom in order for learning to be achieved. Both situations – complete prohibition or random use of Arabic - are problematic. However, research has shown that the strategic use of students' native language along with the foreign language of instruction can be effective (see Lee & Luykx, 2006). However, there are advantages and disadvantages to code-switching in the science classroom that need to be explicitly considered.

Code-switching in the Science Classroom

Code-switching refers to a communicative strategy, used commonly in multilingual settings, in which speakers mix more than one language in their speech. This mixing can occur in various forms. It can simply involve occasional insertion of some lexical items (e.g. nouns and verbs from some technical domain) from one language with predominant use of another language. At another extreme, it can involve long stretches of speech in one language followed by long stretches in another. Other types and degrees of mixing can occur as well. Code-switching is a subtle process that is not yet fully understood. Various functions may be served: from attempts to help a listener understand through translation of what might be a difficult phrase, to drawing on a language felt to be more expressive for some purpose and on to word or phrase insertions from a language of high status to signal socioeconomic class and establish power relations.

All types of code-switching can occur in classrooms in multilingual environments. While some bilingual programs will have more than one language of instruction for a given school subject, mostly one language is designated as the language of instruction either for all subjects or for any given subject. If this language is not students' native language, tensions between the use of the native language and the language of instruction can occur. An often stated fear by educators in such settings is that allowing code-switching (i.e. allowing random use of the native language when it isn't the language of instruction) prevents adequate development of the foreign language of instruction. This is a genuine fear, and moreover, problems can arise when teachers use code-switching in certain ways despite very good intentions. On the other hand, allowing code-switching has been shown to be beneficial when put to particular uses.

The fear of poor development of the language of instruction if random code-switching is an established norm is suggested by a study conducted of the use of language during lectures in the Faculty of Oral and Dental Medicine at an Egyptian University (Qabary, 2003). Qabary (2003) found that code-switching between Egyptian Arabic and English was very common with particularly frequent use of Arabic as the "matrix" language with English insertions. While Qabary (2003) argues that this style of code-switching had an important communicative function and allowed for the insertion of colorful anecdotes which were likely to increase student interest and understanding, extended use of this form of speech is very likely to prevent development of student proficiency in academic use of English.

Another potential problem with code-switching in educational settings was illustrated by Luykx, Lee, and Edwards (2008). They studied the strategy of "concurrent translation" between English and Spanish used in elementary school in the US. This school had a bilingual education program and employed two teachers for every classroom: and English speaker and a Spanish and English bilingual teacher. A strategy used frequently was instruction in English with insertions of translation in Spanish. These "concurrent translations" were intended to help many of the students who were native speakers of Spanish and whose English was still weak. The analysis of classroom discourse conducted by Luykx et al. (2008) revealed frequent problems with this strategy, primarily the absence of exact translations (some of which had a cultural component - for example, differences in common units of measure). These led to many unsatisfactory classroom exchanges where the concurrent translation seemed to make communication more, rather than less, difficult.

However, a number of studies have demonstrated benefits of code-switching (Cleghorn, 1992; Rollnick & Rutherford, 1993, 1996; Setati, Adler, Reed & Bapoo, 2002). Cleghorn (1992) has shown that a teacher's use of code-switching while lecturing about science in a Kenyan elementary classroom allowed more precise meanings to be communicated and provided richer meanings for students to make sense of the main concepts. Moreover, the use of words and phrases from students' native language allowed the teacher to connect what was being studied to students' everyday experiences. In contrast, the teacher lecturing in English only had the effect of encouraging students to use phrases as imprecise cues to meaning and encouraged limited single word or short phrase contributions by students to classroom discussion.

In other research conducted with South African teacher trainees, students were allowed to use code-switching in student group discussion (Rollnick & Rutherford, 1993; 1996). The research found that this use of code-switching helped the teacher probe student misconceptions and allowed students to explain ideas more effectively to each other. Overall, the research indicates that the flexibility and subtlety in communicating afforded by code-switching can support the implementation of teaching for conceptual change strategies considered to be a very effective teaching strategy.

Despite these advantages, it is important not to lose sight of the problem stated earlier: consistent use of code-switching will not allow for the development of adequate proficiency in the academic use of the language of instruction in the long run. For this reason, it is important to embed use of code-switching within a broader, strategic plan for use of language in the classroom. Research has begun to explore the effectiveness of planned trajectories of language use that begin with informal use of native language with code-switching between it and the language of instruction (English) and lead eventually to academic use of English (Setati, Adler, Reed & Bapoo, 2002). However, obstacles to the adequate and successful implementation of these language trajectories are yet to be completely overcome.

Given the limited research available, this area of inquiry is still at its initial stages. However, consideration of the findings available so far does allow us to make more subtle judgments and evaluations of language related decisions made in schools and classrooms frequently. This developmental workshop aimed to introduce participants to the available research and encourage discussion of the advantages and disadvantages of the use of code-switching in the science classroom.

Description of Session

The workshop was structured as follows:

1. Introduction (15 mins.): In an introductory presentation the challenge of teaching science to non-native speakers of the language of instruction in the Arab context was surveyed and a quick outline of the kind of research that has been conducted on this problem was presented (see Amin, 2009 for extended review). Participants were provided with

references to allow them pursue any of the ideas presented in more depth (see References below)

2. Presentation and discussion of examples of code-switching (90 mins.): In this main section of the workshop participants were presented with excerpts of teacher lecturing and classroom dialogue that included many examples of types of code-switching. These excerpts were extracted from the published research reviewed above. Each set of excerpts were presented to illustrate a particular type of code-switching to motivate discussion of advantages and disadvantages of mixing languages.

3. General discussion (15 mins): The session ended with a general discussion of code-switching and more generally the challenges of navigating the language policies found in schools.

Conclusion

This developmental workshop aimed to introduce participants to the available research and encourage discussion of the advantages and disadvantages of the use of code-switching in the science classroom. The issue of whether or not, and what particular form, to allow code-switching in Lebanese science classrooms is but one of many language related issues that educators need to become more aware of and actively discuss. We are expecting children to tackle demanding science curricula in a language that they are not comfortable with and our support thus far has been largely limited to teachers' individual efforts. A collective and deliberate effort in the domain is crucial if good quality science education can be provided for all students.

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Can Earthquakes Be Useful?

Mounib El-Eid

Abstract

The title of this contribution may initiate an objection caused by our common sense, since we usually think about the destructive nature of earthquakes. In this contribution, I report on an experiment I have done in a junior-senior course I have taught during the fall semester of 2009-2010 at AUB. The course entitled "Introduction to Astrophysics" included 11 students of physics, mathematics and engineering. My aim was to find out whether motivation for learning can be enhanced through increasing the student's knowledge. I selected one chapter of the course dealing with the properties of the Earth and its atmosphere. I connected this issue with the problem of "global warming" and "Ozone depletion". The outcome of this "experiment" and the feedback of the students will be presented in this contribution.

Introduction

The question on how to motivate and enforce learning is not easy to answer. The reason being, in my opinion, is that learning is group oriented. Understanding the needs of a certain group of students is a crucial element in effective teaching. Students are intellectual persons. Thus, I think that an authentic need of students is to increase their knowledge. If I could address their intellect, I would be very motivating.

Let me illustrate this latter idea. In the program of the course I mentioned in the abstract, one chapter was devoted to the structure of the Earth and its atmosphere. In the next section, it will become clear how useful earthquakes are in getting deep insight about the inner Earth down to the center. Understanding the structure of the atmosphere is crucial for the continuation of life on Earth; the problem of global warming and ozone depletion are famous effects in this context.

The human being cannot influence the processes occurring within the Earth's interior, even with atomic bombs. In contrast, human populations can interfere severely to influence the earth's atmosphere through pollutions of different kinds. Pollution may be avoided if the cause is known. Thus, knowledge about the atmosphere is essential for reducing or avoiding pollution. Also, knowledge about earthquakes is an essential element to minimize their destructive impact. In the next section, I will describe a sample of the material I presented to the students including mathematical tools (not to be included here), which I have used to get their feedback. Such results are present in section four.

How useful are earthquakes?

Earthquakes act as stabilizing factors in the Earth. They are caused by the more or less random motion of the tectonic plates as shown in Fig. 1. An accumulation of pressure between the boundaries of the plates has to be removed which is achieved by earthquakes. In other words, earthquakes are natural manifestations of the earth's geological activities. Therefore, knowing more about earthquakes should enable us to minimize their risks.

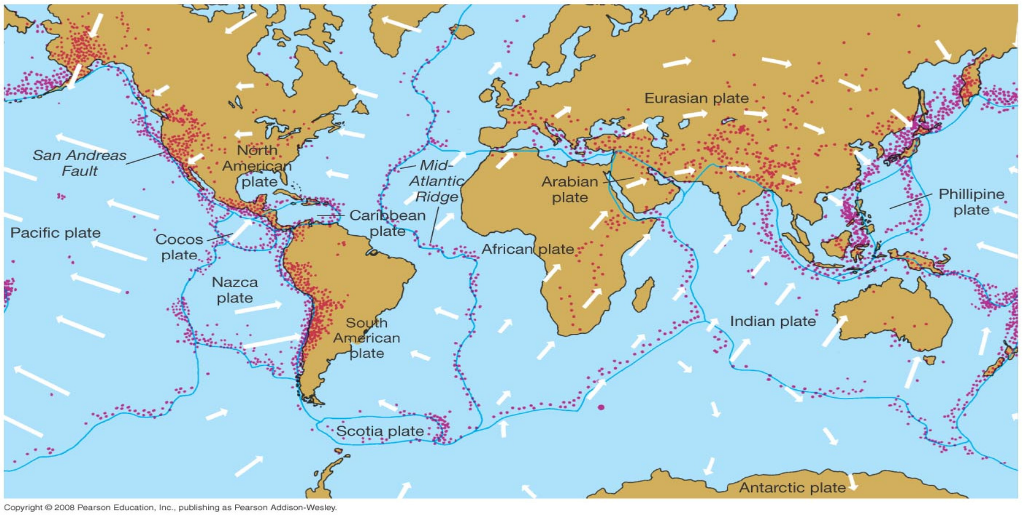

Figure 1 Earth's major plates, the boundaries of these plates are the scenes of violent seismic and geological activities. Most of the earthquakes occur where the plates separate and collide or rub together. The red dots represent epicenters where earthquakes have occurred. This figure is taken from ref. [1].

Seismic waves are actually disturbances generated by earthquakes. There are two types of these waves: transverse waves (or S- waves) and longitudinal waves (P- waves or pressure waves). The two types are illustrated in Fig. 2

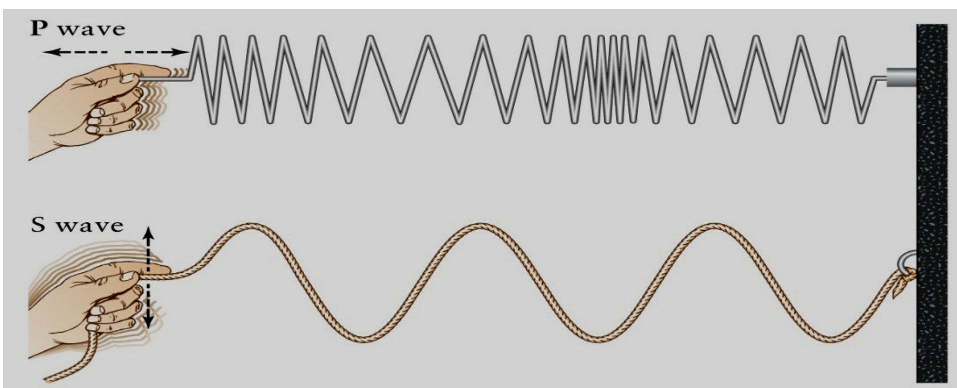

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Figure 2 The two kinds of seismic waves are generated by earthquakes. They travel through the Earth differently. P-waves are analogous to waves produced by pushing a spring, while S-waves are analogous to the waves produced by shaking a rope up and down.

The two types of seismic waves exhibit different behavior. S-waves cannot travel through a liquid medium of the Earth, since they deform the liquid and are consequently absorbed. In contrast, P-waves can travel through a liquid medium as well as a solid medium. This will be explained with the aid of Fig. 3.

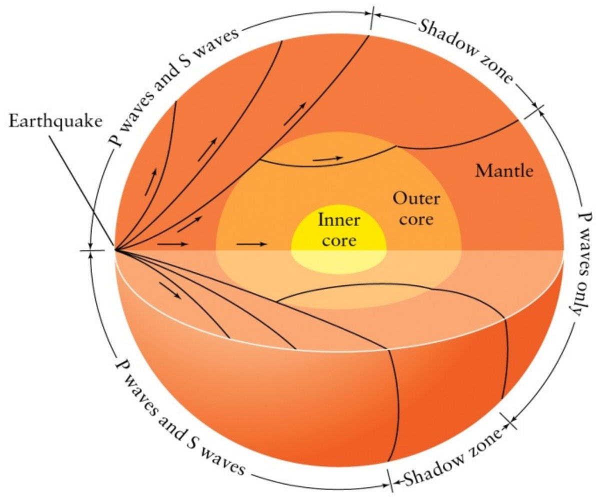

Figure 3 Earth's internal structure and path of seismic waves. Notice how the waves are bent through the different regions. Notice also that no S-waves are observed on the opposite side of the earthquake (see text for explanation).

