A TEACHING AND LEARNING PORTFOLIO

by

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A teaching and learning portfolio serves in partial fulfillment of the requirements for a Delta Certificate in Research, Teaching, and Learning.

The Delta Program is a project of the Center of the Integration of Research, Teaching, and Learning (CIRTL). CIRTL is an NSF-sponsored initiative committed to developing and supporting a learning community of STEM faculty, post-docs, graduate students, and staff who are dedicated to implementing and advancing effective teaching practices for diverse student audiences.

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Dear Reader,

Please find enclosed my teaching portfolio which documents my training and growth as a teacher. Although this portfolio is not meant to summarize all the teaching experiences that I have, it is designed to give you a glimpse of who I am as a teacher. I start my portfolio with a statement that describes my philosophy as a teacher. This teaching philosophy is anchored around my desire for continued growth, engagement of all class participants (me included), my interest in tailoring instruction to meet the different needs of my students, the need to provide ample and diverse opportunities for students to explore, collaborate and take risks in a non-threatening learning environment, to mention but a few.

The rest of the portfolio demonstrates how the main tenets which guide my teaching are put to practice. For this purpose, I selected a sample of projects which I was involved in and were very beneficial to my growth as a teacher. Through my involvement in these various projects, I came to view '*teaching as a calculated and reflective practice where research methods are applied in order to improve the teaching/learning experience'*[1]. I got to realize the importance of a supportive, respectful and inclusive environment that is engaging, interactive and student-centered, for the enrichment of the learning experience of all students. Above all, I came across a number of tools that has and will help me in my endeavor to create a learning community that honors diversity and capitalizes on it.

In one section, I reflect on my experience in planning and execution of a station in a Science Expedition hosted by the College of Engineering in the Spring of 2006. I chose to be part of this endeavor because I believe in the importance of university outreach initiatives in recruiting and retaining minority groups in STEM (Science, Technology, Engineering and Math) fields. Although, the station was designed to explicate the density concept to children of various age groups, for me it was an opportunity to explore the potentials of exploratory learning and test the knowledge I accumulated about the constructivist approach in education.

In another section of the portfolio, I reflect on the development of an online assessment tool based on concept inventories and designed for senior Engineering students. Because I can see the potential of online learning I chose to work on this project to familiarize myself with a tool (FLASH Macromedia) that is gaining popularity in web-based and computer assisted learning. It is important to realize, though, that the technological aspect of this project is only one of its facets. The main facet, in my view, is related to designing the questions used to assess students' performance, as well as gathering and interpreting data to assess the tool.

Another section of this portfolio focuses on a teaching activity designed to serve as an ice-breaker, a conversation starter that I tested with a group of mock students. The group consisted of the two class instructors and six other Ph.D. candidates. While carrying out this class activity, I experienced one of the very enlightening moments when I could see diversity in action. I used visual exploration as a means to build a learning community that benefits from the different perspectives a diverse group of learners has to offer.

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1. As quoted from the Delta Program for Teaching and Learning website www. delta.wisc.edu.

Finally, I critically review the available literature on the widely used end-of-semester evaluation tool. Although research does not totally condemn the end-of-semester evaluation, it raises some flags concerning its effectiveness as an assessment tool, highlighting many biasing factors that may result in a distorted image of the teaching/learning process. Because evaluation is indispensable to any scientific process, I designed a two-part assessment tool to complement the end-of-semester assessment tool. The developed tool not only helps me evaluate my teaching, but also evaluate my students' learning experience.

Thanks for taking the time to read my portfolio and I am looking forward to your comments and suggestions.

Aya Diab

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Teaching Philosophy

"I never teach my pupils; I only attempt to provide the conditions in which they can learn." –- Albert Einstein

"No man can be a good teacher unless he has feelings of warm affection toward his pupils and a genuine desire to impart to them what he himself believes to be of value." – Bertrand Russell

In the streets of Cairo, I learned from my Dad on our daily trip to and from school. Back there, back then, I remember my Dad walking me on a wall- a fence that encircled Al-Kobba public park, holding my hands up to my sides like a flying bird, we used to have conversations about everything. Through these conversations, I learned - though I doubt I knew I was learning - values like freedom, strength, dignity and honor. In my Mom's lap, while she was putting me to sleep, I remember learning things like love and sympathy, understanding and responsibility. These values I believe shaped my personality and definitely my view of life.

As I sit now and write my teaching philosophy I recall my parents in several situations. They never told me what to do; all what they did is to set an example, convey abstract concepts and encourage me to reflect upon them. My teaching philosophy therefore, stems from a personal conviction that a teacher is the one who teaches his or her students how to learn. It is anchored in a love for my craft and a desire to dedicate my life to educating my students. As a teacher, I believe that my responsibility is not just to disseminate information to students, nor just to evaluate their mastery of the course material, but to inspire them to pursue knowledge actively and to become independent thinkers. Conveying concepts and problem solving techniques is important in fields like engineering sciences. However, I feel that it is as important to interpret the solution and the physical significance of the problems investigated. It is especially important to have students realize that engineering isn't about numbers in a text book, or on a calculator; it is a whole world of diverse and expansive study that is related to everyday life. It makes a huge difference to link the knowledge they gain in a Fluid Dynamics or Heat Transfer class to the formation of breeze on a summer day night or what makes a mother blow into the food before feeding her child.

Based on my own personal experience, I developed an appreciation of the fact that a lot of what we learn is actually obtained outside of the classroom; hence, one of my goals is to encourage the use of both formal and informal sources of information and help my students seek knowledge everywhere and all the time. I believe that as an educator, my duty is to invite my students to look around and find applications to what they learn in the classroom and come back with questions, which will certainly enhance their learning.

A teacher-student relationship should be one of partnership where both parties contribute. In this learning experience, I provide my students with a positive learning environment where they can experiment, be creative, interact and collaborate with their peers. This kind of interactive environment, students do not assume the role of the spectator, rather, they are creative and engaged participants who use higher order thinking skills. One of my favorite strategies to achieve this goal is to scaffold their learning experience by using open ended questions and design problems. These types of activities not only involve judgment and evaluation which are among the higher order skills in Bloom's taxonomy, but also hone interpersonal communication skills, sense of engagement and capitalize on diversity. They also convey the message that there isn't always *'one correct'* answer.

However an interactive and creative learning environment is contingent upon students assuming personal responsibility for their own learning. This, in turn, requires the teacher to create a comfortable and non-threatening learning environment in which students can feel free to share ideas, make mistakes, and ask questions. In order to eliminate the risk of embarrassment and failure, in this learning community, I encourage everyone to learn each others' names, I invite my students to come to my office and to ask questions or make suggestions and show my appreciation and support when they do. Moreover, I encourage them to freely express their ideas and opinions in large groups as well. These are only a few methods that create a comfortable yet challenging learning environment which is more conducive to a qualitatively different learning experience.

Students are all intelligent in their own individual way and our responsibility as teachers is to inspire and provide the suitable environment for this intelligence to flourish. As a teacher, I do my best to tailor my instruction to meet my students' different learning needs. Only then do I consider my mission accomplished. Definitely to reach this goal, I am in a dynamic state in which I learn everyday about my students, my subject, as well as myself. In the learning/teaching experience, my own learning style would definitely affect the style that I use in the classroom; but, I also recognize students' varying learning styles. I will therefore try to incorporate a variety of teaching techniques and a variety of testing methods in order to reach out to my students in an effective way. I will use variable tools like: question and answer, discussion, and hands on learning experiences. An inspiring example that I will always recall as a graduate student in the Fluids class of Professor Lester Su at UW-Madison; who explained the concept of vorticity and the formation of vortex rings by bringing into the classroom a very simple experiment. One day, he brought to the classroom a box of which he had cut a circle off one side. He filled the box with smoke using a smoke generator. He then hit the side opposite to that of the hole, thus generating vortex rings. We could then ***'see'*** the vortex rings come out of the box and deform as they moved around the classroom. Until now I can still see in my mind the same vortex rings that I saw back then in my Fluids class some four years ago.

