AC 2010-15: ASSESSMENT OF PROBLEM-BASED LEARNING

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Assessment of Problem-Based Learning

Abstract

Utilizing real-world problems as a stimulus for student learning is not at all new and has been in practice for a very long time. Problem-based learning has been defined as minds-on, hands-on, focused, experiential learning (Wilkerson & Gijselaers, 1996). A problem-based curriculum is significantly different from the traditional discipline centered curriculum (Woods, 1994). Instructors are considered to serve as problem solving colleagues assigned with the responsibility of promoting interest and enthusiasm for learning. Instructors are also encouraged to act as cognitive coaches who can nurture an environment that can support open inquiry (Barrows, 2000). It is important that the aims and objectives of problem-based learning be reflected in every aspect of the learning environment created. Problem-based curriculum should document accomplishments at the upper levels of Bloom's Taxonomy Triangle (Boud & Feletti, 1991). Scholars in the area of cognitive science and educational psychology have identified four features that clearly separate a problem-based curriculum from a traditional, topic-based curriculum (Nickerson, et. al. 1985). In this presentation, the author describes how he has utilized and assessed the five features in his Senior Design Capstone Course. He also presents analyses of the feedback data he obtained and suggests guidelines for further improvement.

Introduction

One has to appreciate the fact that students need motivation to become lifelong learners. Thereore it is the responsibility of the instructors in higher education to develop, generate, create and establish an environment in which students not only obtain necessary background knowledge, but also become enthusiastic in becoming lifelong learners (Deemer, 2003). Educational psychologists have argued that one may want to focus on solving certain specific problems in a particular type of classroom so that teaching is less emphasized compared to a productive learning environment (Aspy, 1970). Scholarly teaching not only helps instructors experiment their innovative ideas, but also helps the students to focus more on the process of learning through a discovery approach (Broadley, Broadley, Slater, & Suddaby, 2000).

Researchers have also concluded that students are indeed focused on learning the subject matter than on just obtaining impressive grades (Pollio and Beck, 2000). Regardless, students also admit that grades are extremely important for them, keeping in perspective, their future career goals. This may appear like conflicting interests, however one should appreciate the fact that the goals and objectives of students as well as the instructors still remain the same, namely the importance of emphasizing learning in the classroom environment. Students should have a desire to accomplish a better performance on the learning modules that promote deeper processing techniques and challenges (Graham & Golen, 1991). Researchers have also concluded that effort and capability are closely related and there are plenty of recorded studies that correlate strong motivation to cognitive engagement creative learning (Pintrich, 2000, Ames and Archer, 1988).

The Five Principles

It is quite common for colleges and universities to offer several types of precollege-level courses. These types of courses are basically designed to teach the essential academic skills that are necessary for success in some chosen upper level courses (Brier, 1984). For example, a pre-calculus course may be necessary for a group of students who may be quite competent in English literature. Another example would be a technical writing course that could help scientists, mathematicians and engineers with their journal publications. In a similar manner, for *Problem Based Learning* to work effectively, one has to appreciate the following five principles.

DEFINE: First, the instructor must clearly define the objectives of the course in question. In addition, the instructor should also provide a detailed path for attaining these goals. Such a structure will prepare the students to admire and handle the course with great enthusiasm and creative productivity.

DESIGN: Secondly, the instructor should design *Learning Modules* that can create interest and motivate the student body towards becoming metacognitive learners. In other words, one should be able manage one's own learning. One module should build on the previous module, thereby adding to the knowledge base the students already possess. In other words, students should learn, *"How to Learn."*

DEVELOP: Third, the course should be developed in a systematic manner so that the learner can appreciate the fact that the course is being built on the previous knowledge acquired. For example, knowledge of Physics and Mathematics must be effectively utilized in a *Mechanics* course. It is important to recognize that a methodical approach has always been the principle behind solid fundamental knowledge acquisition.

DEPLOY: Once the first three ideas have been secured in place, it is now necessary to implement them at the required level with appropriate advantage. Here, the instructor should utilize multiples modes of delivery techniques. Such a method has been suggested by Fleming and Mills. Lectures, Reading, Writing, Visual Aids, Tactile and Kinesthetic modes of delivery help to reach students with diverse learning skills.

DECIDE: Finally, there should be an assessment of the course, the curriculum, the learning environment, the student body, and the instructor. It is important to conduct separate assessment of all the above-mentioned five. Once the five sets of data are in placed in their appropriate context, one can judge the impact of problem based learning on the learning environment itself.