(a) The absence of S–Waves on the opposite side of the earthquake implies that they have traveled through a liquid medium. They are simply absorbed, since they deform the liquid. However, P– waves travel through solids and liquids.

(b) The existence of the "**shadow zone**", that is also the absence of the P-waves, is due to the specific way in which P-waves are refracted at the boundary between the solid mantle and the molten core. By measuring the size of this zone, it is possible to conclude that radius of the molten core is about 3500 km, about 55% of the Earth's radius.

(c) On the opposite side of the earthquake, the P-waves arrive faster than expected through a liquid region. One can then conclude that they travel through a solid. This is confirmed by looking at the temperature variation inside the earth expected through a liquid region.

Again, earthquakes help to understand structures as deep as 5000 km from the surface. Indeed, the interior of our planet has a curious structure – a liquid outer core sandwiched between two a solid inner core and a solid mantle. Before I started the chapter on the Earth, I made a questionnaire and another one has been constructed after finishing the chapter. The results are described in the next section.

The Experiment in the form of questions (No names were required with the responses)

I. Questions before teaching the chapter "Earth" (12 students responded, number of votes are shown in brackets):

Q1. What do you know about the inner Earth?

(a) Nothing **(2)** (b) little **(4)** (c) basic knowledge **(6)**

Q2. What do you know about the Earth's atmosphere?

(a) Nothing **(1)** (b) little **(2)** (c) basic knowledge **(9)**

Q3. Do you think it is important to know how the Earth's atmosphere is made?

(a) Yes indeed **(12)** (b) I don't care **(none)** (c) why should I know all that **(none)**

Q4. Do you think we can live on this Earth without having its atmosphere?

(a) No need for an atmosphere for life to exist **(none)**
(b) No life without atmosphere around the Earth, even though I don't exactly why **(1)**
(c) Indeed, life depends on Earth's atmosphere and I really want to learn why? **(11)**

II. Questions after teaching the chapter "Earth" (8 students responded, number of votes are shown in brackets):

Q1. Was it useful to learn the details about the Earth?
Responses on this question:

- Yes, very interesting, it is a little difficult without having notes before hand
- I think a bit more details about magnetic field, earthquakes, greenhouse effect and less details about the atmosphere. This student missed the point: all these are related to the atmosphere
- It was worth knowing
- Very useful and important

Q2. Do you think it is worth-telling your friends about the knowledge you have gained?

(a) indeed **(7)** (b) May be **(1)** (c) not important **(none)**

Q3. After you have learned some details about the Earth and its atmosphere, especially about global warming and the ozone problem, are you going to be engaged in active work to protect the environment?

(a) I am motivated to do it **(6)** b) I don't care **(1)** (c) undecided **(1)**

Q4. Are you now convinced that earthquakes are useful?

(a) Indeed useful **(6)** b) I had wrong imagination about earthquake **(2)**
(c) earthquakes are bad actions of nature **(none)**

Q5. Your teacher thought: you will be excited and grateful if he could increase your knowledge about the Earth and its atmosphere. Or, he thought increasing your knowledge may motivate you to learn more.

(a) He was right **(8)**   (b) He missed the point **(none)**
(c) It is not a matter of increasing knowledge. I am interested in having a good score in the course **(none)**

Conclusion

Although the whole experiment that I have done may look too simple, it has, in my opinion, a nice result that the expectation of the teacher should match the needs of the students. I thought about what I was doing and I was right. I am convinced that the student, being an intellectual person, can be highly motivated if he/she starts feeling that his knowledge is steadily increasing. He/she would see the beauty of the subject and the benefit of it at the same time. What makes me convinced about my little experiment is that the evaluation of the students was really high 4.6/5.0.

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Science and Values: "A Story of Challenge"

Diana Sarieddine & Randa Abu-Salman

Abstract

Science is not value-free, on the contrary, there is a story of challenge between both. Values intersect with science; the scientific enterprise is embedded in a set of values in which the latter can emerge from science as a product as well as a process. Integrating values in the teaching of science and assessing learners' acquisition of these values present a challenge for educational research and researchers. In this session, we aimed at proposing different sets of values and suggesting one way for assessing learners' acquisition of these. This was done through several activities, in which attendees were involved in classifying some pre-established values, developing their own and proposing means for evaluating the acquisition of such. In addition, during the session, attendees were introduced, in general, to the notion of values and to the approach used for assessment at our sister schools.

Introduction

Scientific literacy is being emphasized as a worldwide important aim of science education curricula. Developing scientifically literate individuals who: appreciate scientific knowledge, differentiate between evidence and opinion, are capable of understanding and using scientific knowledge to solve personal and societal problems, and understand the nature of science (NOS) (Lederman, 1992). In understanding the nature of science, students realize the sociocultural embededness and subjectivity of the scientific enterprise in addition to other aspects. According to Aikenhead (1996), the scientific enterprise is considered "socialized", where he assumes the existence of an integrated relationship with ethics, politics, social groups, technology etc… Unfortunately, high school science is decontenxtualized from its social environment where science is taught in isolation from society.

According to Allchin (1998), science does express a wealth of *epistemic values* and inevitably incorporates *cultural values* in practice. The pursuit of science as an activity is itself an implicit endorsement of the value of developing knowledge of the material world. And the values of scientific knowledge may well be considered in the context of the values of other social projects. Science is not exempt from ethics or other social values. Individual scientists express the values of their cultures and particular lives and integrate scientific values with other ethical and social values when they engage in scientific activity. Scientists engaging in science activities typically value reliability, testability, accuracy, precision, generality, simplicity of concepts, and heuristic power.

The purpose of this session was to increase participants' awareness and understanding of the central and challenging role that educators face in teaching values within their disciplines and how they can develop means to integrate and teach these values within the process of scientific inquiry. There is a need to develop scientifically literate teachers who appreciate science and understand its nature; educators who can improve scientific curricula by providing learners with a necessary authentic context (socio-scientific issues that would introduce values in science teaching) and by applying teaching methods and questioning techniques that enable higher-order thinking. Thus, this would allow for argumentation and value judgment, which are central constituents of decision-making processes.

Strategy

The following strategy was adopted during the session:

- A short presentation explaining the purpose of integrating values in science teaching and the role of educators in teaching and integrating these values within their science curricula.

- Demonstration of: first, the means for integration of values in science teaching using samples of Performance Tasks/PBL done in our classes; and second, the means of teaching values in our school using samples of unit plan strategies developed at our schools, where the participants were introduced to a set of values in the three scientific disciplines: Physics, Chemistry and Biology and were given guidelines for developing values and for integrating them within the teaching of science. Following this, two examples of different contexts for teaching these values in integration with the teaching of science were discussed: (STS) science technology society and (PBL) problem based learning.

- Group work: Distribution of a certain scientific content from within the science curriculum in the 3 domains, Physics, Chemistry and Biology for different class levels, the participants were asked to develop a set of values relevant to the content and to propose means for teaching them. This was followed by sharing ideas and discussion.

Description of session

A power point presentation was first used for the introduction of the topic, the purpose, and the role of educators. The second part of the session engaged the participants in a task of classifying values within a certain scientific context followed by a brief discussion about the nature of science from a cross-curricular perspective. Based on their work, participants were introduced to some ways of integrating these values in the teaching of science and the means of teaching these values through samples of performance tasks done in our classes and samples of values developed at our schools. In the third part of the session, participants were put in groups and were engaged in hands-on activities to develop a set of values pertaining to a scientific content within the science curriculum and proposed means for teaching them. In the fourth part, participants presented the work done in a gallery, related it to ideas in the presentation, discussed the possibility of integrating values in their science classes in areas where the curriculum lends itself.

<u>Samples of activities used:</u>

Sample of Performance tasks/ PBL projects in the three scientific disciplines and the proposed values after discussion of each:

Food and Fitness

Biology: Grade 9 (Integration of sports and of nutrition)

- Your task as learners is being responsible to open up a fitness center. The criteria followed by the center should encourage customers to enrol since this fitness center not only cares about and provides an appropriate physical activity, but also cares about and provides a balanced and proper diet for a diversity of customers.

Proposed values: wellbeing, efficiency, reliability, commitment, respect for the individual, catering for needs.

Ads sound too good to be true; all you have to do is take a pill!!

Biology: Grade 10

- "All you have to do is take a pill, and you'll suddenly find yourself muscle-bound and full of youthful energy".
- What those ads don't tell you is you'll empty out your wallet and possibly harm your body using an unproven therapy.
- Hormones are chemicals your body makes to help keep your vital organs working properly.
- You work in a public health department, as a health educator, and you are asked to prepare a pamphlet to inform the public about the particular use of one of these hormones.

Proposed values: argumentative writing, , transferring learning into ideas supported by research, awareness, accountability, respect, concern, honesty, integrity, productivity

Keeping Coffee Hot

Chemistry: Grade 7

- Coffee, espressos, and lattes have become more and more popular in our country. Keeping coffee hot has become important to a lot of companies. What things affect how long coffee stays hot?
- You are working in a company for making cups. You have been hired to investigate about some of the factors affecting keeping coffee hot. Your task will be to conduct an experimental study, in order to determine which of the factors will keep the coffee hot for a longer time.
- You will be presenting your report for the manager, to encourage him to use cups with certain qualifications.

Proposed values: accountability, quality of work, practicality, productivity, awareness, ideas supported by research.

Soaps and detergents

Chemistry: Grade 11 SE

- You are currently employed by a major manufacturer of soaps and detergents which has spent years in the development of a new product. Your team has been asked to do a test on the product.
- You must develop and implement a procedure, collect some data, determine what those data mean, and then report your results back to management who will then determine if the new product has lived up to expectations.

Proposed values: Dependability, maximum utilization of resources, productivity, commitment, integrity.

Boat building

Physics: Grade 9

- You are an employee in a boat factory. Your job is to find out the different factors affecting the floating of a boat, as well as the shape and the material the boat is made up of.
- The purpose of this task is to design and construct a boat made up of different materials, and see which boat floats the best using three solutions of different salinity and steel ball weights. You will construct a boat of your own design, and then, as a group, you will test the boats designed by the different members of the group, to see which boat floats the best.

Proposed values: Team work, precision, reliability, efficiency, productivity, quality of work, accountability, safety.

The Effect of Speed on Car-Barrier Collisions

Physics: Grade 8

- After the many accidents occurring in your country, you decided to work for a safety association. You were asked to conduct some research to investigate speed as an important variable regarding force of impact (collision of the car with an obstacle) in order to persuade youth about the dangers of driving at a high speed.
- In this event you will use a model system to investigate how the speed of a car affects the results of the collision of the car with a barrier. You will be varying the location from which a car starts to roll on a ramp.

Proposed values: Safety, respect rules, responsibility, self control, order, concern for others, awareness

Samples of values developed in lesson plans at our schools within the curricula of the three disciplines in Science at different levels:

Chemistry / Biology: Grade 12

- As there is a dynamic equilibrium in a reaction system, there is also a state of equilibrium between all issues that govern our daily life; in relationships, in decision making, in reactions to different stimuli.
- Recognize the factors that affect the state of equilibrium in our daily life: mental, psychological, moral, ethical, social and environmental.
- Identify some characteristics of the state of equilibrium in everyday life: between obligation and duty, between expenditure and earning.

Biology: Grade 9

- Appreciate the delicate and synchronized systemic functions of our body. What governs our behavior depends on our bodies' adaptation to the best possible outcome fit.
- Learners value food as a nutritional source and appreciate its nature which provides them with the necessary energy for performing their bodily activities.
- "How similar we all are in our marvelous variation". (Kenneth Kidd).
- Learners value genetic information as the determinants of their identity. Moreover, they appreciate the diversity and polymorphism of organisms, the human race in specific.

Physics: Grade 8

- Realize the importance of respecting road signs and speed limits.
- Safety precautions in driving: wearing seat belts and using cell phones.
- Accountability to precautions done when there are oil spills on roads.
- Punctuality and good time management lead to safe driving.

On Pollution: All grade levels

- Develop awareness towards sustainable development. (Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.)
- Develop responsibility towards the repercussions of pollution in the environment.
- Be a global citizen. You are a part of this globe create a positive impact.
- Be the change you want to see in the world. (Ghandi). Change starts with you.

Conclusion

The purpose behind this session stemmed from our awareness that the traditional science curriculum aims at: (1) preparing learners for the next level of education, (2) teaching them how to answer directly to specific questions and (3) placing them in separate disciplines of science: physics, biology and chemistry. On the contrary, science integrated with values aims at developing citizens that are capable of decision making; in other words, empowerment of individuals. Such integration allows learners to grasp a firm understanding of their everyday lives, and renders them capable of participating in responsible social/political actions. Thus, the aim is to develop informed decision makers, who appreciate their nature, society, environment, everyday lives.