Reflecting upon my teaching philosophy, my goal is to be an enthusiastically vibrant learner. This is why I anticipate that my philosophy will evolve as I gain experience and knowledge. I feel that I can continually improve my teaching by being open minded to new ways to present information. I will also strive to improve learning in my classroom by creating an environment in which students can practice and develop critical thinking.

Water Works!

An Exploratory Approach to Learning

Motivation

One of my goals is to simplify science and engineering concepts to students at a young age *especially* female ones. In this pursuit, I am motivated by the under representation of women in science fields in general and engineering in particular. Science expeditions and similar university outreach initiatives build bridges between the university and the society in general. Through such activities the university opens its door to the community at large and can also target underrepresented groups, for example women and people of color. Moreover, when women and people of color are involved in planning and execution of such activities, we not only increase the visibility of female scientists and engineers, but also help them enjoy a sense of pride in what they're doing. This way, the STEM (Science, Technology, Engineering and Math) fields which have been charged with being *historically Eurocentric [and] masculine*[2], can provide *counter-stereotypes*[3] which will not only *moderate the implicit stereotypes*[3], but also provide role models to the targeted minority sectors of the society.

Description of the Water Works Station

This led me to enroll in a DELTA course entitled: '*Informal Science Education: A Practicum*'. In this class, I participated with two other students, Gabriel Detjin and Elizabeth McNeill, in designing an exploration station for the Science Expedition held in the Engineering Campus in April of 2006. Our station was called *'Water Works!'* and aimed at demonstrating the concept of density. Our station consisted of three main components: two interactive activities to illustrate the concept of density and one informative poster to describe a real life application of density concepts. Our overall goal was to encourage learning through fun activities and to give participants the opportunity to learn about density-related ideas that they could expand on at home.

2. Gayle A. Buck, Diandra L. Leslie-Pelecky, Yun Lu, Vicki L. Plano Clark, and John W. Creswell, Self Definition of Women Experiencing a Nontraditional Graduate Fellowship Program, Journal of Research in Science Teaching, vo. 43, no. 8, pp. 852-873, 2006.
3. Cathy Middle Camo, Diversity In the Physical Science Curriculum: The Intellectual Challenge, for publication in NSTA Handbook of College Science Teaching, 2006.

Water Works endorsed the exploratory learning/teaching approach to demonstrate the concept of density. Exploratory learning/teaching is a learning/teaching technique that depends on exploration and experimentation to discover a concept as opposed to the widely used didactic lecturing technique used to convey a certain concept. Although exploratory learning seems fun and flexible, it is guided.

We designed a number of experiments that aimed at allowing the children from various age groups to explore the effects of shape, size, material, weight, and other controlling factors on flotation. Figures 1 through 6 show the different objects we used in our experiments. Our goal was to prepare an environment for them to discover the concept of density through their observations. At every stage, we wanted to challenge the perceptions they'd formulated through presentation of a set of contrasting ideas and letting them construct new ones according to their own pace and learning preference. We wanted them to go through the steps of scientific thinking: formulating a hypothesis (Is it color? Is it shape? Is it weight? Is it volume, etc), testing (trying to float/sink objects of same/different colors, geometry, mass, etc), observing and finally letting them come up with their own conclusions without interfering with their thought process—we only guided them.

Figure 1. Demonstration of the patriotic pour experiment showing the components used: water, red corn syrup and blue lamp oil.

Figure 2. Rubber balls with different colors but same size, shape and material to rule out the effect of color on floatation.

Figure 3. Similar film containers containing different amount of coins.

Glass pebbles used.

Figure 4. Containers with similar shape and color but different size contain the same number of glass pebbles.

Figure 5. Mother duck and baby ducks.

Figure 6. Float-or-sink activity.

Research Guided Design

Recent research[4] indicates that the exploratory teaching/learning involves three basic steps:

1. motivation to acquire knowledge
2. knowledge construction
3. knowledge application and refinement

To motivate our audience while realizing their age and background, we tried to set up a learning environment that it is *'likeable [and] meaningful to the [children]'.* This was accomplished by using colorful objects, toy-like, familiar everyday objects. We tried to maintain a non-threatening discussion format. Our role was to facilitate their discussion, to *'provoke and give [them] the opportunity…' 'to express their beliefs [and] opinions" and hence "contribute positively to the creation of [knowledge]'*[4]. Through scaffolding we were able to make them go through the systematic scientific thinking process, where the different variables are being identified, isolated and eliminated one at a time. Directed group discussion, helped the kids to collectively come up with some hypotheses and test them. Guided by *"suitably designed questions"* the kids could *"understand", "construct and revise appropriately their mental model in case of perceived misconceptions'*[5].

For example, we asked the kids what happens if we were to insert three identical rubber balls same shape, same size and same material but different colors in water: Will they float? Will they sink? Will any of them behave differently? We asked them to predict the behavior of the balls and then compare their prediction to the actual result of the experiment. With color eliminated as a governing factor, they were challenged to check whether shape, volume, or mass or a combination of two or more defined density.

Because we made sure we addressed all sectors of expected audience, we decided to include a poster in our station so that parents and older kids can be involved in some ways in which density concept applies in nature. The poster was designed to be visually appealing, as shown in Figure 7. It was based on the killer lakes of Cameroon and how density played a role in this tragedy. We used a story telling style in writing the poster explaining the problem and the solution in order to attract the targeted audience. Our idea of including the poster turned out to be very useful specifically for parents who were waiting for their kids to get through the various activities of our stations. In fact a number of older kids stood by to read through the poster and we actually received a number of comments and questions from parents about this story of the killer lakes and how long it took the scientific community to solve the puzzle of the killer lakes. Also one of the parents mentioned that he had read that a similar situation has led to the perishing of some animals at some point in time.

4. Agoritsa Gogoulou, Evangelia Gouli, Maria Grigoriadou, Maria Sanarakou, *Exploratory + Collaborative Learning in Programming: A Framework for the Design of Learning Activities*, Proceedings of the third IEEE International Conference on Advanced Learning Technologies.
5. Lischner, R., Explorations: Structured Labs for First-Time Programmers, Proc. Of SIGCSE 01 Conference ACM Press, Charlotte, USA, 2001, pp. 154-158.

Remarks

Based on our observations of the audience on the day of Science Expedition, we believe that our approach in designing our station was successful. By contrasting ideas and highlighting one parameter at a time, the concept of density appeared to be easier to grasp. We tried to expose children to basic principles of experimentation and teach how to systematically analyze their observations and construct knowledge through guided discussions with their peers.

A major drawback of this work is the method of assessment. Our evaluation technique was to unobtrusively collect information about participants using a simple form filled out by a Water Works team member. Performance was assessed through observing the involvement of those individuals who participated in the various activities of our station. The kids seemed engaged in the various activities, they were curious to see whether the objects will float or sink. Older kids could formulate the problem as they played with the objects, and some actually explained to other kids what was going on.

