Assessment of Innovative Environments that address Intellectual Curiosity

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Abstract

The principle behind a cognitive competence, intrapersonal competence, interpersonal competence, and practical competence is extremely useful while creating interesting and innovative environments that address intellectual curiosity. 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. Regardless, a problem based curriculum is significantly different from the traditional discipline centered curriculum. It is important that the aims and objectives of problem based learning are reflected in every aspect of the learning environment created. Scholars have identified four features that clearly separate a problem-based curriculum from a traditional, topic-based curriculum. It is important that the aims and objectives of problem-based learning are reflected in every aspect of the learning environment created. Problem-based curriculum should document accomplishments at the upper levels of Bloom's Taxonomy Triangle. 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. To address intellectual curiosity, the instructor should create environments that are interesting and innovative. In this presentation, the author describes how he has utilized the four features in the courses he teaches. He also presents analyses of the feedback data he has obtained and suggests guidelines for further improvement.

Introduction

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. Regardless, a problem-based curriculum is significantly different from the traditional discipline centered curriculum. It is important that the aims and objectives of problem-based learning are reflected in every aspect of the learning environment created. Scholars have identified four features that clearly separate a problem-based curriculum from a traditional, topic-based curriculum. It is important that the aims and objectives of problem-based learning are reflected in every aspect of the learning environment created. The four features are discussed in detail below (Arnold, 1999; Barr and Tagg, 1995).

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). The author has previously discussed the importance of these ideas in a previous ASEE publication, entitled "Assessment of The Four Features of Problem-Based Learning." In that presentation, the author described how he had utilized the four features in the courses he has taught. He also presented analyses of the feedback data he had obtained and suggested guidelines for further improvement (Ross, 1993; Tozman, 2004). Some of those ideas have been reproduced here for sake of clarity and completeness.

Four Features

1. **Learning must be cumulative:** The subject matter is not learned by the student in great depth at one long stretch. On the contrary, the topics are introduced gradually and repeatedly. Furthermore, the level of complexity of subject matter should increase with the progression of time.

2. **Learning must be integrated:** The subject matter is must not introduced with a stand-alone approach. Topics are always discussed as the correlate to a real world problem.

3. **Learning must be progressive:** The student's learning needs keep changing continuously. Learners begin acquiring specific and knowledge of subject matter. As time progresses, this knowledge base is expanded and integrated with what has already been learnt.

4. **Learning must be consistent:** The learning environment created should ensure repeatability. Every learner should accomplish identical goals and educational outcomes. Individual learning styles should have no impact on the knowledge acquired.

The *ACORN* Model

Universities, Colleges and Educational institutions do not adapt to change easily. Their traditional infrastructures call for ideas that are much more likely to foster stability rather than change. In spite of this, one should recognize that things are changing for the better, in many cases. Now-a-days Universities are showing greater interest in the teaching activities of its faculty members, and Lilly Conference on College Teaching is a classic example. Opportunities are being provided for teachers to learn more about the 'scholarship of teaching.' Foundations, Endowments and Grants have been supporting initiatives aimed at improving classroom teaching. The use of 'ACORN' model suggested by Hawkins and Winter to conquer and mastering change, may offer some helpful hints for implementing and assessing of Innovative Environments that address Intellectual Curiosity (Hawkins and Winter, 1984). The author has successfully used these principles in his classroom activities. He has also presented his findings in various other conference presentations, including ASEE national conferences (Narayanan, 2002 – 2012).

Action : It is possible to effectively change things *only* when an honest attempt is made to improve quality. Both the Management and the employees, must join forces and should actually try out to

successfully implement new idea. Appropriate action is always well rewarded.

Communication : Changes are successful *only* when the new ideas effectively communicated and documented in place. The entire workforce 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 management and the employees, but also between the employees themselves.

Ownership : Support for change is extremely important and is critical. Both the management and the employees should accept that changes are essential and are taking place for the betterment of employees, management and the company as a whole. *Only* strong commitment for accepting and implementing changes demonstrates genuine leadership. Employees must also enjoy the pride of *ownership.*

Reflection : Feedback helps towards thoughtful evaluation of the changes implemented. *Only* reflection can provide a tool for continuous improvement.

Nurture : Implemented changes deliver results *only* when nurtured and promoted with necessary support systems, documentation and infrastructures.