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STSE as an Effective Strategy that Increases Students' Motivation and Learning in Science Classroom

Rana Iskandarani & Amal Zaatari

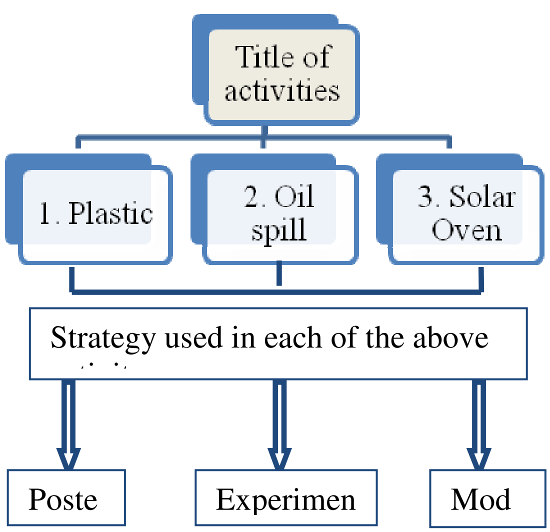
Abstract

It was a great opportunity to present and share our experience with different teachers in SMEC 12. The session provided the teachers with strategies to practice the integration of science and technology in their classrooms. Participants were appreciative of what we presented.
Finally, we thank all those who made that day and our work possible.

Introduction

We live in a rapidly changing world, where the boundaries between science, technology, society and environment are constantly blurred, undefined, and unclear. Problems such as genetic engineering, water and waste management, environmental degradation, global warming and many socio-scientific environmental issues attack us today. One way to address these complex issues is through science, technology and environment education (STSE). STSE seeks to interpret science and technology as a complex social issue in order to promote the development of critical, scientifically and technological literate citizens that are capable of understanding STSE, making informed decisions and acting upon those decisions. Although STSE has been taught within the past few years, it has made fewer strides in practice. We suggest that science teachers play a role in the adoption of the STSE perspectives and simply implement issue-based STSE which will challenge the traditional images of a science teacher and science instructional ideologies.

Strategy



Description of session

Participants were divided into three groups where each was given 30 minutes to finish their assigned activity. The three activities were the following:

➢ <u>First activity</u>:

Plastics

Background

Plastic is all around us. Plastic is versatile, lightweight, flexible, moisture resistant, durable, strong and relatively inexpensive. It can also be chemical resistant, clear, opaque, and practically unbreakable. But the widespread use of plastic is causing unprecedented environmental problems and serious health risks, especially for children. Plastic should be used wisely, with caution and only when suitable alternatives do not exist or are not available.

Task

In this activity you will:

1. **Identify** the code present on the bottom of plastic containers.
2. **Record** the properties of each plastic code.
3. **Decide** which plastic container is safe to use for food storage.

Procedure

1. **Read** the plastic code chart.
2. **Fill** in the table (student sheet 1) by examining the plastic items provided.
3. **Read** student sheets 2 &3 to complete the charts about the properties and dangerous uses of plastics with BPA and Phthalate.
4. **Use** the information on student sheet 1 and the summary of the charts to make a poster about plastics.
5. The poster should **include**:
   a. Types and codes of plastic items safe and unsafe to use.
   b. Effect on health when using plastics with BPA and Phthalate.
   c. Pictures. (Provided)

Plastic code Chart

When you turn a plastic container over, you will generally find a code number stamped or printed on the bottom of the container and surrounded by a pyramid of arrows. Those codes identify the type of plastic used in manufacturing that item. Here is an explanation of what those codes mean.

Code & Symbol	Name	Properties	Product Application
1 PETE	PET or PETE	Clarity, toughness, barrier to gas and moisture, resistance to heat.	Plastic soft drink and water bottles, beer bottles, mouthwash bottles, peanut butter and salad dressing containers, oven film, oven pre-prepared food trays.
2 HDPE	High Density Polyethylene (HDPE)	Stiff, resistant to chemicals and moisture, permeable to gas, easy processing.	Milk, water, juice, cosmetics, shampoo, dish and laundry detergent bottles, trash and retail bags, yogurt and margarine tubs, cereal box liners.
3 V	Polyvinyl Chloride (V or Vinyl or PVC)	Versatility, ease of blending, resistance to grease/oil and chemicals, clarity.	Toys, clear food and nonfood packaging, shampoo bottles, medical tubing, wire and cable insulation, construction products such as pipes, flooring, carpet backing, window frames.
4 LDPE	Low Density Polyethylene (LDPE)	Easy processing, barrier to moisture, flexible, easy sealing.	Dry cleaning, bread and frozen food bags; squeezable bottles (i.e., honey, mustard).
5 PP	Polypropylene PP)	Resistance to heat chemicals and grease/oil, barrier to moisture.	Ketchup bottles, yogurt containers and margarine tubs, medicine bottles.
6 PS	Polystyrene (PS)	Versatility, insulation, clarity, easily foamed ("styrofoam").	Compact disc cases, foodservice applications, grocery store meat trays, egg cartons, aspirin bottles, cups, plates, cutlery.
7 OTHER	Other	Dependent on resin or combination of resins.	Hard clear plastic used to make baby bottles, water pitchers, , three and five-gallon reusable water bottles, food containers, compact discs, cell phones, automobile parts, computers.

Student Sheet 1

Name of the plastic item	**The plastic container code**	**Type of plastic (e.g. PETE, HDPE, PVC, PS...)**	**Texture test: Smooth or textured)**	**Flex test(Does it bend?) yes or no**	**Scratch test: easy or hard**	**Clarity (Clear or opaque)**

Student Sheet 2

Phthalates

Phthalates are a class of chemicals that are added to children's plastic toys and teethers to make them more flexible. They are also found in many households, personal care products, and medical supplies.

- *Effect on health:*

  Phthalates are not bound to PVC, so when they are mouthed or chewed by children, they can be ingested, leading to: liver and kidney damage or breast cancer.

- *Phthalates are found in:*

  Plastic containers with recycling number 3
  Plastic items that have a “plastic-y” smell
  Rubber baby toys
  Teethers
  Play dough
  Play make-up (particularly nail polishes)
  Vinyl floors, wallpaper
  Shower curtain
  Lotions, shampoos

- *Tips for Avoiding Phthalates:*

1. When choosing shampoos, soaps and lotions for your children, watch for the term "fragrance" in the ingredient list. This is a clue that a combination of chemicals which may include phthalates may be present.
2. Choose plastics with the recycling code 1, 2 or 5. Keep in mind that you will not find recycling codes or material labels on all products, so check trustworthy resources that provide well-researched, non-toxic product guides.
3. Pregnant mothers should avoid personal care products and plastics containing phthalates. Phthalates may cross to the unborn baby and cause hormone disruptions in the baby.

Student Sheet 3

Bisphenol A (BPA)

BPA is a chemical used primarily to make plastic durable and scratch-resistant. It can leach off polycarbonate plastics used over a long period of time, when mouthed by young children or while heating during washing, microwaving, or scratching.

- *Effect on health:*

  BPA in plastics have been linked to cancer, birth defects, structural damage to the infant's nervous system such as brain/heart disease, diabetes and obesity in children, and changes in behaviour such as hyperactivity.

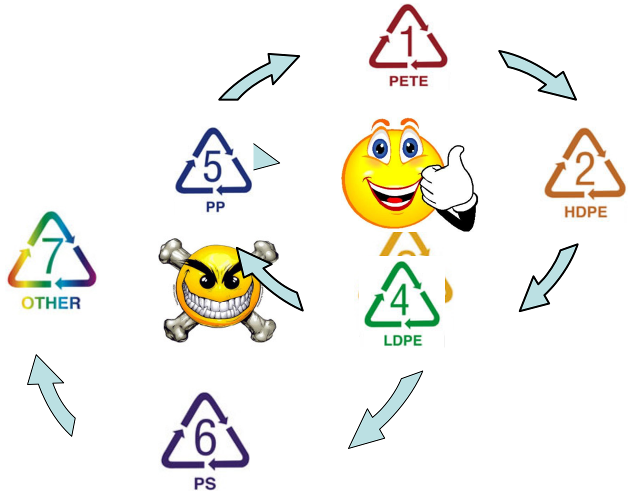
- *BPA is found in:*

  Transparent Plastic container or baby bottles with recycling number 7 and the letters PC, which stand for "polycarbonate" plastic.
  Inner lining of food and beverage cans
  Hard plastic water bottles
  Food storage containers
  Sports equipment
  Plastic toys
  Plastic drinking cups
  Sunglasses and eyeglasses

- *Tips for avoiding BPA:*

  1.Avoid heating plastic containers with the recycling number 7 and the letters PC in microwave ovens or by adding boiling water into them, particularly when preparing infant formula.
  2.Wash the containers by hand with warm water and soap, instead of in dishwashers.
  3.Use stainless steel and glass water bottles.
  4.Throw away worn or scratched polycarbonate plastic containers.
  5.Pregnant women should eat or cook fresh or frozen products instead of canned foods to reduce infant exposure to BPA.
  6.Use wooden toys instead of plastic ones.
  7. Do not store acidic of fatty food in plastic containers.

Pictures of plastic codes and examples



➢ **<u>Second activity</u>:**

OIL SPILL

Objective

By the end of this activity, the students will be able to:

- perform an experiment using different kinds of sorbents to clean oil spills
- identify the best sorbent to clean oil spills
- explore different methods to clean an oily feather
- identify the best method for cleaning an oily feather

Background information

More than 60 million gallons of oil enter the oceans every year, but it's not reported on the news. Naturally, oil seeps from oil-bearing rock layers into the ocean. However, oil leaks mainly happen accidently when tankers running aground spill oil. Currently, these accidents deposit about 37 million gallons of oil into the ocean every year. The largest amount of oil entering the ocean through human activity is the 363 million gallons that come from industrial waste and automobiles. When people pour their used motor oil into the ground or into a septic system, it eventually seeps into the groundwater. Coupled with industrial waste discharged into rivers, oil becomes part of the run-off from waterways that empty into the ocean. All of this oil affects ocean ecosystems. When an oil spill occurs in the ocean, the oil may spread across miles of open water and up onto beaches, littering them with tar balls. The coastal areas that are the habitat for fish, birds, and other wildlife are often the most vulnerable. Animals may perish when the oil slicks their fur or downy feathers, decreasing the surface area so they are no longer insulated from the cold water. Or the animals may ingest the oil, and then become sick or unable to reproduce properly. When an oil spill occurs along a coastline, it affects the human population as well as wildlife.

Methods to clean oil spills

There are a wide range of methods that may be used to clean oil spills. Which methods and tools oil spill responders choose depends on the circumstances of each event: the weather, the type and amount of oil spilled, how far away from shore the oil has spilled, whether or not people live in the area, what kinds of bird and animal habitats are in the area, and other factors. These methods include:

- *Mechanical*

1. Booms- It's easier to clean-up oil if it's all in one spot, so equipment called containment booms act like a fence to keep the oil from spreading or floating away.

2. Skimmers- are machines that suck the oil up like a vacuum cleaner, blot the oil from the surface with oil-attracting materials, or physically separate the oil from the water so that it spills over a dam into a tank.
3. Sorbents- These are materials that soak up liquids by either absorption or adsorption. Oil will coat some materials by forming a liquid layer on their surface (adsorption). Absorbent materials, like paper towels, are used to soak up oil from the water's surface or even from rocks and animal life on shore that becomes coated with oil.

- *Chemical*

1. Dispersants- such as detergents, break apart floating oil into small particles or drops so that the oil is no longer in a layer on the water's surface. The problem with this method is that dispersants often harm marine life and the dispersed oil remains in the body of water where it is toxic to marine life.
2. Burning- Burning of oil can actually remove up to 98% of an oil spill. The spill must be a minimum of three millimeters thick and it must be relatively fresh for this method to work.

- *Biological*

Bioremediation- There are bacteria and fungi that naturally break down oil. This process is usually very slow- it would take years for oil to be removed by microorganisms.

<u>Experiment I</u>: Cleaning an Oil Spill

Materials

- Measuring cup
- Vegetable oil
- Three kinds of sorbents (cotton, nylon stocking, Styrofoam)
- Droppers
- Liquid detergent
- Watch
- Rubber gloves
- Tweezers
- Waste bucket
- Paper towel
- 250 ml graduated cylinder
- Container
- Spoon

Procedure

1. Fill the graduated cylinder with water until it reaches 150 milliliters. This should fill your ‘ocean’ container about half full when you pour the water in.
2. Using a graduated cylinder, measure out 25 milliliters of oil. SLOWLY pour the oil into your container so that the surface of the water is covered with an oil layer that is 0.5 cm thick.
3. What happens to the oil? Does it sink or float?
4. You job is to clean up the oil spill, using any of the clean-up tools provided. Use a watch to keep track of how much time you use to clean up the oil using this tool (3 minutes for each trial). How successful were you? What estimated percentage of oil were you able to clean up? Record your results in table 1.
5. Repeat the simulation by adding oil to replace the amount that you cleaned up. Try different material to clean the oil spill. Make sure you record your results in table 1.
6. Create another oil spill .This time add 5ml of detergent directly to the oil. Stir water to mix the oil and detergent. Record your observation.