Implementation

For purposes of assessment, the author utilized the principles of *VARK* as outlined by Fleming and Mills (Fleming and Mills, 1991). The objective was to determine the extent to which the student population was receptive to different delivery styles. Audiovisual Aids such as Power

Point Slides were used to study the students' learning capabilities in the *visual* mode. Lectures were also delivered to accommodate the *aural* mode of learning. Research reports, reading and writing assignments were included to examine the *reading* mode of learning. Lastly, laboratory demonstrations, experiments and exercises were set up to encourage students to learn in the *kinesthetic* mode. Students were later examined on all the topics, quizzes were graded and tabulated using a rubric based on Washington State University's critical thinking rubric. The author has provided full details in Appendix A.

Conclusions

Dr. Hunter R. Boylan, who is the Director of the National Center for Developmental Education at Appalachian State University in Boone, North Carolina, is of the opinion that students fail to do well in college for a variety of reasons. Only one of them is lack of academic preparedness (Boylan, 2001). Factors such as personal autonomy, self-confidence, ability, study behaviors, social adjustments, diversity and discrimination also play a vital role in the recorded grades (Astin, 1977, Chickering, 1969 and Sedlacek, 1987). Many politicians think funding will ultimately solve the problem. Legislators and educators frequently confuse the funding of a solution with the actual solution of a problem. Hodgkinson reports that even huge financial support and massive infusions of dollars have failed to improve the quality of knowledge at the high school level (Hodgkinson, 1985 & 1993). Passing legislation may be worthless because the problem may not be actually addressed if the legislation is not implemented efficiently and effectively,

There are documented cases wherein students have specifically indicated that they would like to engage in a lively classroom discussion, rather than being simply lectured to. These lively classroom discussions have shown to allow greater student participation. Although, some scholars say that such a method puts forth a completely different approach to college education compared to a traditional lecture format (Midgley, 2002). Therefore, it is important to assess the students' learning capabilities and not just his/her memory. In other words, assessment of learning is not a third-party research project or someone's questionnaire; it must be viewed as a community effort or nothing, driven by a faculty's own commitment to reflect, judge, and improve (Marchese, 1991 & 1997).

Hawkins and Winter's ACORN model documents ideas and provides guidelines to conquering and mastering change (Hawkins and Winter, 1997). The model is shown in Appendix D. The instructors should utilize these helpful hints while developing assessment procedures that may lead to implementing the necessary changes at educational establishments (Narayanan, 2004 & 2007). From the data collected, it appears that students are indeed much more receptive to the kinesthetic mode of learning. In other words, learners prefer hands-on-training. Audio-visual aids may help, however, lectures have the least amount of impact. One can say that, in the twenty first century, problem-based learning is extremely useful and productive, but it should be implemented in the appropriate manner to maximize the yield. More research is needed to examine in detail the benefits students receive.

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APPENDIX A : Methodology of Assessment (Narayanan, 2007 & 2009).

Assessment of Problem Based Learning was carried out using the principles of VARK as outlined by Fleming and Mills (Fleming and Mills, 1991). The approach and philosophy was to determine the extent to which the student population was receptive to different delivery styles.

The instructor chose four different topics and delivered them in four different modes during four different 50-minute lecture class periods.

Topic **V**:	Visual Aids such as Power Point Slides were used.	(Visual)
Topic **A**:	This was delivered in the traditional lecture format.	(Aural)
Topic **R**:	Students were required to read and submit their findings.	(Reading)
Topic **K**:	Laboratory setting was used that included demonstrations.	(Kinesthetic)

The four topics chosen were not exactly identical. However, they were fairly similar in their complexity.

Four separate quizzes were assigned that covered all the four topics.

Grading was holistic and the instructor documented his observations.

No quantitative grade points or percentages were recorded.

The author's approach for gathering data is shown in Appendix B.

Analysis of bar chart is shown in Appendix C.

Grading was based on student's knowledge of the topic.

Appendix D shows the actual bar chart generated using the data collected.

The *ACORN* Model of Hawkins and Winter is shown in Appendix E.