Although, anecdotal evidence was used such as our observation of the questions asked, or inquisitive behaviors that were common, a more formal assessment method would be more appropriate. Students' degree of engagement is an indicator, but other variables need to be measured: for example, student's perception of the set of experiments, of the learning experience and their learning gains. Moreover, pre and post tests should be conducted to quantify any improvement in learning gains. These tests should include cognitive questions such as the definition of density, in addition to more sophisticated questions that measure the judgment and evaluation abilities in real life situations that involve density.

Water Works

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University of Wisconsin-Madison
EPD 690 Informal Science Education for Scientists: A Practicum

Can Density Play Against Us??

Have you ever thought about the role density plays in our daily life? Different liquids have different densities. This important property has helped humans survive for thousands of years. But sometimes density can be dangerous! This is what happened in Cameroon's killer lakes.

The Killer Lakes of Cameroon

In the 1980's over 1,800 people were killed by toxic emissions from 2 lakes in Cameroon. For more information go to:
http://perso.wanadoo.fr/mhalb/nyos/

The Problem

Carbon dioxide (CO_2) formed in the Cameroon lakes as a result of volcanic activity at the lake bottom. Normally, the upper layer of the water acts as a lid keeping the CO_2 in the bottom of the lake. However a disturbance such as volcanic activity, a wind storm, or an earthquake can cause the CO_2 to rise to the surface, releasing CO_2 into the atmosphere. Since CO_2 is denser than air, it moves along the ground, pushing breathable air up and causing death of living creatures.

Degassing is the Solution

To protect the people living around the lake, scientists have found a way to reduce carbon dioxide buildup in the lake. A vertical pipe is set up to pump CO_2 to the surface. The CO_2 at the base of the lake dissolves in the water, making it lighter than the water in the rest of the lake. At this point the system becomes self-powered and the pump is no longer needed as expanding gas bubbles drive the flow of the gas-liquid mixture.

Figure 7. Snapshot of the poster.

Use of Concept Inventories as an Evaluation Tool

Project Description

In a DELTA course entitled, '*Effective Teaching with Technology'*, I designed an online assessment tool for a class taught at UW-Madison during the Fall semester of 2006. This assessment tool has been used in an undergraduate course, NEEP 411, offered by the Engineering Physics Department and taught by Prof. Michael Corradini who agreed to be my mentor in this endeavor. The class had 26 students enrolled, 21 of which took the quiz.

When I started working on this project I picked up a book entitled: "Effective Teaching with Technology in Higher Education: Foundations for Success" by A. W. Bates, Gary Poole[6] and was very much affected by it. It was there where I first learned about the two leading epistemological positions: objectivism and constructivism. And I figured that my tool should take the constructivist's approach if we are to really measure students' understanding of the basic engineering concepts that are presented in class.

Hence the idea of the project was to utilize the concept inventories developed by a team of faculty members in various higher education institutions[7,8,9] to test different levels of students' understanding of these basic concepts. The questions are not straightforward yet they do not require extensive calculation either. They are rather designed in such a way as to make the student undergo a thought process through which he or she tests their own knowledge and apply it to real world problems. The questions also require the student to apply judgment and evaluation, which are considered to be among the high thinking levels in Bloom's taxonomy[10], to an engineering design situation.

While designing my tool, I didn't want it to be a conventional tool that aims at just assessing students' performance. I wanted it to be an opportunity for the students to learn

6. Effective Teaching with Technology in Higher Education: Foundations for Success" by A. W. Bates, Gary Poole, 2003, Jossey-Bass Inc Pub, ISBN: 0-7879-6034-9.
7. Heat Transfer Concept Inventory developed by a team of faculty at the University of Wisconsin (Martin, Mitchell, and Pfefferkorn) and the University of Illinois (Jacobi and Newell).
8. Thermodynamics Concept Inventory developed by Clark Midkiff, University of Alabama, with support from the Foundation Coalition.
9. Fluid Mechanics Concept, Version 3.3, April, 2006, Jay Martin and John Mitchell, (University of Wisconsin) and Jacobi and Newell (University of Illinois).
10. Benjamin S. Bloom, 1984, Taxonomy of Educational Objectives, Published by Allyn and Bacon, Boston, MA.

as well. Indeed, the notion of '*Teaching as Research*[11]*'* has helped me in rethinking how I would go about executing my project. For example, research indicates that giving effective feedback that is '*timely, perceived as relevant, meaningful and encouraging, and offers suggestions for improvement that are within a student's grasp'*[12]can be regarded as a very good way of facilitating the learning process for the students. So I decided to provide this "effective feedback" to spur and hone the student's critical thinking skills as they take the quiz.

Therefore I decided to use FLASH quiz template which allowed me not only to give the students instantaneous feedback but also I could control the type of feedback the students get for answering any one question. Moreover, as Figure 4 shows, I could choose whether or not to give the student a second chance to attempt the questions. If the student makes a mistake in the first attempt, an automated message indicates that the answer is wrong and prompts the student to try again. In case the student makes a mistake in the second try, the feedback would have the right answer. Since short answer questions were prone to spelling mistakes, consideration was taken for these questions to provide the student with a second chance. In addition a number of possible answers were given to the program, one of which is the symbolic form of the dimensionless group which requires inputting only the first two letters. This is demonstrated in Figure 4.

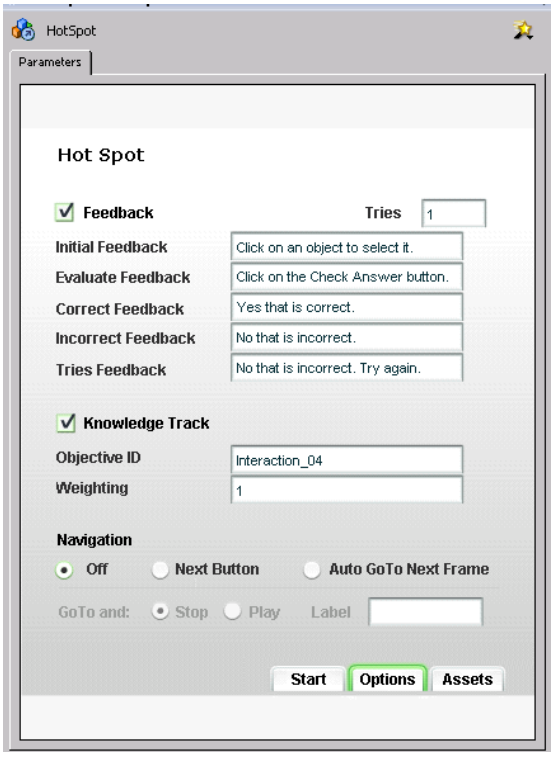

Figure 8. Feedback Options in FLASH.

Addressing Diversity Issues

Because different students learn differently, in picking the questions that appeared in the quiz, I tried to take extra care to present the information in ways that appeal to a wide variety of learning styles. The pre-test was designed in the form of essay questions so that the students get the chance to express themselves in their own words. In developing the e-

11. The phrase "Teaching as Research" refers to the act of teaching as a calculated and reflective practice where research methods are applied in order to improve the teaching/learning experience as quoted from the website of the Delta program http://www.delta.wisc.edu.
12. Brown, G., Bull, J., & Pendlebury, M. (1997). Assessing Student Learning in Higher Education. London: Routledge, as listed in http://evaluate.curtin.edu.au/local/docs/5providing-feedback-for-student-learning.pdf.

quiz, I tried to vary the way the information was presented to / solicited from the students. In all the questions, I tried to combine visual and verbal representation of the problem. Some questions required input from the students in the form of a short answer, whereas other questions (multiple choice, true or false or hot spot) required just clicking on the right answer(s). Figure 1 shows a sample of the different forms of questions that appeared on the e-quiz.