Assessment and Analysis

Appendix A shows the procedure for carrying out *Assessment.*

Topic studied: Advanced Engineering Mathematics.

Student Population: A junior level course with 18 students participating in the study.

Background: The students have had two semesters of college level calculus.

The grading was administered using a rubric similar to Washington State University's Critical Thinking Rubric. Appendix B shows the rubric utilized.

A sample of grading scheme is shown in Appendix C. The data obtained was tabulated using a Likert Scale (Narayanan, 2007).

Four *"Primary Traits"* or *"Characteristics"* were identified and assessed. Assessment tools that were utilized included, but not limited to quizzes, home works, research documents, laboratory reports, examinations, project binders, etc.

Appendix D documents this assessment data collected, using a bar chart that utilizes Likert Scale.

Appendix E indicates how to use the pause procedure to enhance lecture recall. Researchers Ruhl, Hughes & Schloss are of the opinion that *If Instructors Talk Six Minutes Less, Students Learn More.*

Appendix F lists the ten principles of learning.

Obviously one should attempt to achieve mode values of **5** on all the characteristics; however this is probably unrealistic in an undergraduate environment.

1. **Learning must be cumulative:** The students have recorded an acceptable value of **4** on Likert Scale. The students are fairly capable of handling the increased level of complexity of subject matter with the progression of time. The instructor should attempt to achieve the maximum possible score of **5** on Likert Scale.

2. **Learning must be integrated:** This category has again recorded good, acceptable score of **4** on Likert Scale. The students have understood the importance of correlating to a real world problem.

3. **Learning must be progressive:** A modest score of **3** on Likert Scale is not what should be expected in this area. The student's learning needs to improve a lot. This indicates that the instructor should attempt to expand the knowledge base better.

4. **Learning must be consistent:** An unacceptable score of **2** on Likert Scale is disappointing. This indicates that individual learning styles does have a strong impact on the knowledge acquired. Instructional delivery styles may have to be changed in order that this deficiency is corrected.

Conclusions

In order to assess innovative environments that address intellectual curiosity, the instructor has to necessitate changes, primarily in *Instructional Delivery Styles.* Each instructor's delivery style is different and one may even arrive at two different sets of data for the same subject and topic when two different instructors are involved. The author would like to state that *Washington State University's Critical Thinking Rubric* has proved to be extremely valuable in documenting the effectiveness of creating innovative environments. This Rubric has helped the instructor address and assess perceptual dimensions of learning.

The ultimate goal is to create an innovative environment that can deliver information to the learner in the best possible manner that suits the receiver's optimum learning style.

Acknowledgements

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PLEASE NOTE:

SOME OF THESE REFERENCES ARE A PART OF "GENERAL BIBLIOGRAPHY." They are not specifically cited in the body of the paper. They are included here for sake of completeness and clarity. They are of great use while conducting further research work.