Table 1: Results of “Cleaning up an Oil Spill” experiment

Material	Type of cleaning method (sorbent, skimmer, etc.)	Time needed	Estimated % of oil cleaned up	Comments: (i.e., not very effective, left with oily cotton, etc.)

Which material cleaned the oil spill? ______________________________

Which is the fastest method to clean an oil spill? ______________________

Which clean-up method has the least impact on the environment?

____

____

____

____

____

Effect of Oil Spills on Sea Birds

Sea birds have a high risk of contact with oil spills due to the amount of time they spend on or near the surface of the sea or on oil polluted shores. And while searching for food, since several species of fish are able to survive beneath floating oil. The effects of oil spills on sea birds are:

1. When birds come in contact oil spill, the thick and heavy oil coats their feathers and affects their ability to stay afloat on water surface due to the increased weight and lack of air trapped in the feathers.
2. Oil damages the interlocking mechanism of birds' feathers by breaking down its water proofing and thermal insulation properties. This will prevent them from being able to keep their body temperatures constant.
3. When birds preen their feathers, they ingest oil and poison themselves with the toxic chemicals.
4. Oiled birds can transfer oil to nesting material and eggs, which can be lethal to young.

Method to clean oiled birds

For birds to survive oil spills, well-equipped bird-rescue crews must be mobilized quickly. Once the birds are stabilized, the cleaning process begins:

- The animals are placed in plastic dish tubs and, using a mixture of warm water and mild soap, rescue workers scrub the birds' feathers. For the eyes and ears, a water pick or toothbrush is used to avoid damaging sensitive organs. Birds don't like to be handled, so it is done quickly but efficiently.

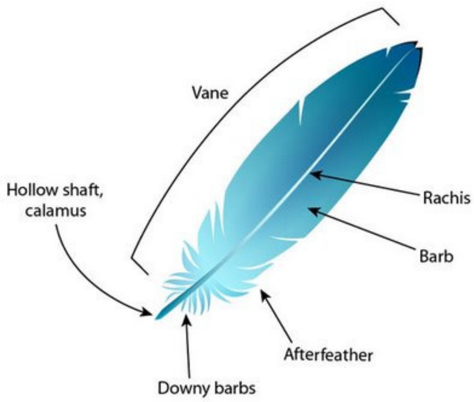
- Once scrubbed, the birds are rinsed with warm water, placed in cages with air dryers to dry.

- Then, birds are released into a warm water pool to get their feathers in order. As part of the preening process, the birds rub natural oil, which is secreted from a gland at the bottom of their tails, over their feathers. The oil acts as a conditioner.
- When the birds regain their natural weight, they are released back into the wild.

<u>Experiment II</u>: Cleaning Oily Feathers

Materials

- Five clean bird feathers
- Four bowls
- Vegetable oil
- Dish-washing detergent
- Hot and cold water (the hot water should be about the same temperature you'd use to wash dishes and not too hot to put your hands in)



Procedure

1. Closely examine your feather and write down how it feels like?
2. Hold the feather in your hand and drop it. What happens?
3. Gently break apart the interlocking mechanisms of the feather to see how the tiny barbs break apart. Then stroke your fingers with the contour of the feather and watch how the barbs hook back together to keep feathers strong and smooth.

4. Fill a bowl with clean water. Take a bird feather and put it in the bowl. Note how the feathers repel water, allowing it to float.
5. Dip a feather into the oily water. Then take your feather out and examine it. How does it feel like?
6. Hold the feather in your hand and drop it. Does it fall with the same speed as the clean feather? ___________________________
7. Gently break apart the interlocking mechanisms of the feathers to see how the barbs break apart. When you stroke your fingers with the contour of the feather, do the barbs hook back together? _______
8. Put the oiled feather in the clean water bowl and write what happens and why?
   ____
9. Get a bowl and add some vegetable oil. If you'd like, you can mix a little cocoa powder with the vegetable oil to make it show up better and look more like crude oil.
10. Fill the bowl with water to 2 cm below the rim. Pour some oil on the water.
11. Dip three feathers into the oil.

Try the three methods to clean oily feathers:

a. Cold water washing: Put some cold water in a bowl, and then try washing one of the oiled feathers in it. Watch what happens.
b. Hot water washing: Put some hot water in a bowl, and then try washing one of the oiled feathers in it. Watch what happens.
c. Washing with detergent: Put some hot water and detergent in a bowl, and then try washing one of the oiled feathers in it. Watch what happens.

Take a look at the feathers now, and then try to answer the following questions in complete sentences.

1. Which of the above three method is the best to clean oiled feather?

____
____
____

2. How do you think oil spill might affect the survival of a water bird having these feathers?

____
____
____

3. Imagine that you're washing a real, live bird that has been oiled. What things would you need to think about? Which method would you choose to clean the bird?

____
____
____
____

- **Third activity**

Solar Oven

Objective

By the end of this activity, students will be able to:

- identify the importance of sun as a source of energy
- make a model of a solar oven
- test the solar oven to see if it works well
- think of ways to improve a solar oven

Background information

Our sun is a constant source of energy. Each day, the sun bathes our Earth with unimaginable amounts of solar energy, most of which comes in the form of visible light. Sunlight is the most important source of energy for all living things. Without it, Earth would be lifeless. Sunlight can be a practical source of energy for everyday jobs such as cooking, heating water, or warming up homes. The challenge is to find ways to transform sunlight into usable heat. The most efficient way to transform sunlight into heat is to concentrate sunlight onto a dark surface. Dark surfaces absorb most of the visible light that falls upon them and reflect very little. Visible light that is absorbed this way usually causes the dark-colored surface to warm up. Of all colors, the black color is able to absorb most of the light and transfer it to heat energy.

- **Choose one** of the following models of solar oven to make your solar oven.

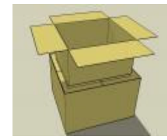
Simple Solar Oven

Materials

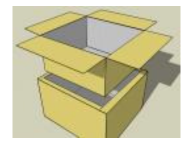
- 2 cardboard boxes (one smaller than the other).
- Cling film.
- Aluminum foil
- PVA Glue and duct tape
- Cardboard
- Brushes for painting and gluing
- Scissors
- Matt black powder paint – mix with water

- Wadding (straw, shredded paper, or other insulation material)
- Plastic bag or oven bag to house the pots

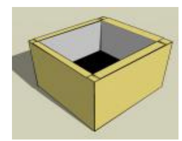
Procedure



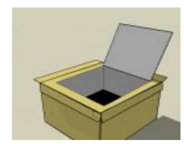
• Find two boxes. One should fit inside the other with a 3 cm space on each side. The space will be filled with newspaper.
• Line the bottom of the large box with crumpled newspaper.



• Place the smaller box inside the larger box.
• Fill the space between the sides of the two boxes with crumpled newspaper.
• Line the sides of the inner box with aluminum foil. You can use a non-toxic tape or fold the edges of foil over the top of the box to hold it in place.
• Cover the bottom of the smaller box with black construction paper.



• Lay a piece of cardboard on top of the large box and trace the shape of the box onto the cardboard.
• Add 2 inches around the trace line and cut out to make a reflector.



• Cover the cardboard piece with aluminum foil. Smooth out any wrinkles and secure the aluminum foil to the cardboard with non-toxic glue or tape.
• Staple the reflector to the outside back of the large box.
• Situate the oven with the box opening up and the reflector facing the sun for maximum heat.
• Place food to be cooked in the solar oven.
• Stretch clear plastic wrap across the top of the large box. Secure the plastic with tape around the entire box.

Questions

1. How could you increase the efficiency of this cooker?
2. What is the purpose of having insulation (shredded paper) around the baking chamber?
3. What would happen if you painted the inside of the baking chamber white instead of black?

❖ Windshield Shade Solar Cooker

Materials
• Car windshield shade
• Velcro
• Oven or grill rack
• Plastic baking bag

• Bucket
• Black pot

Procedure

- Lay the sunshade out with the notched side toward you.
- Cut the Velcro into three pieces, each about 4 cm long.
- Sew one half of each piece, evenly spaced, onto the edge to the left of the notch. Attach the matching half of each piece onto the underneath size to the right of the notch so that they fit together when the two sides are brought together to form a funnel.
- Press the Velcro pieces together, and set the funnel on top of a bucket or rectangular plastic wastebasket.
- Place the oven rack inside the funnel so that the rack rests on the top edges of the bucket or wastebasket. Since the sunshade material is soft and flexible, the rack is necessary to support the pot.
- Put a black pot inside a plastic baking bag.
- Place the black pot on top of the oven rack.

Tips & Warnings

• You can use a stick to hold the oven open in windy weather.
• You can move the cooker to maximize the gain from the sun.
• After using your oven, simply fold it up and use the straps normally for storage.
• The contents inside your solar oven will be very hot, so that the food should be remove with caution

❖ The Paracuina Solar Cooker

Materials

• An umbrella (if possible, with a minimum of 120 cm of diameter when open)
• Aluminum foil
• White standard glue
• A manual saw for metals
• A manual drill
• A tripod (any support for flowerpots of 3 legs will serve)
• Tools: tape measure, a brush, permanent labeler, scissors.

Procedure

- Open the umbrella
- Stick, with white glue, one strip of aluminum paper on each of the "sides" that form the umbrella.
- Using a pair of the scissors, cut and stick more aluminum pieces to fill the places of the umbrella that still haven't got reflector.
- PAY ATTENTION: Use sunglasses at this point!
- Put the umbrella facing the sun, locate on the handle with the permanent labeler, the most shining zone.
- Using drill, make a hole to penetrate the plastic piece that moves above and under the handle and the handle. Through this hole, pass any elongated piece that blocks the movement of folding (a pencil, a brush, etc.)
- Once the umbrella is blocked, cut the handle with the manual saw. Remember to keep the handle since the cooker will be able to be folded.
- Mark with the labeler the points where the tripod will stand and make holes with the scissors.
- Insert the legs of the tripod in the holes.
- Cover the pot with an oven bag and put it on the tripod.






After all the groups finished doing an activity, each was given 15 minutes to present their activity and answer the questions.

Conclusion

It was a great opportunity to present and share our experience with different teachers in SMEC 12. The session provided the teachers with strategies to practice the integration of science and technology in their classrooms. Participants were appreciative of what we presented. Finally, we thank all those who made that day and our work possible.

A Holistic Context of Teaching Science: An Integrated Approach

Rola Sarouja & Salwa Rifai

Abstract

Integration aims at giving the learners a holistic instead of a fragmented outlook on their studies. This overcomes the separation between form and function in students' minds. A holistic curriculum is inquiry-driven, interdisciplinary and integrated, and based on explicit assumptions of interconnectedness. Central to the aim of achieving a well-balanced personality through education, is to have values across the curriculum, integration of disciplines (inter and intra), and

the process of teaching and learning both inside and outside the classrooms. In this session, samples of integrated activities between science and other subjects were presented, afterwards an application of how to integrate a science theme with other subjects was done.

Introduction

Integration aims at giving the learners a holistic instead of a fragmented outlook on their studies. Thus, the topics can be presented in a more meaningful way. This overcomes the separation between form and function in the students' minds of the system concerned.

Strategy

What is Holistic Education?

Holistic education is concerned with the development of learners' intellectual, emotional, social, physical, artistic, creative and spiritual potentials. It seeks to engage learners in the teaching/learning process and encourage personal and collective responsibility. A holistic curriculum is inquiry-driven, interdisciplinary and integrated, and based on explicit assumptions of interconnectedness.

Benefits of holistic education

A holistic curriculum encourages learners to be active learners who explore, understand and participate in the world around them. By exposing learners to a wide variety of disciplines, they can fine-tune both cognitive and non-cognitive skills while preparing for a well-balanced life outside of school. Central to the aim of achieving a well-balanced personality through education, is to have values across the curriculum, integration of disciplines (inter and intra), and the process of teaching and learning both inside and outside the classrooms. Thus, having these values as the platform for character building, the teaching of various subjects should aim at developing different learners' potentialities and interests.

Need for integration

"Knowledge learnt in isolation is rapidly forgotten".

Here comes the importance of integration which according to the dictionary means "to make entire". Integration is defined as the organization of teaching matter that interrelates or unifies subjects frequently taught in separate academic courses or departments. Often learners don't solve problems because they don't understand the context in which the problems are embedded. The separate subject curriculum can be viewed as a jigsaw puzzle without any picture.

Benefits of integration

- Each discipline becomes stronger in its own merit

- There is increased mutual respect among teachers of various disciplines; promotes interdepartmental collaboration
- Teachers improve their teaching skills and expand their repertoire of strategies and techniques
- Enthusiasm and motivation among students
- Increases learners achievements in different disciplines
- Helps the constructivist approach of hands-on minds-on learning.
- Reduces fragmentation of courses
- Prevents repetition and waste of time
- Learners earn to apply their knowledge to practice

Flaws with the present system are:

- Unnecessary repetition
- Disjointed approach to teaching
- Confusion in the learner's mind due to difference in opinion
- Disunity and hence the subject as a whole is never grasped. This discourages students from learning and they get disinterested in applying their knowledge to practice.