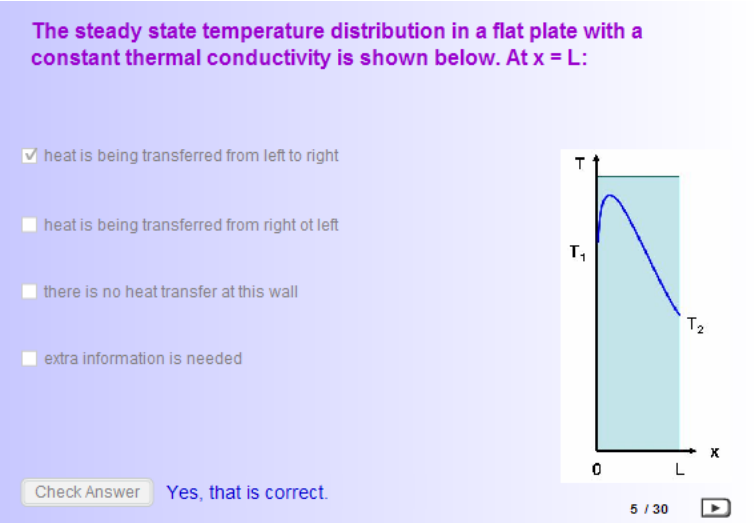

Figure 9a. A multiple choice question. Information presented in the verbal as well as visual format.

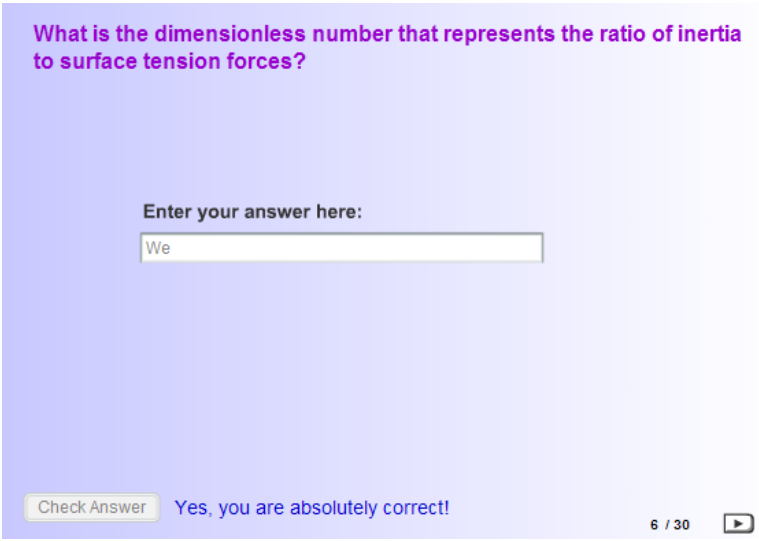

Figure 9b. This question solicits a verbal input from the user.

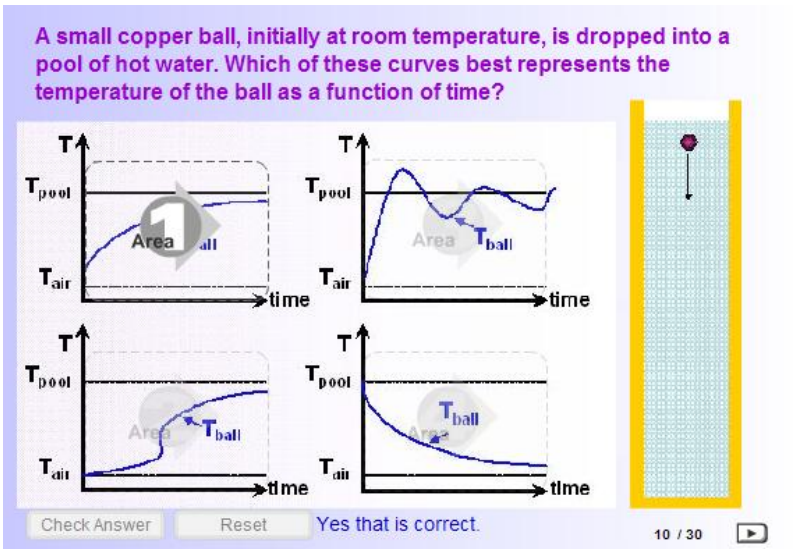

Figure 9c. Hot spot question where the user is required to pick the expected trend based on the verbal information given in addition to the visual aid.

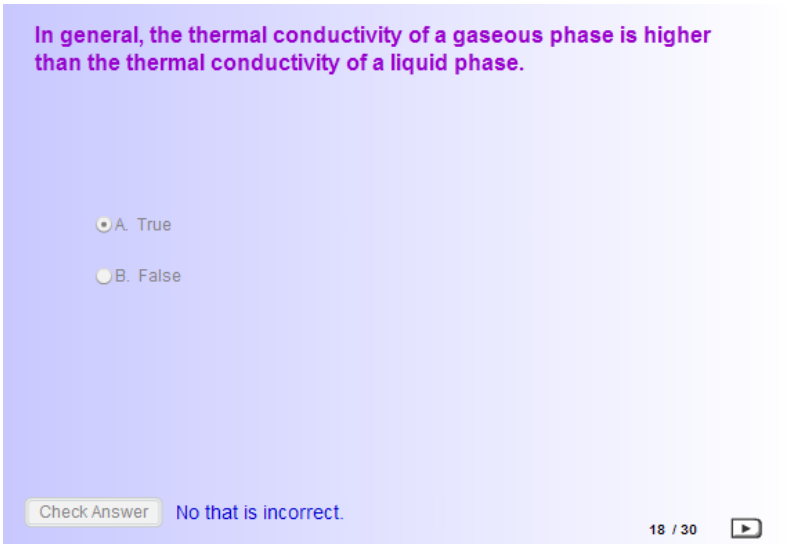

Figure 9d. A multiple choice question that requires some processing of different pieces of information before coming up with an answer.

Students' Perception of the Tool

It was important for me to get a feel for the students' perception of the e-quiz that I developed so I asked them to fill out a survey. The first question of the survey requested the students to assess how hard they thought the e-quiz was. Figure 2 shows the answers I received for this question. Only 1 student thought the quiz was very hard while 2 students

chose moderate for an answer. Interestingly enough the rest of the students were equally divided between hard and easy.

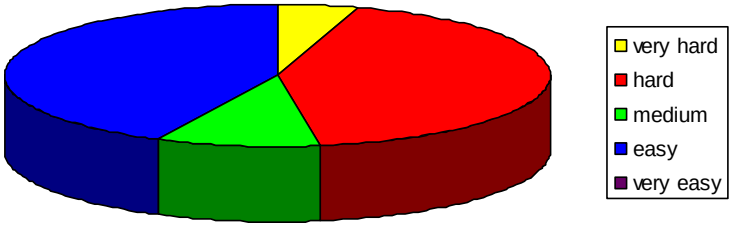

Figure 10. Students' responses to the first question of the survey: How would you rate the quiz?

When students were asked to rate the usefulness of the feedback, there was also a divide among the students. In general, 52.4% of the students were in favor of the given feedback. Specifically, 2 students checked "very useful", 9 students checked "useful" and the remaining 10 students chose "not useful" as an answer. This is summarized in Figure 3.