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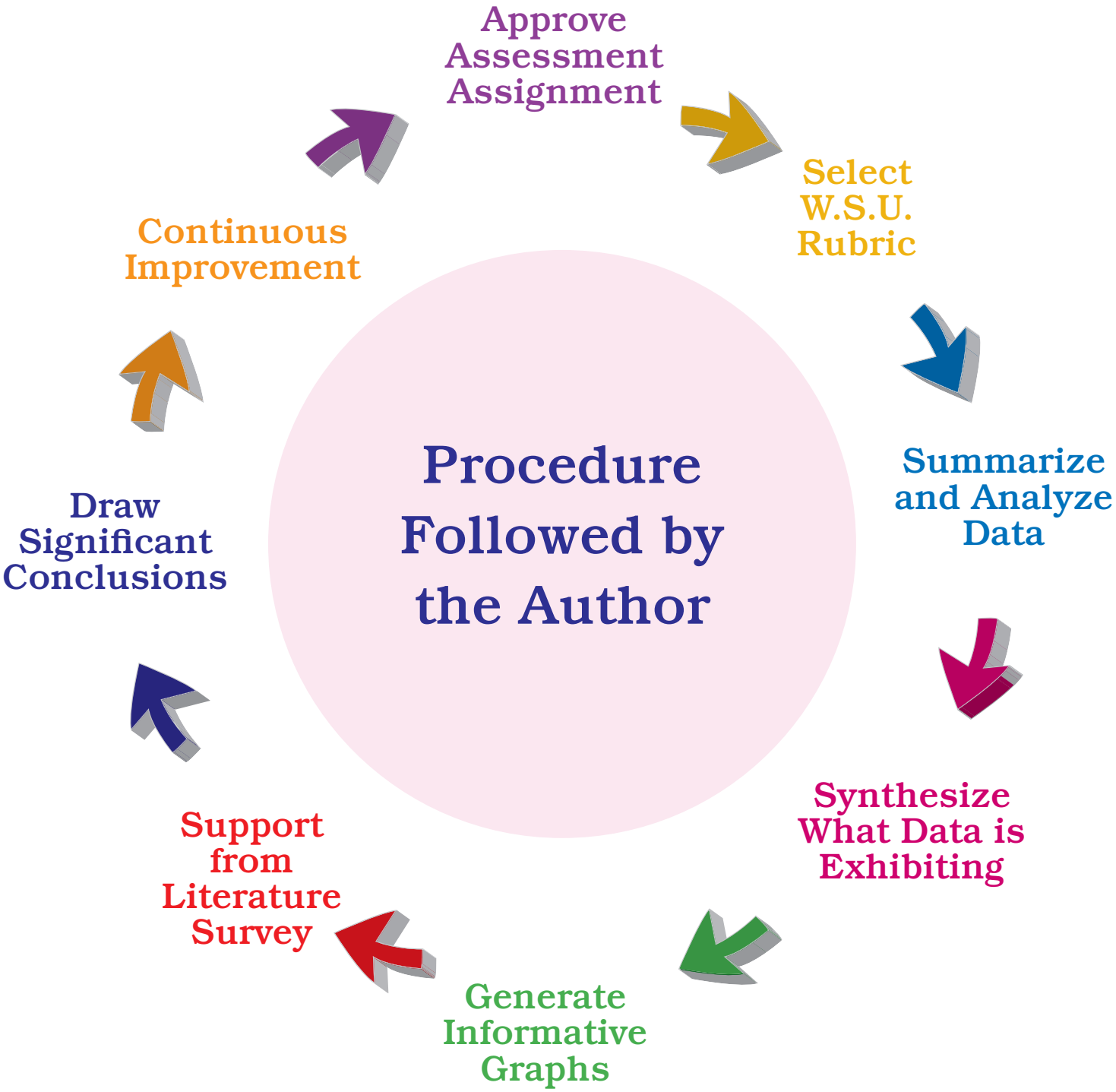

Approve Assessment Assignment
Select W.S.U. Rubric
Summarize and Analyze Data
Synthesize What Data is Exhibiting
Generate Informative Graphs
Support from Literature Survey
Draw Significant Conclusions
Continuous Improvement
Procedure Followed by the Author

APPENDIX B : Critical Thinking Rubrics (Courtesy of W.S.U., Pullman, WA)

	Rubrics based on Likert Scale	
5	Has demonstrated excellence. Has provided documentation. Evidence of critical thinking ability. Very good performance	Has analyzed important data precisely. Has answered key questions correctly. Has addressed problems effectively. Has evaluated material with proper insight. Has used deductive reasoning skills. Has used inductive reasoning skills. Has employed problem solving skills. Has discussed consequences of decisions. Has been consistent with inference.
3	Has demonstrated competency. Adequate documentation. Critical thinking ability exists. Acceptable performance.	Data analysis can be improved. More effort to address key questions. Need to address problems effectively. Expand on evaluating material. Improve deductive reasoning skills. Improve inductive reasoning skills. Problem solving skills need honing. Must discuss consequences of decisions. Has been vague with inference.
1	Poor, unacceptable performance. Lacks critical thinking ability.	Absence of analytical skills. Answers questions incorrectly. Addresses problems superficially. Lacks documentation. Inability to evaluate material. Shows no deductive reasoning power. Inductive reasoning power non existent. Poor problem solving skills Unaware of consequences of decisions. Unable to draw conclusions.

Source: Critical Thinking Rubric, Washington State University, P.O. Box 644530, Pullman, WA 99164 - 4530 USA.(2005) http://wsuctproject.wsu.edu/ctr.htm

APPENDIX C [2012 Data]

Rubrics courtesy of W S U, Pullman, WA.