Methods of integration

Integration can involve two or more subjects and it covers the following aspects:

1-Integration of values: in every lesson plan, values including social, spiritual and moral are integrated.
Examples of values:
1- Appreciate God's creations
2- Respect each other while working in groups
3- Appreciate the importance of nature and protect our environment
4- Work cooperatively in groups
5- Appreciate the importance of non-living things to living things

2-Integration of themes

3-Integration of competencies/skills: Interdisciplinary skills include skills that are used in several subjects rather than exclusively belonging to one subject. Most of these skills are taught in the elementary level and used in intermediate and secondary classes.
How to integrate?
First, by using scientific methods in the other subjects, and secondly, by looking at the scientific aspects of other subjects.

Procedure:
1- Preparation of vertical progression
2-Preparation of yearly plans
3- Coordinators board meeting where parallel scheduling takes place: parallel scheduling can be related either to concept and/or skills and /or theme.

4- Class meetings: teachers share new ideas for integration where outings and field trips can be part by serving concepts and/or skills and/ or themes

Description of session

We proposed several examples of integration of science with other subjects. At the end of the workshop, attendees were given term plan **(Annex 1)** and they were asked to propose integration activities of science with other subjects. The attendees worked in groups and presented their work that was discussed; they showed interest in the proposed integration activities and shared different experiences about integration in their schools.

Conclusion

Integration between different subject matters especially science concepts and their application to real life will develop the holistic education of learners. It is vital for dynamic teachers to emphasize "integration" of science with other subject matters by:

- Making time for integrative reflection and relate the topics to the learners' real life so they will understand and comprehend the science concepts in a meaningful way
- Adopting different strategies, techniques and tools in implementing integration
- Coordinating and discussing with other teachers to create cross-disciplinary units and facilitate implementation of integration
- Always remember: "It is possible to store the mind with a million facts and still be entirely uneducated." (Alec Bourne)

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Eric Maass,2001,how could I integrate science with other subject matters

Emergent Conceptions of Subject Integration in Teacher Education: An Action Research Study by Sandra Blenkinsop and Penelope Bailey,1996

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http://www.sedl.org/afterschool/toolkits/science/pr_integrating.html

Appendix I

Term 3				
Subject	**Title**	**Values**	**Integration**	**Project**
Arabic	الوحدة الثّالثة: الرّسالة والإعلان: – الرّسالة الإخوانيّة. – أرزه رمزه. – الاختيار صحّة.	– حسن الضّيافة وإكرام الضّيف. – لكلّ بلدٍ مميّزاته. – المحافظة على البيئة وعلى الثّروات الطّبيعيّة. – تجنّب الوقوع فريسة للإعلانات الهدّامة.		
	الوحدة الرّابعة: البيئة: –زراعة تحترم البيئة. –بنتاعل اللّبنانيّة محميّة الصّنوبر والسّنديان. –نشيد البيئة.	– تقدير جمال الطّبيعة والعمل على المحافظة على معالمها.		
English	Unit 4: Problem Solvers - The last dragon - Sing to the stars -Unit 5:Heroes - Martin Luther King - Gloria Estefan	Learn how to solve problems and overcome difficulties. Appreciating hard work and determination. To accept people as they are. Establish equality between all people.		

	Unit 5: Heroes - Doctor King - Gloria Estephan	Learn to use power and fame to support those who are in need.		
	Unit 6: Friend and foe - Salmon summer - Wild fires	Appreciate how working independently helps an individual construct his own identity. Appreciate positive and negative perspectives of natural disasters.		
French	Unite 3: Papa loup et maman poule	- Reconnaître la valeur des aliments - Apprendre à vivre en compagnie, protéger les autres animaux et prendre soin d'eux. - Avoir pitié des petits animaux innocents. - Se réjouir de la présence des autres. - Apprendre à ne pas être égoïste. - Reconnaitre le rôle du père. - Apprécier l `affection familiale.		
	Unité 4 : SOS danger sur la terre	-Reconnaître la valeur de la nature -Respecter les animaux -Découvrir la richesse de la terre. - Apprendre à protéger les animaux.		

Math	Geometry Dividing by one-digit divisor Fractions	- Appreciate and respect differences between people. - Try to intersect with your goals. - Good and evil should be parallel: they never meet. - Measure and cherish your deeds and try to convert them to the best. - Value each person's space and privacy. - Our hands, hearts and voices will always be in the circle of trust. - Always support and stand up for each other to the power two.		
Technology	Unit 5: Force and pressure	-Appreciate group work -The importance of safety rules		
	Unit 6: Electricity Hazards			
جغرافيا	الوحدة الرابعة: المجال الجغرافي وتوزع السكان	– يدرك أهمّيّة التواصل بين الشعوب – يعي ضرورة ترشيد المياه		

تاريخ ومدنيات	الوحدة الرابعة: التواصل	– يدرك أهمية التواصل بين الشعوب من أجل تحقيق المبادئ الإنسانية (محاربة الفقر– المساعدة على تدارك الكوارث الطبيعية و البشرية – يدرك أهمّيّة تقريب المسافات بين الشعوب		

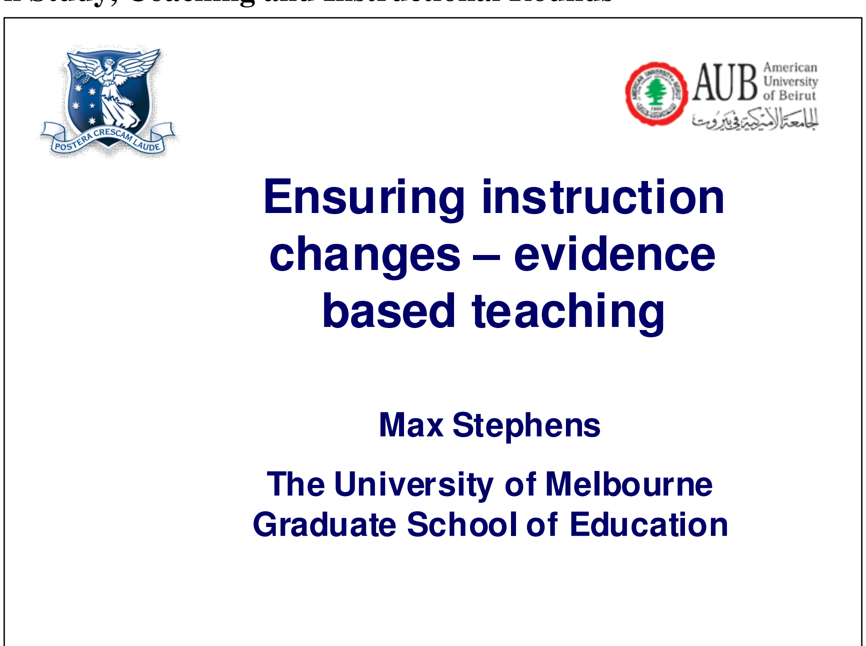
Sciences	Title	Values	Integration	Project
	Unit 5: Solid Earth -structure of Earth -Earth's surface -Natural Disasters			

Science and Mathematics

Ensuring Instruction Changes- Evidence Based Teaching-Looking Closely at Three Models: Lesson Study, Coaching and Instructional Rounds

Max Stephens

SLIDE 1



SLIDE 2

Three strategies for improving teaching and learning

- Lesson Study
- Coaching
- Instructional Rounds

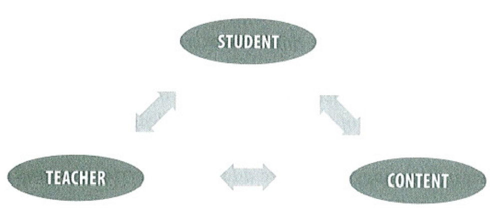
What is the common element that binds together these three strategies?

SLIDE 3

Defining the Instructional Core

- The word may be new but it is the common element that binds together all three strategies:

FIGURE 1.1 THE INSTRUCTIONAL CORE



SLIDE 4

Seven Principles

FIGURE 1.2 SEVEN PRINCIPLES OF THE INSTRUCTIONAL CORE

1. Increases in student learning occur only as a consequence of improvements in the level of content, teachers' knowledge and skill, and student engagement.
2. If you change any single element of the instructional core, you have to change the other two.
3. If you can't see it in the core, it's not there.
4. Task predicts performance.
5. The real accountability system is in the tasks that students are asked to do.
6. We learn to do the work by doing the work, *not* by telling other people to do the work, *not* by having done the work at some time in the past, and *not* by hiring experts who can act as proxies for our knowledge about how to do the work.
7. Description before analysis, analysis before prediction, prediction before evaluation.

City et al. p. 23

SLIDE 5

Four steps to improving teaching and learning

- Teaching and learning need to be seen as linked.
- Teachers need to identify and focus clearly on one or more "problems of practice"
- Teachers need to develop appropriate skills to help them critically examine instruction and its impact on the quality of students' learning
- Teachers and other key agents in the school need to build a shared vision of what improved teaching could look like

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SLIDE 6

Moving ahead on a "problem of practice"

- A "problem of practice" is how the team expresses a problem for students' learning:
  - What changes to current teaching are likely to overcome that problem?, or
  - What kind of teaching may have brought about the problem in the first place?
- Here the focus is on the first meaning

SLIDE 7

Linking Learning and Teaching

- The starting point is current practice
- The challenge is to identify a specific "problem of practice" in which current teaching:
  - may be falling short
  - can be made more effective
- And ensuring that teachers will be involved directly in bringing about change and will know when it has taken place

SLIDE 8

Focus on the Instructional Core

- The term "Instructional core" is defined as the interactions between teachers, students and content.
- The links between learning and teaching have to be taken seriously following this initial phase of locating a "problem of practice".
- How will teachers work seriously on this over weeks and months?
- How can teachers be helped to work together to examine their instructional practice/core?
- There is always a temptation for teachers to move outside the instructional core – and to locate problems elsewhere e.g. lack of money, poor school leadership, tests are too difficult, our students can't, not enough time, our parents don't…(you know the story, etc)

SLIDE 9

Examining the Instructional Core

- Having teachers examine their own practice, to relate it to a school's instructional core and to talk about it with other teachers is a new experience for many.
- A warning: Teachers who are worried about
  - classroom management or
  - lack of support from the school administration or
  - lack of engagement by students

  are not ready to think about the quality of teaching (i.e. instructional core) until these more basis concerns are addressed.
- Teachers also need to develop some skills and protocols before this work can commence.

SLIDE 10

Examining the instructional core

- In examining teaching itself, there needs to be a solid respect for being objective and scientific. This is shown by:
  – Respect for evidence
  – Cultivation of a shared and precise vocabulary
  – Collaborative conversations guided by shared norms
- The danger is that conversations about instruction don't go very deep.
  – Sometimes this is described as "happy talk", i.e. talk that doesn't really challenge practice. Instances of "happy talk" are: "the students appeared really interested in the lesson", "they were engaged for the whole lesson", "the lesson was well planned". You know this kind of talk very well.

SLIDE 11

Linking Learning and Teaching

A possible activity:

- Having identified several areas where most students are not performing well, ask teachers to brainstorm why they think this is a problem for the school.
- Ask teachers to write down their "hypotheses" ("explanations") on Yellow post-its and to hand them to you. (Each teacher can come up with no more than three possible explanations of poor performance. Teachers' names should be not be attached.)
- You then place the Post-its on a white board.
- As a first analysis, how many of the hypothetical explanations start with "students don't or can't", or focus negative things about students? Are teachers seeing the problem in terms of what students can't do and what they lack in mathematics learning?

SLIDE 12

How to move the conversation forward to talking about teaching and what teachers can do?

- Students don't come to high school adequately prepared for complex problems.
- Students aren't able to think abstractly.
- Students give up when the problem is hard.
- The vocabulary on the state math tests is unfamiliar to students.
- Students have a math phobia—they think they can't do math.
- Students aren't familiar with the format of the state test.
- Students have a lot of social and emotional issues.
- Students are working after school, and they don't do their homework.

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SLIDE 13

Notice that all these responses locate the problems with "students" and what they can't do

- How will you move the conversation from "students" (or "parents" or "community," etc.) to "teachers"?
- How will you frame the work as an opportunity to improve instruction, rather than as a failure (proactive vs. reactive)?
- How will you help teachers have a questioning rather than a defensive stance?
- How will you surface and get people to acknowledge the fundamental assumption that teaching matters for learning?

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SLIDE 14

Linking Learning and Teaching

The activity (continued):

- For a next round of analysis, look at the explanations offered:
- How many of these focus on the curriculum, or upon teaching/instruction, motivation/expectations, or on problems with tests, and have a final ("the rest") category for things that teachers have no control over themselves
- After discussing these explanations, then ask teachers how many of their given explanations could be re-framed in terms of teachers and teaching?
- Use a different colour of Post-it to overlay any explanations where the subject has now been changed to "teachers can" or "teaching .."
- Which of these are seen as feasible, i.e. worth working on
- This is a useful first step to focus thinking on teaching and to identify what changes to teaching can be undertaken.