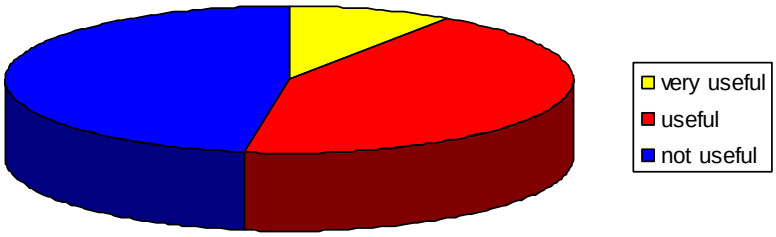

Figure 11. Students' responses to the second question of the survey: How would you rate the usefulness of the feedback?

The survey also asked about the best and worst things they liked or did not like about the quiz, respectively. Since these two questions were rather open, I tried to group similar responses. The most popular features of the quiz were the instantaneous feedback and the fact that it was conceptual; each was listed 4 times. In fact I was happy to see these two features listed as the most liked features since the tool was built with those in mind. Some responses were rather surprising. For example two students listed the fact that the quiz would not affect their grade; as the best thing they liked about the quiz. One of these students even appended his/her answer with "*which means I don't need to think much*". Another intriguing response was the fact that the quiz required "*just clicking*".

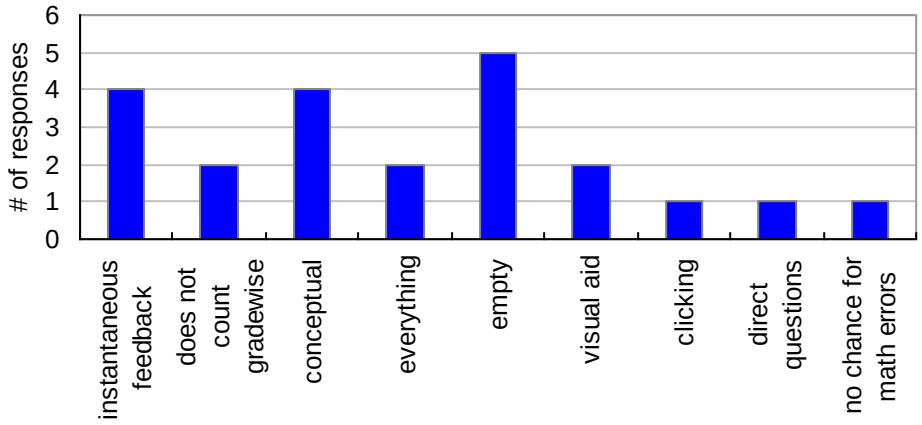

Figure 12. Students' responses to the fifth question of the survey: What's the best thing you liked about the quiz?

Students' Performance Assessment

According to Table 1, the average grade on the e-quiz (65.4%) was higher than that for the paper quiz (60.7%). It was easier for the students to get the full mark on the e-quiz (100% as opposed to 87.5%). This is reasonable since the questions in the paper quiz required explanation on behalf of the students which pointed out to me while grading that some concepts were not as concrete as I would have liked to see. Although they were able to point out to the important factors affecting a specific trend, they were not as good in trying to put the different pieces of information together in a concise and consistent manner. Of course the short answer/ multiple choice format does not reveal that.

Table 1 Summary of Students' Performance on Both Quizzes

	Mean Grade%	Min Grade %	Max Grade %
Paper Quiz	60.7	25	87.5
E-Quiz	65.4	48	100

I wondered whether the same students who performed well on the e-quiz were the same ones who performed well on the paper quiz. Figure 14 shows the students' grades in both quizzes cross plotted for comparison. In general average students performed roughly similarly in both formats. However, at the head and tail of the distribution, one can notice some discrepancy. Some of the students who did really well on the paper quiz, didn't do as well on the e-quiz. Students who didn't do a very good job on the paper quiz performed better on the e-quiz. Although confusing, it shows how the e-quiz can me be misleading if the students just click by my mere chance on the right answers and not for the right reasons.

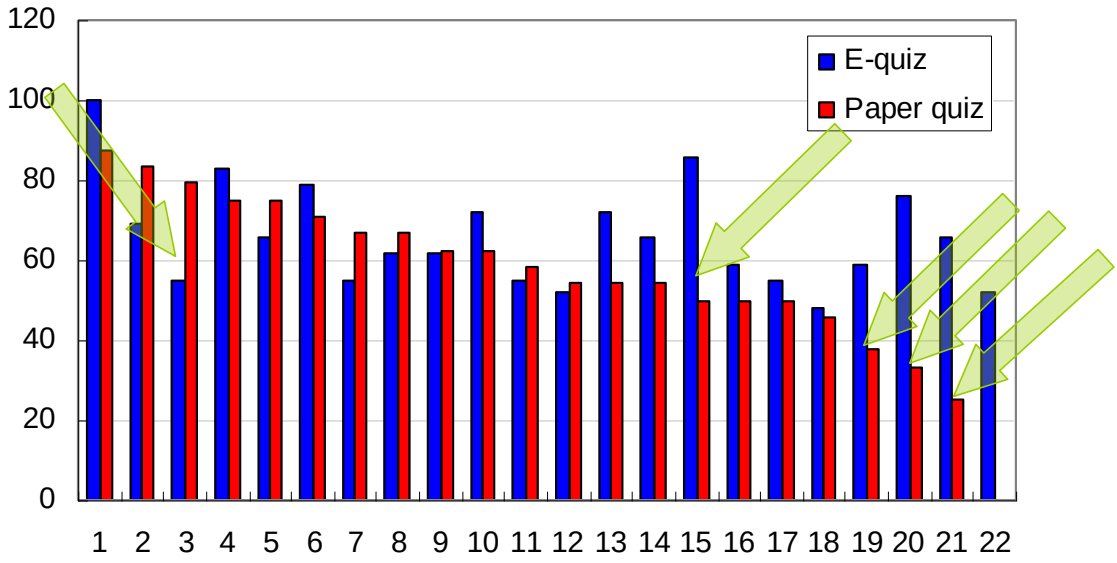

Figure 13. Students' performance on both quizzes with the x-axis indicating the student code number and the y-axis indicating the student's grade in percentage.

Remarks

Several remarks can be pointed out by inspecting the overall performance of the class. The paper quiz was able to differentiate between the students and hence the larger standard deviation. In my view, the electronic quiz can mask a lot of information that can be useful in assessing students' understanding of the concepts they were tested on. Without a detailed record of the students' responses, it is hard to know for sure whether the students picked the right answers for the right reasons or by mere chance. Since the e-quiz is based on short answers/multiple choice type of questions, it is necessary to ask the same question in a number of different ways so that along with a detailed record of the students' responses, one can judge whether the right answers are consistently chosen or not. Hence if I were to use this tool again, I'd definitely not use it for a high stacks exam, but would rather have these quizzes distributed throughout the semester and use it for formative rather than summative assessment. It should help me and my future students identify misconceptions so that we can work on them through out the semester.

In general, a good assessment strategy would utilize various kinds of questions that combined problems, essay-type of questions, short answer type of questions as well as projects.