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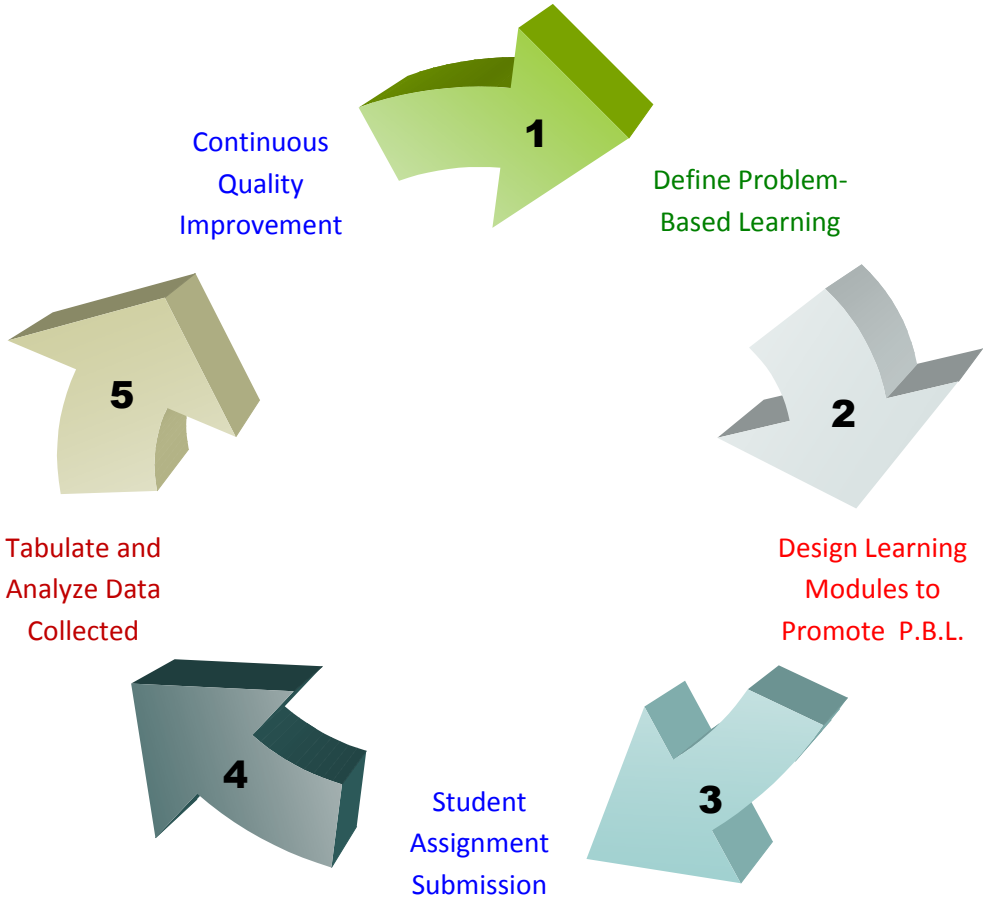
APPENDIX B: Author's approach.



The author has previously used similar approach in other research and other ASEE publications.

APPENDIX C: *VARK* BAR CHART ANALYSIS

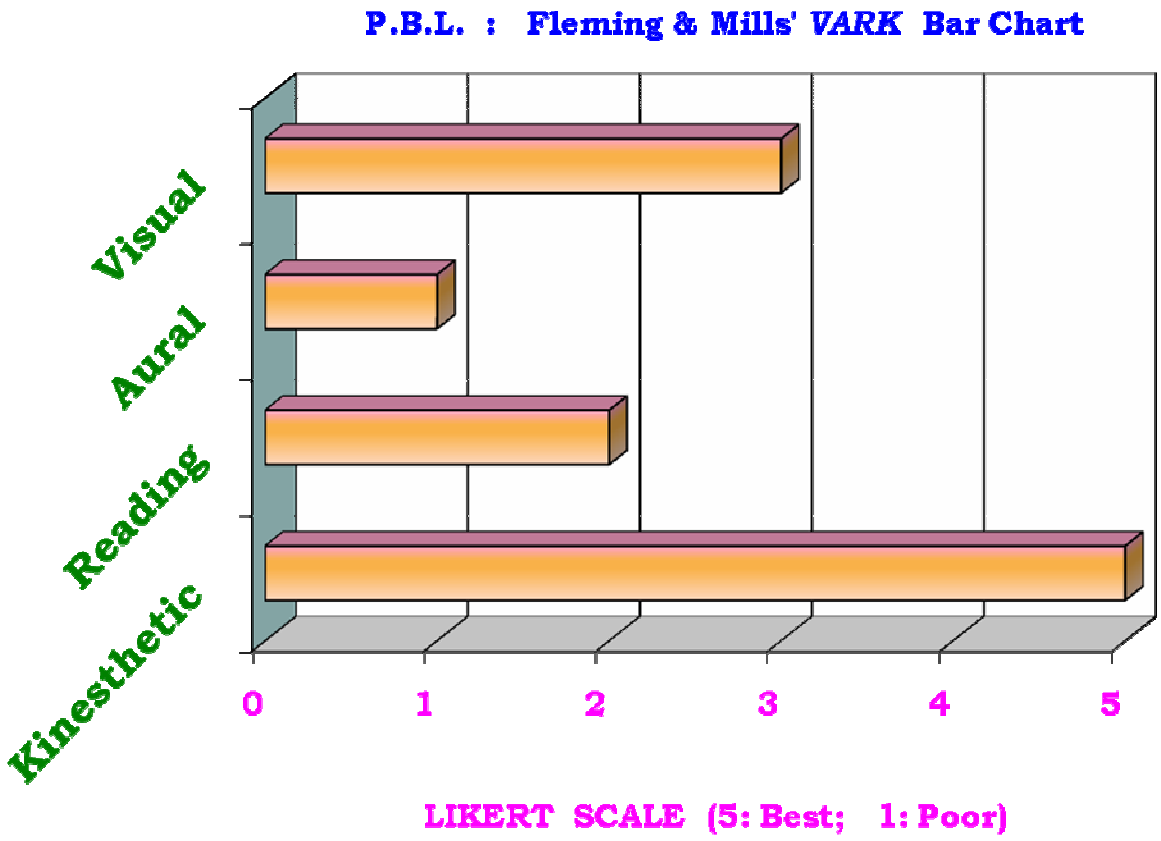
1. VISUAL: Visual aids help the learners to a very large extent. Demonstrations, Field Visits, Plant Tours also help. Students learn better, when they can actually *see* something. Greater retention is accomplished by this mode of delivery. One can recall the famous phrase: *A Picture is worth a thousand words.* This has scored better than the reading mode, securing a **3** on Likert scale.