SLIDE 15

Which of these responses is more likely to clarify a "Problem of practice"?

There's too much math to teach in a year—no time to spend on long problems.	Parents don't know the math, so they can't help their kids.	Teachers spend most of their time on applying formulas, not on complex problems.	I put multistep problems at the end of assignments, and they are often skipped.
I don't really teach strategies for doing multistep problems.	Teachers spend too much time lecturing at students and doing all the work.	Students don't practice on their own enough.	The math book doesn't have enough multistep problems to practice, and I don't have time to find more.

SLIDE 16

Evidence based teaching

- In order to give expression to a "problem of practice" teachers have to be able to describe what students are currently able to do with a shared understanding of what changes to teachers' own practice are likely to be effective in bringing about improvement
- Specifically, teachers and those supporting them have to be clear about:
  - What data will answer their questions teaching and the improvement of learning?
  - What are teachers themselves ready, willing and able to do?
  - What resources are available to work on these issues, including people and time?

SLIDE 17

Respect for evidence

- What kind of data about teaching will teachers – and those supporting them – be able to call upon?
- Anecdotal data is not going to be enough!
- Examples of "solid" evidence are:
  - Students' work samples or actual problem solutions
  - Classroom visits, video tapes
  - Self-reports backed up by other evidence
  - Surveys or interviews with teachers
  - (Have teachers to extend the list as required)

SLIDE 18

A shared and precise vocabulary

- It is important for teachers to be able to talk about what they notice in a precise way that is readily understood by others
- An outside facilitator has a key role in helping teachers to use words in a careful precise way. For example, "Students appeared to be engaged/not engaged" will need to be unpacked:
  - What do you mean by "engaged"? Students paying attention, doing what the teacher asks, understanding what they are doing, like what they are doing? etc
  - What did you really notice?
  - Did other people see the same thing? etc

SLIDE 19

Conversations guided by shared norms

- For example, if teachers are invited into other teachers' classrooms, that:
  - The goal is to investigate some agreed problem of practice not to make judgements about their colleagues
  - The focus is on the instructional core: the interactions between teachers, students and (specific) content
  - Observations should be backed up by evidence
  - What is observed should not be discussed outside the group
  - Observations are framed on the basis of evidence, not on judgements about other teachers
- In particular, there will need to be an agreement that what is discussed will not be shared outside the group

SLIDE 20

Evidence based teaching

- How will teachers know if:
  - changes to teaching have taken place, and
  - these changes have been effective
- Relying on internal resources (i.e. teachers talking among themselves) to make these judgements is probably not enough
- External resources, such as
  - a facilitator for Lesson Study or
  - a teaching coach or
  - trained observers using Instructional Rounds,

  are well placed to bring about a blend of both in analysing and evaluating success in dealing with agreed "problems of practice"

SLIDE 21

Evidence based teaching

Three important questions for teachers to discuss and be clear about:

- What kind of data are teachers prepared to make available and to examine to address an agreed problem of practice?
- Are teachers accustomed, for example, to having other people in their classrooms watching them teach, and are they accustomed to being in other teachers' classrooms?
- Are teachers accustomed to having another teacher teaching in their classroom?

SLIDE 22

Evidence based teaching

- Setting up agreed norms is going to be very important
- Making good use of non-observational data will be important for re-assuring teachers
- For a start, someone, like a coach, needs to work with teachers in their classrooms to model what it is like to work on a problem of practice
  - You may think you are modelling very clearly, but how do you know that what you are doing is being noticed accurately?
  - Modelling small pieces rather than whole lessons

SLIDE 23

What Coaching Can Contribute

- Coaches are especially well placed to lead teachers at each school towards action in the following areas:
  - Identification of specific mathematics topics at each school
  - Prioritising dimensions that need to be targetted
  - Deciding where coaches are best placed to be working
  - Determining a time frame for teacher development
  - Agreeing on evidence to gather to confirm changes to teaching
  - Agreeing on evidence to gather to confirm changes to learning (in the short and medium term)
- The goal is improving teaching – knowledge or teaching and teaching practice – leading to improved student understanding and achievement.

SLIDE 24

The Coaching Cycle

- The coaching cycle involves regular review on how things are going and what needs to be done next.
- Coaches' work needs to tie in with the other "school improvement" processes. For example, is it appropriate to use it with *Lesson Study* or *Instructional Rounds*?
- A crucial element is the decision on how to gather evidence of changed teaching and changed learning. That is at the heart of the coaching process.
- Teachers across year levels have to be committed to working with coaches for long periods of time, (over a major part of the year).

SLIDE 25

The Coaching Cycle

- The big danger is that coaches and teachers think that they can settle for "filling in the holes" when a larger plan of teacher change is needed for student improvement.
- What do coaches need to think about as they prepare for sessions with teachers?
- Each additional session should contribute some specific objectives to a systematic and school-wide plan for long-term action to improve teaching and to evaluate progress.

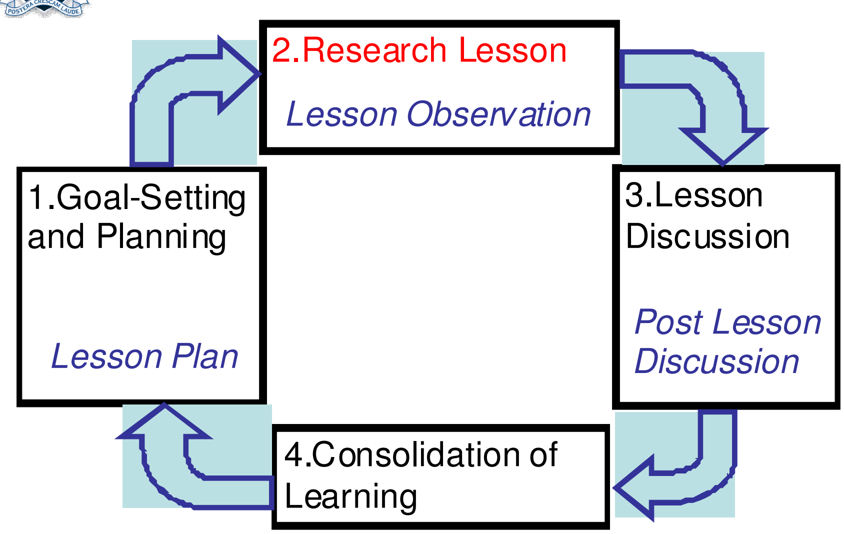
SLIDE 26

Coaching Potentialities

- Coaches engage directly with teachers in classrooms
- Involving experienced teachers (sometimes from another school) to improve teaching and learning
- Immediate contact with teachers to solve these issues
- Needs to be focussed on general “problems of practice” that have been identified across the school and not directed at individual requests for help
- Needs to be accountable to the school leadership team for achieving clearly stated goals

SLIDE 27

Lesson Study Cycle (Lewis (2002)



SLIDE 28

Lesson Study Potentialities

- Teachers work over a sustained period on a well defined problem of practice, with deep focus on instructional materials
- Objective is to improve the quality of students' learning
- Involves expert, experienced, and less experienced teachers
- Engages an outside facilitator to guide research and review phases especially and is resource intensive (time and personnel)
- Focussed on building collective capacity (knowledge for teaching) over many cycles – not directed at rapid change of individuals
- Accountable to the school leadership team for achieving clearly stated goals

SLIDE 29

What Instructional Rounds Can Contribute

- Modelled on medical (hospital) rounds used in the training of young doctors working with specialists and others
- Key people from a network of schools working in a school on a "problem of practice" that requires further refinement
- Four key steps
  - Identifying a problem of practice
  - Observing
  - Debriefing
  - Focussing on the next level of work

SLIDE 30

Instructional Rounds

- Key people from a network of schools working in a school on a "problem of practice" that requires further refinement
- What does an Instructional Round look like
  - A network convenes in a school hosted by a member or members of the network (e.g. principal or superintendent)
  - The focus of the visit is a specific "problem of practice" – an area of instructional improvement that the school and the system are wrestling with and would like the networks feedback on
  - The network divides into smaller groups that visit classrooms for about 20 minutes each
  - Network members visit and record evidence of what they observe relating to the problem of practice

SLIDE 31

Instructional Rounds

- What does an Instructional Round look like (cont.)
  - After classroom visits the entire group (observers and teachers) meets to share evidence of what has been observed and to debrief
  - The group looks for patters that explain student performance and teaching practice in the school
  - The network discusses the next level of work and makes recommendations
  - The network meeting may include professional development to improve knowledge and skills related to the problem of practice

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Four dimensions

Instructional Rounds as:

- an organisational process
  - practices that can be used and adapted across schools
- as a learning process
  - using information and evidence from multiple sources
- as a culture building process
  - respecting the evidence and moving beyond surface descriptions e.g. student engagement
- as a political process
  - making a public statement about fostering professional knowledge and accountability from within

SLIDE 33

Instructional Rounds Potentialities

- Responds to a “problem of practice” that requires further refinement
- Immediate contact with teachers in classrooms to clarify the problem of practice and to suggest remedies
- Engages school administrators and outside expertise in looking at specific aspects of teaching and learning
- Quickly defines “problems of practice” but solutions may miss deeper aspects of pedagogical content knowledge
- A catalyst for action and needs to be directly involved in building teacher capacity

SLIDE 34

Trade-offs and compromises

- Using *limited resources* and *fewer forms of evidence* to examine an agreed problem of practice ("instructional core") is likely to reach solutions quicker, but this has the risk of sacrificing depth and accuracy in improving the dimensions of teaching and learning
- *Push too hard* and you are likely to get resistance, *not push enough* and teachers are less likely to change
- *Relying on a few enthusiastic teachers* is likely to get the work done quicker, but other teachers will be left on the fringes of the "problem of practice" (and some may be happy to be left that way)
- Sticking always to the goal of promoting deep and connected leaching supported by more effective and more focussed teaching but knowing that this will mean different things for different teachers, e.g.
  – Those who are experienced and already committed
  – Those who are experienced and not committed
  – Those who are inexperienced but 'super keen' to try
  – Those who are inexperienced and not encouraging

SLIDE 35

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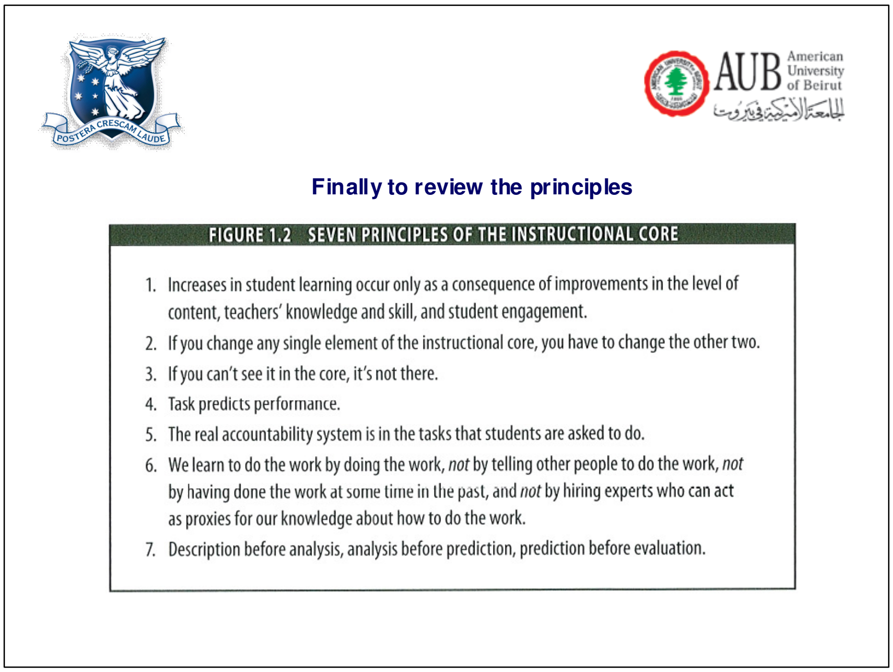
Gary R. O'Mahoney, Robin J. Matthews, and Bruce G. Barnett

Instructional Rounds in Education: A Network Approach to Improving Teaching and Learning

Elizabeth A. City, Richard F. Elmore, Sarah E. Fairman, and Lee Teitel (Harvard Education Press, Cambridge MA

SLIDE 36



Changing the roles in the classroom and going beyond the lesson content in order to achieve better learning

Ramzi Ataya

Abstract

Some students grasp concepts easily and are able to achieve good results on tests but unfortunately, this is not the case for all. Teachers are somehow at a loss when it comes to reaching underachieving students to provide them with support. Most teachers get frustrated when different teaching strategies and repeated explanations do not produce the desired results. The proposed approach is to go beyond content by adding the prerequisite skills and study habits and involve all students in varied learning situations that suit their own abilities and skills in order to guarantee success. Each student is a unique individual that has a specific learning style and a certain set of skills and abilities that need to be identified in order to design lessons that will reach all learners. To go beyond content does not mean to teach more or further, it actually means to make the lesson meaningful to each child. How this can be accomplished is the purpose of this interactive session. Each participant will have the opportunity to share successful

experiences where all students were able not only to grasp the lesson but also to generalize the concept and put it to good use.