Care should be taken or practiced in designing questions for students assessments because the quiz itself may be biased in such a way as to favor one gender to the other. Research [13] indicates that female students may not do as well in these kinds of assessment

13. Melissa Dancy, The Myth of Gender Neutrality, AIP Conference Proceedings, n 720, 2004, p 31-4.

'even when [the questions] *appear on the surface to be gender neutral*[13]*'.* This is attributed to the fact that female students are less likely to take risks as their male peers do. In case they are not sure of an answer, female students would rather leave the answer empty than take a risk and guess the right answer. Moreover, there is evidence[14] that female students are reluctant to give an answer that they don't believe in as opposed to male students who find it easier to give the answer they learnt even if they don't quite believe in it. This tendency is likely to harm female students when the question is of the multiple choice or true/false form. Therefore it seems that essay questions are likely to benefit both genders.

After meeting with Alice Anderson[15] and Mike Litzkow[16], I realized that my tool will not, as I planed it, be accessible to a wide range of audience. To redesign my tool according to the theory of universal design, will however require making a lot of modifications that require learning new technological tools that I am not familiar with. Unfortunately, adapting my tool to student audiences with special needs was not possible within the allotted time and my lack of technological expertise in this area. But this is a step that I should pursue as a second phase of my project as well as in other upcoming endeavors.

14. Timothy L. McCaskey, Melisa H. Dance, and Andrew Elby, Effects on Assessment caused by Splits between Belief and Understanding, AIP Conference Proceedings, n 720, 2004, p 37-40.
15. Alice Anderson, alice.anderson@doit.wisc.edu.
16. Mike Litzkow, mlitzkow@facstaff.wisc.edu.

Using Visual Explorer to Teach Heat Transfer

Visual exploration is a creative way of actively engaging students in thinking about complex concepts. Through interaction with the image(s) as well as their peers, students can more easily understand the concepts and more importantly, identify connections between the concepts being studied and their lives. In the process, a learning community can be founded. Group discussions involve various perspectives on the topic and therefore provide a great opportunity for the members of this learning community to find meaningful connection between the course content and their lives, backgrounds, experiences, …etc which in turn instigate their motivation and enhance their engagement. The creators of the tool describe it as follows:

> *In mission-critical situations many different perspectives are typically present, information and other resources are frequently lacking, and yet the responsible group needs to be coherent in its purpose and clear in its understanding in order to take urgently needed action. How do people find coherence leading to action in such situations? Through dialogue. Visual Explorer facilitates dialogue and helps groups reach a shared understanding about specific challenges. It includes 224 carefully chosen color images that invite examination and explication, and thereby acts as a resource for groups seeking to explore complex topics. Groups using Visual Explorer can collectively explore a complex topic from a variety of perspectives, building a shared understanding in preparation for making choices and taking action.*
>
> **"***Visual Explorer: Picturing Approaches to Complex Challenges"*,
> CCL Press, 2001, by Charles J. Palus and David M. Horth.

My first experience with the visual explorer tool was in a class offered by DELTA entitled: Diversity in the College Classroom. The pictures were laid on the table and we were asked to choose a picture that has the meaning of diversity embedded somehow in it. Each student was then asked to comment on her choice of picture, and the rest of us listened. I was amazed by the different perspectives every student brought to the table and could then see the potential of the visual explorer in enhancing students learning in a science classroom.

As a participant in the Delta program, I took part in the Delta Internship Seminar and was given the opportunity of running a class period. I chose to talk about creative methods of engaging students in science classrooms. I demonstrated how we can use the visual

explorer to engage the students in talking about a science topic of interest to me: heat transfer.

Every student in the mock class had the chance to pick a picture in which he/she could see heat transfer represented. Then everyone was given time to walk the rest of the group through how he/she sees heat transfer represented in the chosen picture. Finally the rest of the group members could add their own interpretation of the picture which makes the learning experience very rich, capitalizes on the diversity of the group and creates a learning community that is welcoming, respectful and supportive. This exercise, in which every student claims the floor, helps build self confidence in the speaker and enhances the listening skills of the listeners. Moreover, every student takes responsibility for their own learning experience because they have to find ways to connect what they learn in class with what they experience in their everyday lives.

Some of the comments that I got on the use of the visual explorer in a science classroom include:

> *'……it was a really excellent and engaging example for us to try out and then discuss. I also liked that it got us talking about what it means to engage diversity. …… Overall, I thought you did an excellent job and I really enjoyed the class time!' –Dr. Don Gillian-Daniel, class instructor*

> *'Sigh ...I thought you did an absolutely terrific job. Your use of the images in a way that was purposeful and effective for the science topic was really mind opening for me. It was one of the better examples I've seen of putting learning-through-diversity in action. As was the question and discussion of how best to engage students in that exercise.' ' –Prof. Bob Mathieu, class instructor*

> *'I like this method as a way of starting a conversation about a new topic. I think that it would work best in a group that includes some people that have some knowledge about the concept before starting the discussion, even if that knowledge is light. It was a good connection to where you might see heat transfer in real life.' Adam Creuziger, PhD candidate*

Certainly, the visual explorer has a great potential as an ice-breaker, a conversation starter, a community builder that capitalizes on the diversity of the learning community to

increase students' active engagement. It is worth noting that, the measure to the success (or lack of) of this tool, relied on qualitative data based on my observations of the engagement of the mock students in addition to their perception of the tool and the learning outcomes. My evidence to the success of this tool in creating a learning community is the fact that after this class period, my colleagues and I continued our conversation long after the class period was over. Even when we decided to leave the building we walked together until we reached our destinations. Because this never happened before, I have reason to believe that the exercise we had together did create a learning community.

However, these group of mock students have all been involved with the Delta program. They have been educated about the potential of new technologies in education and hence are all open to non-traditional methods of teaching. Should I expect the same openness from regular students?

I have to admit that at this point, I can't anticipate the effect this tool will have on undergraduate students who have never been exposed to such a tool before. Will students be open to seeing the potential of the tool? Will they speak up? Will they engage in conversations with their peers? Or will they resist and reject it as they may towards what's new and non-traditional?

Before I test the tool with real college students, I will not know for sure whether or not the tool will do what it's intended to do. More quantitative data is needed to support the potential of this tool in a science classroom is needed. This data should aim at correlating the perceived and achieved learning gains to the use of this tool.

A Critical Investigation of End of Semester Evaluations

Introduction

My involvement with the Delta program helped me realize *'the act of teaching [is] a calculated and reflective practice where research methods are applied in order to improve the teaching/learning experience'*[17]. This process will therefore consciously rely on existing evidence from the educational literature as well as real time data gathered from the classroom. In this process assessment is core since like any closed control system, to reach a *set condition* (setting clear goals, instructional objectives and learning outcomes) there needs to be *continuous monitoring* (assessment) followed by *reflective rectification* (to the teaching practice).

As with any 'scientific' experiment, one starts off with a hypothesis, design an experiment to test whether or not the hypothesis is true, observe what happens and drive conclusions and recommendations based on the findings. So for any hypothesis to be scientific, it has to be testable. Similarly, a teacher has to have a plan, a goal and some expected outcome of the teaching process. Whether or not the goals have been fulfilled, whether or not the 'observed' outcomes coincide with those expected, is to be determined using some assessment method, be it formative or summative.

It is customary in STEM (Science, Technology, Engineering and Math) fields to have evaluation forms with a set of questions that focus primarily on the instructor's knowledge and performance. These questions may or may not reflect the students learning experience and furthermore they may not reflect the groups' success in creating a learning community, an inclusive learning environment where all voices are heard.

In one of the DELTA courses that I had taken; specifically the one entitled*: 'Diversity in the College Classroom',* I consulted the literature in educational research to learn more about methods of assessment and in particular the widely used end-of-semester evaluation.