2. AURAL: This is the traditional *lecture* mode. This has recorded the lowest score of **1** on Likert scale. One may conclude that the attention span of the students is not very good and is totally inadequate in a 50-minute lecture class and they are unable to grasp the importance of the subject matter just by listening. This is particularly true to certain disciplines such as science and engineering. Other disciplines such as performing arts or fine arts may also record a low score on the Likert scale.

3. READING: Providing reading assignments has its own advantage. Time constraints do not exist, as they do in a lecture class. In case the students have difficulty, they can read a particular topic two or three times to understand a required concept. In other words, the learner can learn at his/her own pace. Reading may be suited to certain disciplines like English literature, however, reading may not be very beneficial in another area such as performing arts. This type of delivery mode has scored better than the aural mode, securing a **2** on Likert scale.

4. KINESTHETIC: The best mode of delivery is the *kinesthetic* mode. Most learners do so by doing. Whether it be problem solving in a mathematics class or it be conducting an experiment in a chemistry laboratory, students really enjoy this type of learning when it is implemented properly. Engineers, Surgeons, Artists and a wide variety of other professionals are productive when they actually perform a problem-solving task. Lectures and reading only supplement what they learn by practice. It is therefore necessary to include PBL techniques wherever possible and whenever possible. This has scored best, securing a **5** on Likert scale.

APPENDIX D: *VARK* BAR CHART



APPENDIX E: THE *ACORN* MODEL OF HAWKINS AND WINTER

The present day varying economic conditions are highly volatile and the technical skills required by the modern industry is constantly changing. It is therefore essential and imperative to understand that the role played by colleges and universities is quite different from what it was several decades ago. The use of 'ACORN' model suggested by Hawkins and Winter to conquer and mastering change, may offer some helpful hints on assessment and for implementing the needed changes at universities and colleges.

Action : It is possible to effectively change things *only* when an honest *action* is taken and an attempt is made to improve quality. Both the Faculty and the students, must join forces and should actually try out to successfully implement new ideas. Appropriate action is always well rewarded.

Communication : Changes are successful *only* when the new ideas effectively *communicated* and documented in place. The entire workforce comprising of faculty, staff, students and administration should work toward a common goal. They should have a very structured and clear idea of what their goals and objectives are. Proper briefing at regular intervals help bridge the *communication* gap not only between the faculty and the students, but also between the students themselves.

Ownership: Support for change is extremely important and is critical. The administration should buy into this concept wholeheartedly. Both the administration and the faculty should accept that changes are essential and that changes are taking place for the betterment of students, management and the university community as a whole. *Only* strong commitment for accepting and implementing changes demonstrates genuine leadership. Faculty and students must also enjoy the pride of ownership.

Reflection : Feedback from students, industry, faculty and administration helps towards thoughtful evaluation of the changes implemented. *Only* reflection can provide a tool for continuous improvement. Constant updating should always receive priority billing and the entire university should *reflect* on its achievements.

Nurture : Implemented changes deliver results *only* when *nurtured* and promoted with necessary support systems, documentation and infrastructures. The main responsibility falls upon the shoulders of the administration. Faculty, Staff and students can definitely contribute in this area, however *nurturing* requires strong financial and emotional commitment.

Source: Hawkins, P., & Winter, J. (1997). *Mastering change: Learning the lessons of the enterprise in higher education initiative.* London, United Kingdom: Department for Education and Employment.

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