Introduction

Some important facts:

- It is not enough for a teacher to master the subject in order to be a good teacher.
- Knowing does not necessarily imply conveying, therefore, there are other factors that will affect the success of a lesson.
- Repeating the same explanations or going over the same exercise several times can be a frustrating and self defeating activity.
- Using the best material and support resources is an important element but does not guarantee success if teachers do not use the material properly in accordance to the teacher's guide.

Knowing these facts makes it necessary for us to look into what makes a student understand and learn new concepts and skills in order to be able to use them successfully. How can we help students become better learners? What are the skills that will help students improve? How can a lesson make sense to all students?

Strategy

There are a lot of teaching strategies that are used in classrooms all over the world, to list a few:

• **Class discussions:** The teacher plays the role of a guide/facilitator and helps students discuss topics that are relevant to the lesson at hand. The teacher helps students identify what is going to be learned and what prerequisite knowledge is needed. Questions that are generated during this process serve as a guide to the teacher. In language arts, this is evident in the "teacher read aloud". This latter procedure introduces the theme, key vocabulary words and the reading strategy that will be used throughout the theme. In Mathematics, teachers are encouraged to display what has been learned during the previous year, what is going to be learned now, and what they will learn next year. Meanwhile, in Science, viewing pictures related to the lesson and discussing them serves as a good introduction before getting to the facts.

• **Active Learning:** Meyers and Jones (1993) define active learning as learning environments that allow students to talk, listen, read, write, and reflect as they approach course content through problem-solving exercises, informal small groups, simulations, case studies, role playing, and other activities. These activities require students to apply what they are learning. Many studies show that learning is enhanced when students become actively involved in the learning process.

• **Cooperative Learning:** Cooperative Learning is a systematic pedagogical strategy that encourages small groups of students to work together for the achievement of a common goal.

The term 'Collaborative Learning' is often used as a synonym for cooperative learning when, in fact, it is a separate strategy that encompasses a broader range of group interactions such as developing learning communities, stimulating student/teachers discussions, and encouraging electronic exchanges (Bruffee, 1993). Both approaches stress the importance of faculty and student involvement in the learning process.

• **Integrating technology:** Integrating technology into a course curriculum when appropriate is proving to be valuable for enhancing and extending the learning experience for teachers and students alike. However, this should not be confused with computer literacy. Technology integration is achieved when technological tools are used to support curricular goals and help students to effectively reach their goals. Students are more actively engaged in projects when technology integration is a seamless part of the learning process.

When effectively integrated into the curriculum, technological tools can extend learning in powerful ways. These tools, including the Internet and multimedia applications, can provide students and teachers with:

- Access to material
- Methods of collecting and recording data
- The ability to collaborate with students, teachers, and experts around the world and go beyond the limits of the classroom
- Opportunities for expressing their understanding via images, sound, and text (to increase sensory exposure)
- More meaningful learning and increasing the analytical abilities of students especially in making choices and decisions as well as design
- The opportunity for publishing and presenting their new knowledge and getting feedback from peers and teachers

Other methods include Direct Instruction, discovery method, differentiated instruction…etc

However, teaching strategies and methods are not sufficient to guarantee that learning will take place if the learners' awareness of what is being discussed, presented or developed is not heightened by a skillful introduction of the concept and its meaningful implication in their daily lives. Students will learn better if they are aware why they must learn, how this knowledge can be useful to them and where and when they would need it.

How can this be accomplished?

We have to get to know:

• Each student's knowledge of the previous year material. This is usually provided by an inventory test that can be done during the first week of school. This test will map areas of strengths and weaknesses for the students and will enable teachers to plan remedial procedures to deal with the area(s) of weakness(es).

- Each student's learning style (visual, auditory, tactile…) Knowledge of this is extremely important if we want to design a lesson that will reach all students. Support material and resources available in the teachers' resource packages will provide the tools for this purpose.

We also have to identify:

- Opportunities to have curricular integration, linking lessons from different subjects together. For example, classification in Math can be linked with classification in science as it follows the same concept but different content. The number concept can be reinforced through reading lessons and so forth.
- What links can we find between students' environments and the lesson at hand? This is of great value if we want students to understand why this lesson is important to be learned, where the acquired knowledge will prove to be useful giving a new dimension to the learning process.

We need to present and clarify:

- What are the objectives and outcomes for the lesson?
- What are the criteria for evaluation?
- Method of evaluation :
    - Quiz
    - Test
    - Exam
    - Project
        - Bulletin board display
        - PowerPoint
        - Research
        - Experiment
        - Panel discussion
        - Construction

Description of session

About twenty teachers from different schools and different parts of the country were present at the session. The session was conducted by having the participants answer a guiding question after displaying a slide that addressed different areas of concern for teachers. The teachers were asked to discuss their own contributions, then the presenter defined points of convergence and stated conclusions or clarified items. All participants were actively involved and contributed as expected.

Conclusion

Most teachers if not all, are fully aware of the different teaching strategies and evaluation methods. Yet we find some students unable to progress despite all exerted efforts. It is also clear that we cannot expect to have all students perform at the same level of achievement due to individual differences. However, it is also unacceptable for a student to be failing when there are no physical or mental reasons for this failure.

What can a teacher do in such a case?

1. Make the lesson meaningful to students.
2. Raise students’ awareness about where the lesson's content can be seen, felt, heard, or observed in real life.
3. Let students find out how the lesson's content will help them solve some problems.
4. Read the teacher’s guide well and do not think "I know everything there is to know". You will find specific instructions for students on level, below level, and even English language learners… this will help you provide the right kind of support to your students by using material that is level appropriate.
5. Look at the resources available from the publisher. Do not spend time making your own resources as they are provided for your use. Instead, spend your time planning for your students' needs.
6. Do not use the same evaluation for everyone; instead use the same objectives but different types of questions. Remember our students are not all native speakers.
7. If everything you try fails, do not hesitate to contact the publisher's consultant, we can provide you with advice and support as you are a most valued customer for us.

Using Other Subject Matters to Deepen Understanding of Math and Science Concepts
Ola Itani Zein & Nour Ghusayni

Abstract

Have you ever tried to use a good Math or Science resource that is in a language other than the language of instruction? This session will focus on how transdisciplinary subjects and different languages can provide a good opportunity to launch and inquire into Math or Science lesson. The presenters will focus on how learning Math and Science in different contexts will deepen students’ understanding of concepts, help students make connections and enrich students’ vocabulary. Presenters will also focus on how students can be challenged to view language (other than their main language of instruction) as a tool for learning and communication in Math and Science. The presenters will share their first hand experience using the bilingual approach

with their students and participants will also have an opportunity to apply this approach in similar settings.

Introduction

This session emphasizes the importance of using inquiry as a strategy to motivate students and integrating other subjects will benefit students' learning experiences.

Description of session

The main purpose of this session was to show how learning Math and Science using other contexts can enrich the lessons and deepen students' understanding of material. The session also aimed to demonstrate how using two languages can reinforce the learning of concepts and skills and lead to higher level thinking. It further aimed to help students view languages as tools for communication and means to express themselves orally and in writing.

The activities that were included throughout the session began by engaging participants in hands-on activities where they needed to create their own Science Notebooks and engage in an investigation about the physical properties of light where English and Arabic were used alternatively. After this activity, participants shared what they noticed about the integration of different transdisciplinary skills. A discussion about the purpose of using/creating Science Notebooks and how they reflected students' understanding and thinking throughout the inquiry process was done. In groups, participants then used their teaching experiences to try to develop a list of ideas for a Math/Science lesson that was integrated with other subjects. After the groups shared their ideas, presenters shared samples of student work and self-assessments done in class.

The session went as follows:

a) Participants engaged in an activity where they had to experiment in a dark room, create their own science notebooks, explore the physical property of light, the color of sunlight, and explore how the rainbow is formed in another language (Arabic). (20 mins)

b) This lead to a discussion with participants about what they noticed from the previous activity. (5 minutes)
c) Participants engaged in a brief discussion about what science notebooks are and how they are tools of communication (10 minutes)
d) Participants worked in groups where each group was designated to discuss how a subject matter can enrich their Math or Science lesson (for example, Social Studies, Art, Physical Education, and Music). (10 minutes)
e) Participants shared their ideas. (10 minutes)
f) Participants had the opportunity to see some of the students' work and some self-assessments done by students in different languages. (10 minutes)
g) Feedback and questions. (10 minutes)

Conclusion (suggestions)

Involve the participants in activities and hands-on

- Use the an inquiry approach
- Show evidence of students' work, photos or videos
- Ask the participants how they can apply these strategies in their classroom and help them find a way to do that
- Give handouts that the participants can use

The Brevet Sciences and Mathematics Monitoring Project: The Early Days

Barend Vlaardingerbroek, *Nadya Rizk & Saadeddine Shehab*

Abstract

As well as being filtering and sorting mechanisms, curriculum-based external examinations at critical junctures of the school cycle provide a wealth of information about learning at those levels. This information can be accessed by means of diagnostic analyses of samples of candidate examination scripts. Feedback thus obtained is of value to teachers, examinations personnel, curriculum developers and teacher in-service training providers. The Brevet Sciences and Mathematics Monitoring Project began with a pilot analysis of the 2006-7 Brevet Chemistry and Physics examinations conducted during the summer of 2008. The Project then became a joint effort between AUB and the Lebanese Ministry of Education and Higher

Education, and little progress has been made since. A ‘bottom up’ rather than ‘top down’ approach to Brevet reform is now being considered.

Introduction

The Lebanese Brevet examinations are conducted at the termination of Year 9. They are based on the Year 9 curriculum in nine subjects, including the three sciences (Biology, Chemistry and Physics, weighted at 20/280 each) and Mathematics (weighted at 60/280). Students who pass them (i.e. attain a minimum cumulative score of 130/280) are awarded the Middle School Certificate and may advance to upper secondary schooling (i.e. Years 10-12). Students who fail them repeat Year 9, transfer to the parallel vocational system, or drop out of the education system. Given the ‘high stakes’ nature of these examinations, candidates are given two chances (‘first session’ and ‘second session’) which are a couple of months apart each year. All public schools and most private schools in Lebanon offer their students the Brevet program.

Curriculum-based external examinations at transition junctures (primary to lower secondary, lower to upper secondary, and at the end of the school cycle) are traditional features of French- and British-derived school systems. They ensure a ‘level playing field’ for all candidates at selection bottlenecks and function as quality assurance and school/teacher accountability mechanisms; in countries where they occur, they tend to be widely trusted entities (Bishop, 1997, 1998, 1999; Resnick, Nolan & Resnick, 1995; Wiliam, 1996; Woessmann, 2001; Vlaardingerbroek & Taylor, 2009). It is of critical importance that external examinations are indeed fair and consistent. This requires that they be well written (i.e. clear, unambiguous instructions to candidates), are referenced to curricula, and are accompanied by comprehensive marking keys so that markers apply the same criteria to answers. Analyses of examination question papers and scripts provide subsequent examination writers with valuable feedback information on these technical aspects and thereby function as quality assurance mechanisms (Baird, Cresswell & Newton, 2000; Downing and Haladayna, 1997; Fisher-Hoch, Hughes & Bramley, 1995; Goldstein & Creswell, 1996). External examination scripts moreover represent a potential goldmine of information regarding student mastery of curricular objectives which can be used by curriculum planners and teachers (Vlaardingerbroek & Taylor, 2009, p. 342). The analytical techniques involved may be profitably made use of by schools themselves in the context of ‘mock’ examinations which are conducted to prepare prospective candidates for the ‘real’ examinations.

There is widespread dissatisfaction in Lebanon with the ‘official examinations’, as they are locally called (viz. the Brevet and the Baccalauréat). As a perusal of the electronic archives of the Arabic-language newspaper Al-Nahar reveals that the issue is an annual bone of contention. But despite the stated intentions of several governmental personages over the years to ‘clean up’ the examination system, it appears to be in a state of stagnation.

Teachers are, of course, well aware of the shortcomings of the system, but are largely powerless to enact effective change, particularly in the absence of feedback information emanating from *post hoc* examination analyses. Even that which is put on the Ministry’s website – the paper itself and the marking key – is problematical in that changes are made to the marking keys during pre-marking meetings which are, however, not made to the key as reproduced on-line.