Literature Review on Teaching Evaluation Forms

The end-of-semester evaluation has been used for a long time as a too to evaluate the effectiveness of instructors in higher education. One reason for the wide use of student teaching evaluation forms is that *they don't require much time to administer*. However this summative evaluative tool is usually received by *faculty's cynicism, outright*

17. As quoted from the DELTA website: http://www.delta.wisc.edu.

rejection, hostility and resistance[18,19,20]. Due to their concerns about the validity, reliability, as well as other biasing factors such as: course characteristics, instructor characteristics, student characteristics, limiting academic freedom[21].

These very concerns have been addressed in the literature. For example, with regards to the effect of course characteristics, research has shown that ratings in elective courses are higher than in required courses[22]. In fact the contribution of this biasing factor is shown to account for 1.29 percent of variance which requires creation of separate norms for the different courses depending whether they are elective, mixed elective or required [Brandenburg, Slinde and Batista, 1977]. Moreover, it's been shown in the literature that ratings in higher-level courses are slightly higher than in lower-level courses and that instructors teaching in certain disciplines receive higher student ratings than instructors in other disciplines [Cahsin, 1990-Centra, 1993b-Franklin and Theal, 1992].

The effects of gender on student ratings of professors has also been investigated in the literature. Research shows no significant relationship between gender of the instructor, and his or her overall evaluation but there is evidence that the instructor evaluation is sensitive to the gender of the students participating in the evaluation. In fact, Basow[23] showed that the ratings of male professors are unaffected by student gender, but female professors frequently receive lower ratings from their male students and higher ratings from their female students. Even though these effects may be small in general, they should not be overlooked because in some situations, they can be detrimental. Basow[23] gives a good example for such a situation: a female teacher whose direct teaching style lacks marked warmth or friendliness may find the cards stacked against her when teaching male students in a field where women are a rarity.

Biasing factors such as the instructor characteristics have also been investigated. It is shown that for example rank, age, years of experience and research productivity all have minimal impact on student ratings. Professors receive higher ratings than do teaching assistants [Brandenburg, Slinde and Batista, 1977-Centra and Creech, 1976], and first-year professors usually receive lower ratings than do experienced instructors [Feldman, 1983]. Some studies indicate that faculty research productivity is positively related to their student ratings of effectiveness [Feldman, 1987], and others report a zero correlation between productivity and ratings [Hattie and Marsh, 1996].

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18. Donna Riley, Employing Liberative Pedagogies in Engineering Education, Journal of Women and Minorities in Science and Engineering, vol. 9, pp. 137-158, 2003.
19. L. A. Braskamp and J. C. Ory, Assessing Faculty Work: Enhancing Individual and Institutional Performance. San Fransico: Jossey-Bass, 1994.
20. P. Seldin, The Use and Abuse of Students Rarings of Professor. The Chronicle of Higher Education, 1993, p. A40.
21. H. W. Marsh, Students' Evaluations of University Teaching: Research Findings, Methodological Issues, and Directions for Future Research, International Journal of Educational Research, 1987, vol. 11, pp. 253-388.
22. Liora Pedhazur Schmelkin, Karin J. Spencer and Estelle S. Gellman, Faculty Perspectives on Course and Teacher Evaluations, Research in Higher Education, vol. 38, no. 5, 1997, pp. 575-592.
23. Susan Basow, Student Ratings of Professors are not Gender Blind, Association for Women in Mathematics Newsletter, Vol. 24, No. 5, Sept.-Oct. 1994.

Another biasing factor that can affect the student ratings of professor as well as our interpretation of these ratings lies in the student characteristics. Research indicates that students' prior interest in a course gave somewhat higher ratings[24,25]. Majors tend to rate instructors more positively than non-majors[26]. Furthermore, ratings can be affected by the setting in which they are administered. For example, ratings administered during a final exam are generously lower than those given during a regular class period[27].

Reliability of student ratings, consistency, stability is supported by the results of numerous studies as indicated by Murray, Rushton and Paunonen[28]. In addition the validity of student ratings has been proven by conducting five types of research studies: multi-section, multi-trait-multi-time-hold, bias, laboratory designs, and dimensionality as described by Ory[29].

In short, the problem with students as evaluators is not whether they have useful information or knowledge, but how to get their information and knowledge in a trustworthy form. As they currently stand, end-of-semester evaluation forms seek the student's ranking of the teacher and not his/her judgment of the teaching/learning experience. As Elbow[30] explains —to *rank is to give a single holistic quantitative verdict along one dimension—even though teaching is complex, multidimensional performance. To judge is to look carefully at the performance to distinguish among parts or features or dimensions and decide which parts of the teaching are more effective and which less. Students—indeed all evaluators—need to be encouraged to step outside merely global feelings of approval or disapproval.*

Alternatives to the Summative End-of-Semester Evaluative Tool

Because teaching is a complex phenomenon, it seems unrealistic to be evaluated by only one tool. As indicated by the literature, the end of the semester evaluative tool may provide an unfair representation of the teacher's effectiveness in the classroom as a result of the various biasing factor mentioned earlier. Moreover, it can easily mask a lot of the issues that can be detrimental to the learning experience of the students. Multiple

24. H. W. Marsh and T. Cooper, Prior Subject interest, Students' Evaluation and Instructional Effectiveness, Multivariate Behavioral Research, 1981, vol. 16, pp. 82-104.
25. J. C. Ory, The influence of Students' Affective Entry on Instructor and Course Evaluations, Review of Higher Education, 1980, vol. 4, pp. 13-24.
26. A. K. Feldman, The Significance of Circumstances for College Students' Ratings of Their Teachers and Courses: What We Know and What We Don't Know , Research in Higher Education, 1978, vol. 9, pp. 199-242.
27. P. W. Frey, Validity of Student Instructional Ratings as a Function of Their Timing, Journal of Higher Education, 1976, vol. 80, pp.949-963.
28. H. G. Murray, J. P. Rushton and S. V. Paunonen, Teacher Personality Traits and Student Educational Ratings in Six types of University Courses, Journal of Education and Psychology, 1990, vol. 82, pp. 250-261.
29. John C. Ory, Faculty thoughts and Concerns about Student Ratings, New Directions for Teaching and Learning, vol. 87, Fall 2001, pp. 3-15.
30. Peter Elbow, Making Better Use of Student Evaluations of Teachers, Association of Departments of English, Bulletin 101, Spring 1992, pp. 2-8.

measures must therefore be applied intelligently to provide a more accurate representation of the complexity and diversity of good teaching [Armstrong[31], Timpson et al[32]].

1-Peer Observation

Exchanging classroom visits and soliciting feedback from colleagues and reflective self-evaluation are all effective methods that enhance the teacher's effectiveness in the classroom. Sheppard et al[33]suggest a combination of a reflective memo, student interviews and a summative memo for *near real time monitoring that creates constructive feedback for teaching and learning quality control*. In fact, Ory and Braskamp (1981) indicate faculty preference for different types of feedback (i.e. objective questionnaire items, open-ended questions and group interviews) rather than the specific information conveyed in different items. They actually found that faculty ratings of the quality (e.g. credibility, usefulness, accuracy) of different types of student feedback depend on whether the feedback was for their own self-improvement or for promotion purposes.

Since the peer-observation process lacks anonymity, Sheppard et al.[33] recommended establishing templates for the reflective and summary memos in order to lessen any discomfort that may arise. Some of these templates are readily available on line and I will be using one that I found on the website of the State University of New Jersey, Rutgers[34]. It is a guide to peer-observation that takes into account the various aspects of classroom teaching, for example, classroom setup, content, preparedness, instructor personal qualities and interaction with students, class dynamics, methods of delivery,…etc.