Topic studied: Advanced Engineering Mathematics.

Student Population: A junior level course with 18 students participating in the study.

Background: The students have had two semesters of college level calculus.

Assessment of Four Features (Spring 2012)

TOTAL xx STUDENTS #	A	B	C	D	E	F	G	H	I	J	K	L	.	.	.	X	Y	Z	MEDIAN	MODE	AVG.
1 Cumulative	4	5	3	4	4	4	2	3	5	4	3	4	3	4	4	5	4	4	4		
2 Integrated	3	4	4	3	3	3	4	5	4	5	4	4	4	4	3	5	3	4	4		
3 Progressive	3	2	3	3	3	3	2	4	2	3	2	3	2	3	4	4	3	3	3		
4 Consistent	2	4	4	2	5	2	4	2	4	2	3	4	2	4	2	2	2	4	2		

RUBRIC COURTESY OF W. S. U.
WASHINGTON STATE UNIVERSITY
PULLMAN, WA. 99164.
LIKERT SCALE WEIGHT DISTRIBUTION
(1: Strongly Disagree; 5: Strongly Agree)

Data Collection
Mysore Narayanan.

The data collected are ordinal: they have an inherent order or sequence, but one cannot assume that the respondent means that the difference between agreeing and strongly agreeing is the same as between agreeing and being undecided.

Descriptive Techniques (Likert Evaluation Cookbook 2004)

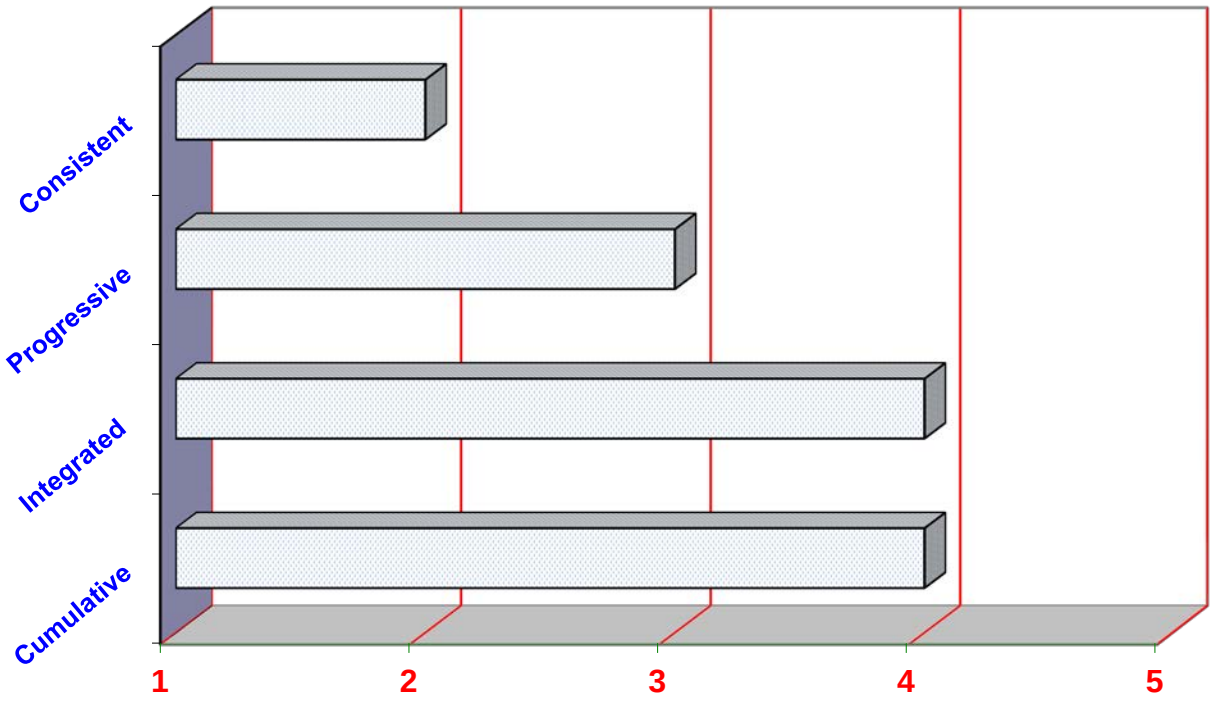
Summarize using a median or a mode (not a mean); the mode is probably the most suitable for easy interpretation.