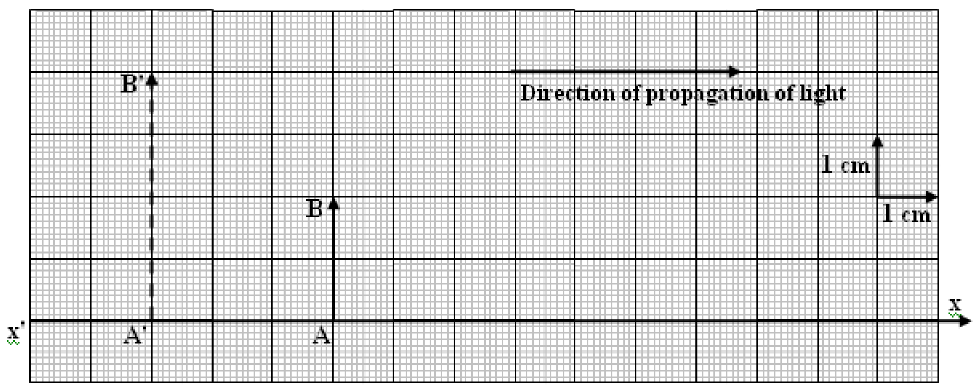
The Project So Far

The Project began with a pilot analysis of 2007 first-session Brevet Chemistry and Physics scripts by Barend Vlaardingerbroek, Lama Jaber, Nadya Rizk and Jana Bayoud over the summer of 2008. Procedures involved the selection of 100 English-language scripts using a stratified random sampling method based on candidate code numbers and the categorisation of candidate errors. The question papers and the marking keys were also subjected to scrutiny (Vlaardingerbroek, Jaber, Rizk & Bayoud, 2009).

Examples of item analyses from the 2007 Brevet Physics examination:

Example 1

The aim of this exercise is to determine, by geometrical construction, the focal length **f** of a lens (L).
The figure below represents, in real scale, a luminous object AB, its virtual image A'B' given by (L) and the optical axis x'x of (L).



1) **Nature of (L)**
The lens L is a converging. Why?

Marking Key

1- (L) is a converging lens because it gives for the object , a virtual image larger than the object. **(1 pt)**

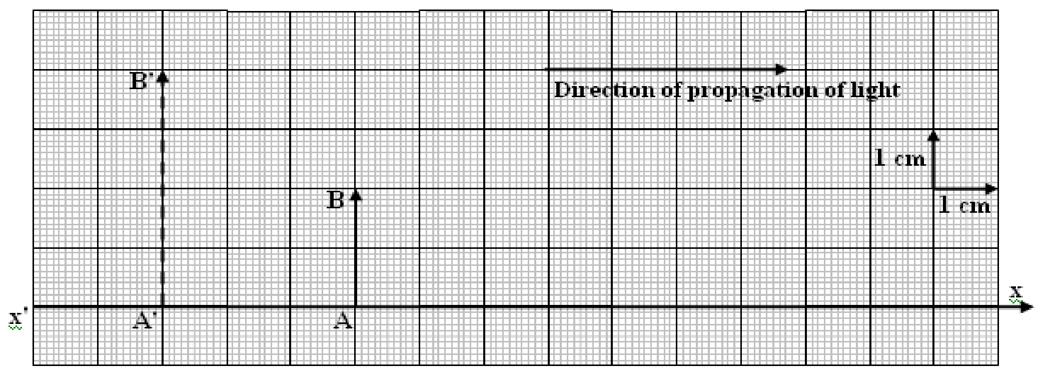
Analysis

Item	No. (%) correct	Item omissions and errors made by 10 or more candidates	n (%)
Ex.1 Q1	22	Noted only that image was magnified Noted that image was virtual or in front of lens	33 11

Despite this being a simple question, only 22% of the students wrote the model answer presented by the marking key (though not necessarily the only correct) and were thus granted the full mark. We pointed out a problem with the marking key: at Brevet level, it is enough to mention that the image is larger as students have not yet studied any case where diverging lenses produce images larger than the objects. A third of the students were unfairly penalised because they were not given partial credit for a partially correct answer; the marking key makes no allowance for partial marks.

Example 2

The aim of this exercise is to determine, by geometrical construction, the focal length **f** of a lens (L). The figure below represents, in real scale, a luminous object AB, its virtual image A'B' given by (L) and the optical axis x'x of (L).



***3)* Focal distance of (L)**

a) A ray issued from B, parallel to the optical axis, meets the lens at a point I. Trace, with justification, the path of this ray.

Marking Key

3- a) Trace **(1 pt)**.

Justification: any ray issued from B emerges from the lens seeming to come out of B' the image of B.(

Analysis

Item	No. (%) correct	Item omissions and errors made by 10 or more candidates	n
Ex.1 Q3a	3	Correct tracing but incomplete or incorrect justification Incorrect tracing and incorrect justification No tracing and incorrect justification	46 32 11

This example aptly demonstrates the diagnostic features of examination analysis and suggests implementable preventative measures. Amazingly, 97% of the candidates failed to present a ‘correct’ justification. (Teachers present were quite stunned with these findings as they recognise this type of question to be a perennial and spend a lot of time teaching students about the type of justification required for it.)

Example 3

Item	Percentage of items not answered	Percentage of correct answers
Q2a	56%	18%
Q2b	40%	33%
Q3a	20%	38%
Q3b	39%	22%
Q3c	10%	65%

Analysis

This example shows how the analysis can also give indications about the length of the examination. Looking through the data, one can see that a significant percentage of students did not present any attempt at solving Questions 2 and 3 for the third exercise. We hypothesised that students simply did not have enough time to answer them; although it is possible also that item difficulty also played a role.

The results of the study were shared with the Brevet examination committees at the Ministry of Education by means of a workshop in April 2009. Funding was released by the AUB University Research Board for the engagement of a Research Assistant (Saadeddine Shehab). Dr Rabih El-Mouhayar, also of AUB, joined the Project at that stage. They were to work alongside ministerial Brevet personnel and conduct analyses of the 2009 Brevet examinations in Biology, Chemistry, Physics and Mathematics. The intention was to write Examination Reports based on the English O-Levels Examiners' Reports format (exemplified by Edexcel, n.d.) and make these available to all Lebanese teachers of Brevet sciences and mathematics through the internet by early 2010.

Unfortunately, the proposed timeline could not be implemented owing to numerous problems emanating from the involvement of ministerial personnel. Many of these people were simply uncooperative and unavailable when needed. Obtaining their release from regular duties took weeks rather than days, and in the end resulted in only partial releases totally inadequate to get the job done. There were also some who flatly refused to participate, as they clearly thought that they were 'helping' us rather than performing a developmental activity of immense potential benefit to the Lebanese education system. All this was despite the support of the Director-General. We finally managed to conduct an analysis of only the 2009 Chemistry paper, examples of which are as follows:

Example 1

First Exercise (7 points)
Ionic Compounds

Ionic compounds such as NaCl, K_2S… are solids at room temperature and they have very high melting points. They conduct electricity when they are molten or dissolved in water and for this reason they are called electrolytes.

3.2 - Specify whether the compound potassium sulphide is, or is not, an electrolyte.

Marking Key

3.2	K_2S is an electrolyte because it is an ionic compound, and ionic compounds conduct electricity when they are molten or dissolved in water.	**0.50**

Analysis

Item	No. (%) correct	Item omissions and errors made by 10 or more candidates	n
Ex.1 Q3.	28	Electrolyte – no justification Electrolyte – wrong justification Non – Electrolyte	33 9 7

This question exemplifies the problems associated with the 'action verbs' that are used in writing the Brevet examinations, in this instance 'justify'. A third of the students answered that K_2S is an electrolyte but did not provide a justification, while another 9% rendered an incorrect justification.

Example 2

Chloroalkanes are very important organic compounds, they are synthesized in the industry. However, chloromethane besides being synthesized in the industry, also it is produced naturally by marine algae. Dichloromethane is used as solvent to extract perfumes, caffeine… Trichloromethane is used as anaesthetic and 1,1,1-trichloroethane is used as solvent in correction liquid such as (Tipp-Ex).

2- Indicate which of the following condensed structural formulas represents 1,1,1-trichloroethane.

a) $CH_3 - CHCl - CHCl_2$, **b)** $CH_3 - CCl_3$, **c)** $CH_2Cl - CHCl_2$

Marking Key

2	The condensed structural formula of 1,1,1- trichloroethane is: $CH_3 - CCl_3$	**1**

Analysis

Item	No. (%) correct	Item omissions and errors made by 10 or more candidates	n
Ex.2 Q2.1	76	Chose c: 1,1,2-trichloroethane Chose a: 1,1,2-trichloropropane	14 5

It is remarkable to note that a single 3-option multiple choice question accounts for 5% of the total marks for this subject! The 76% correct response rate is, however, reassuring. It suggests that the multiple choice format may be more appropriate at Brevet level for sciences than open-ended questions involving problematical 'action verbs'.

The Future of the Project

If the Brevet Sciences and Mathematics Monitoring Project is to be more than an apple in its instigators' eyes, a different strategy will have to emerge. One possibility is to try to merge the Project with a current developmental reform project. Another is to try a 'bottom-up' rather than a 'top-down' approach.

Schools and teachers may themselves become agents of systemic change. In accordance with the notion of the 'de-privatisation' of knowledge and practice (Fullan, 2008), schools need to become more open and willing to share their successful and unsuccessful practices with other schools. Teachers need to become part of a 'community of learners' in which sharing and collaborating are valued practices (Senge, 1990). Collective reflection may lead to the devising of effective measures and solutions for common problems. Conducting examination analyses at school level could be a step in this direction.

Examination reports should comprise at least three sections: a statistical description of the students' responses, a description of the marking key, and an explanation of problems noted in more generic terms (e.g. skill X has not mastered by many/most students). The following item from an Australian Physics examination report (Victorian Curriculum and Assessment Authority website, (http://www.vcaa.vic.edu.au/vce/studies/physics/exams.html) exemplifies these points:

Question 7

Marks	0	1	2	3	Average
%	35	13	12	40	**1.7**

Analysing the horizontal component of the ball's motion (velocity $30\cos 36.9 = 24$ and distance = 72) showed that the time for the ball to hit the advertising board was three seconds. Then, applying the constant acceleration formula, $x = ut + \frac{1}{2}at^2$, to the vertical motion gave a height of 9 m.

Some students attempted to use a range formula and generally became confused. Others omitted the negative sign when substituting into the constant acceleration equation.

There are other sections that can be added to the report; for example, some might want to include recommendations for change or improvement.

Such reports provide evidence-based foundations to help teachers in devising both diagnostic and formative measures. This includes the design of target-specific (customised) professional development materials for teachers of high-stakes examinations classes. As they are compact yet comprehensive, they can be relatively easily shared with other teachers in either print or electronic form. They also help students preparing for the examinations to achieve better as they pinpoint common types of mistakes. If ministerial personnel are unwilling to conduct examination analyses, then it may have to be carried out by volunteer teachers – providing the release of samples of scripts can be assured.

Ultimately, of course, the people in charge of the examination system in Lebanon will have to 'come to the party'. Despite the widespread perception among teachers, academics, newspaper columnists and indeed the public at large that the examination system has been in deep trouble for a long time, the system has become ossified and while platitudes are plentiful, effective reform remains elusive.

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General

Discipline Problems: You Can Handle Them All

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Abstract

Effective classroom management and the ability to cope with different types of students have been the concern of many teachers. In this workshop, participants will be provided with the information, language, and skills they need to guide their students toward appropriate, responsible behavior. Participants will be asked to sit for an assessment questionnaire which will help them identify their weaknesses and pitfalls in terms of handling discipline problems. A quiz tackling several issues pertaining to discipline will be administered. This is followed by a power point presentation which will offer the answers to the different questions raised in the quiz participants had taken. Then, participants watch a movie which focuses on four specific discipline problems. They will be asked to work in groups of five to identify each of the four problems, evaluate the teacher's reaction, and propose better solutions.

Introduction

The session focused on techniques that can be implemented in order to resolve conflicts in the classroom. It shed light on certain discipline problems (class clown, apple polisher, rebel, disrespectful, cheater) and provided effective techniques for better classroom discipline.

Strategy

The outline of the session was the following:

- Definition of discipline
- The secret to effective discipline
- The necessity of a discipline plan
- The differences in values between contemporary and the past generations and its effect on student's behavior
- Why students decide to misbehave
- Choice theory
- Students' basic needs
- Behavior and the brain
- Win-win discipline
- Characteristics of a boundary

Description of session

After introducing the purpose of the workshop, participants were engaged in the first activity. They had to answer by yes or no to an assessment questionnaire including 12 items which helped them identify their pitfalls and weaknesses in terms of handling discipline problems. Afterwards, participants were able to check their answers, which were supposed to be all no, by an analysis displayed in a power point presentation. Next, participants were asked to work in groups to answer quiz questions - activity 2 – that assess their prior knowledge about discipline, punishment, Dr. Glasser's choice theory, the functioning of the brain and the win – win approach. This activity, which dealt with the theory behind effective discipline approach, was the gateway of the workshop. A thorough display of that approach was presented allowing interactive discussions with the audience. Right after that, participants watched four mini-skits that highlighted some of the behavioral problems that teachers may face in their classrooms. The scenes added humor to the workshop since the situations were pictured in a funny exaggerated way. Then, participants filled a chart that described the misbehavior, how the teacher handled the problem, and some techniques for effective classroom management. Finally, participants were allotted few minutes to clarify certain items and to raise questions concerning disciplinary issues raised in the workshop.