In addition, I also developed a two-part formative tool to evaluate the success of my teaching strategies in facilitating my students' learning.

2-Formative Evaluative Tool

As the literature review revealed, more frequent low-stakes informal private formative evaluation can be more effective in improving teaching than the official ones, especially because they are less threatening.

This led me to develop a two-part assessment tool as a semester-long class project for the Diversity in the College Classroom course offered by the Delta program. This instrument is designed to assess whether or not my effort in creating, fostering and maintaining a learning community in which certain ideas such as diversity, teaching as research, active

31. Paul B. Armstrong, Deprivatizing the Classroom, Association of Departments of English, Bulletin 107 (Spring 1994): 13-19.
32. Timpson, William W., Andrew, Desley, Rethinking Student Evaluations And The Improvement Of Teaching: Instruments For Change At The University Of Queensland, Studies in Higher Education, 0307-5079, March 1, 1997, Vol. 22, no. 1.
33. Sheri Sheppard, Michelle Johnson, Larry Leifer, A Model for Peer and Student Involvement in Formative Course Assessment, Journal of Engineering Education, October 1998, pp. 349-354.
34. http://taproject.rutgers.edu/services_tips/POP.php3.

learning are honored and practiced. The tool is basically composed of two questionnaires given to my students the first: one or two weeks into the semester and the second: two months into the semester. By means of this two-part tool I will get an idea about the students' perception of their own class: do we know we have women or minorities in our class? Are there international students among the group? Are there any returning students? When we are doing an in-class activity or a group discussion, do you notice anyone left out of the conversation? Do you do anything to invite them to the conversation? The first part of this instrument is intended to act as a pretest while the second part is meant to measure the change that we as a learning community could achieve through the careful planning of the class.

Students need to know these issues and they also need to be trained to be more conscious and critical of themselves, the instructor and other students' behavior. Moreover, they need to be trained to report it at the least or better stand up for it or rectify any inappropriate behavior. Hence another goal of the two-part evaluation form is to suggest some *questions* that aim at raising students' awareness of issues like diversity, unconscious/conscious prejudices and biases that may arise in class.

I deliberately tried to keep the conversational tone in all handouts to give an invitation to interpersonal communication between my students and myself. I also tried as much as appropriate to communicate my intentions with my students in order to make them feel confident that everything we practice in class is done purposefully and therefore reinforce the idea that teaching is performed with their benefit as the ultimate goal.

Students are usually anxious about the mid-semester evaluation forms because these may have a negative effect on their grade. Hence, as Felder[35] recommends I plan to have my students conduct this activity in a group.

35. Richard M. Felder, What Do They Know Anyway? II. Making Evaluation Effective, Chemical Engineering Education, vol. 27, no. 1, 1993.

Learning Experience Evaluation Form
I-A Mid-Semester Survey

This mid-semester survey is intended to give me feedback about the different aspects of our classroom teaching/learning experience, so far. This feedback would help me assess the extent to which you are benefiting from the teaching/learning strategies, activities, methodology…etc. This assessment will educate me about your needs and consequently help me tailor my teaching to meet your expectations or correct for any faults, for the following weeks to come. I would therefore really appreciate it if you try to reflect upon your experience so far and discuss these questions with a group of 4 of your classmates. If you'd rather work on this on your own, which is fine, please feel free to mention the reason behind this choice. In either case, please write at the upper right corner the number of people in the group. After thoroughly discussing these questions please write down your collective view in the white space. If you need extra space please use the back of the paper.

Note:
These forms are intended to be anonymous to assure you that it is safe to share whatever views, criticism, reservations,…etc you may have.

- Would you please comment on the following aspects of your learning experience:

    - Clarity of stating expectations
    - Frequency of providing examples
    - Repeating difficult ideas in different ways
    - Pointing out practical applications
    - Quality of answering questions
    - Degree to which you find this course/instructor challenging

Note: Please identify the weaknesses/strengths and provide ideas about how to improve teaching in the following weeks.

- How would you describe your learning environment? Collaborative environment? Competitive environment?

- When we are doing an in-class activity or a group discussion, do you notice anyone left out of the conversation? Do you do anything to invite them to the conversation?

- How many students in the classroom, how many did you learn their names during the course so far? Did the class activities help you know other students in the classroom?

- Which of the following pictures best describes your learning experience (learning diagram). How would you modify any of these pictures for a better learning experience.
- How would you rate your contribution to your learning experience in this class?

- How would you rate the contributions of your colleagues to your learning experience in this class?

- How is the course, so far, matching your expectations?

- Did you feel that the reading assignment was reasonable? Did you feel that it helped you understand the material better? Please explain.

- Did you feel that the handouts were reasonable? Did you feel that it help you understand the material better? Please explain.

- Did you feel that the exams were reasonable? Did you feel that they help you understand the material better? Please explain.

- Did you take part in the online group discussion? Did you think that it is a useful tool in the learning process? Please explain.

- Do you study alone or in a group? Why?

- Would you rather do the HW as a part of a group? Would you rather do it on your own? Why?

- Are you in support of the student representatives? If not, would you please give your reasoning?

- How would you describe the overall pace of the class?

Learning Experience Evaluation Form
II-End-of-Semester Survey

This end-of-semester survey is intended to help me assess whether the teaching strategies, methodologies, and the planned activities,…etc, have enhanced your learning experience. Your feedback is greatly appreciated since it brings along a different perspective than mine and will consequently help me tailor my teaching and/or correct for any faults, for the following semester(s).

Note:
This form is intended to be anonymous to assure you that it is safe to share whatever views, criticism, reservations,…etc you may have.

I-Overall Course/Instructor Evaluation:

- How would you rate this course/instructor on a scale of 1 to 5.
  In responding to this question not that,
  5 = one of three or four best courses/instructors you've ever had,
  4 = top 25%,
  3 = 40-75%,
  2 = bottom 40%,
  1 = one of the three or four worst courses/instructors you've ever had.

- What makes you choose this rating? It would be helpful to give examples.

- What do you like best about this course/instructor? List up to three things.

- What do you like least about this course/instructor? List up to three things.

- If you were the instructor, what would you do to improve the course?

- Name one thing in the class you would change? Name one thing in the class you would add?

- Did you feel free to ask questions? Was there ever a situation in which you (or any of your classmates) felt that you were intimidated by the instructor or other classmates?
- Do you think the instructor knows (at least some of) the students' names? If yes what is your estimate of the percentage of names that the instructor knows. Did you feel that the instructor tried to learn the students' names?

- Did you ever feel that the instructor's conduct was inappropriately influenced by students' personal characteristics, such as gender, ethnicity, cultural background or sexual orientation?

- What is your impression about in-class-discussions? Did you find them useful, enlightening? Did you think of them as a waste of time? Did the instructor help facilitate the discussion? For example by raising stimulating questions. If yes did you feel that this was useful?

- Did the instructor link abstract issues to concrete situations and vice versa?

- Were the instructor's answer keys and/or individual comments sufficiently detailed to help you learn? Was the instructor's feedback on students' work constructive?

- Did the instructor manage student participation in an equitable way?

- Did the instructor facilitate group dynamics effectively? Please give examples.

- Did the instructor guide students to useful resources and approaches?

- Was the instructor able to clarify difficult course topics?

- Did the instructor encourage students to participate actively in recitation?

- Would you like to add any suggestions/comments?