Express variability in terms of the range or inter quartile range (not the standard deviation).

Display the distribution of observations in a dotplot or a barchart (it can't be a histogram, because the data is not continuous).

APPENDIX D: Assessment Bar Chart

LIKERT SCALE WEIGHT DISTRIBUTION (1: Strongly Disagree; 5: Strongly Agree)



Analysis of the Bar Chart:

Learning must be cumulative: The students have recorded an acceptable value of 4 on Likert Scale. The students are fairly capable of handling the increased level of complexity of subject matter with the progression of time. The instructor should attempt to achieve the maximum possible score of 5 on Likert Scale.

Learning must be integrated: This category has again recorded good, acceptable score of 4 on Likert Scale. The students have understood the importance of correlating to a real world problem.

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Appendix E:

If Instructors Talk Six Minutes Less, Students Learn More.

Using the pause procedure to enhance lecture recall.

Ruhl, K. L., Hughes, C. A., & Schloss, P. J. (1987, Winter).

Teacher Education and Special Education, 10, 14-18.

In this study an instructor paused for two minutes on three occasions during each of five lectures: the intervals ranged from 12 to 18 minutes. During the pauses, while students worked in pairs to discuss and rework their notes, no interaction occurred between instructor and students. At the end of each lecture, students were given three minutes to write down everything they could remember from the lecture (free recall); 12 days after the last lecture, the students were also given a 65 item multiple-choice test to measure long-term retention.

A control group received the same lectures (using the same anecdotes and visual aids) and was similarly tested. In two separate courses repeated over two semesters, the results were striking and consistent: Students hearing the lectures while the instructor paused did significantly better on the free recall and the comprehensive test. In fact, the magnitude of the difference in mean scores between the two groups was large enough to make a difference of two letter grades depending upon cutoff points!

The implication of this research is staggering, for it essentially says that *if we talk six minutes less, students learn more.* Undoubtedly these counterintuitive results stem from two things:

1) the short lectures (12-18 minutes) are consistent with the research that suggests that students' ability to retain information falls off substantially after 10-20 minutes; and

2) by engaging in an activity that reinforces the information presented, student learning should be increased. This study of Ruhl and others clearly suggests that we have an opportunity to include short, active-learning activities into our lectures with no loss to the content learned. Indeed, students seem to learn more from the process.

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Appendix F: THE TEN PRINCIPLES OF LEARNING

1 Learning is fundamentally about *making and maintaining connections*: biologically through neural networks; mentally among concepts, ideas, and meanings; and experientially through interaction between the mind and the environment, self and other, generality and context, deliberation and action.

2 Learning is enhanced by *taking place in* the context of *a compelling situation* that balances challenge and opportunity, stimulating and utilizing the brain's ability to conceptualize quickly and its capacity and need for contemplation and reflection upon experiences.

3 Learning is an *active search for meaning* by the learner -- constructing knowledge rather than passively receiving it, shaping as well as being shaped by experiences.

4 Learning is *developmental*, a cumulative process *involving the whole person*, relating past and present, integrating the new with the old, starting from but transcending personal concerns and interests.

5 Learning is done by *individuals* who are intrinsically *tied to others as social beings*, interacting as competitors or collaborators, constraining or supporting the learning process, and able to enhance learning through cooperation and sharing.

6 Learning is strongly *affected by the educational climate* in which it takes place: the settings and surroundings, the influences of others, and the values accorded to the life of the mind and to learning achievements.

7 Learning requires *frequent feedback* if it is to be sustained, *practice* if it is to be nourished, and *opportunities to use* what has been learned.

8 Much learning *takes place informally and incidentally*, beyond explicit teaching or the classroom, in casual contacts with faculty and staff, peers, campus life, active social and community involvements, and unplanned but fertile and complex situations.

9 Learning is *grounded in particular contexts and individual experiences*, requiring effort to transfer specific knowledge and skills to other circumstances or to more general understandings and to unlearn personal views and approaches when confronted by new information.

10 Learning involves *the ability of individuals to monitor their own learning*, to understand how knowledge is acquired, to develop strategies for learning based on discerning their capacities and limitations, and to be aware of their own ways of knowing in approaching new bodies of knowledge and disciplinary frameworks.