AC 2009-865: ASSESSMENT OF INNOVATIVE ENVIRONMENTS THAT ADDRESS INTELLECTUAL CURIOSITY

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DR. MYSORE NARAYANAN obtained his Ph.D. from the University of Liverpool, England in the area of Electrical and Electronic Engineering. He joined Miami University in 1980 and teaches a wide variety of electrical, electronic and mechanical engineering courses. He has been invited to contribute articles to several encyclopedias and has published and presented dozens of papers at local, regional , national and international conferences. He has also designed, developed, organized and chaired several conferences for Miami University and conference sessions for a variety of organizations. He is a senior member of IEEE and is a member of ASME, SIAM, ASEE and AGU. He is actively involved in CELT activities and regularly participates and presents at the Lilly Conference. He has been the recipient of several Faculty Learning Community awards. He is also very active in assessment activities and has presented more than a dozen papers at various Assessment Institutes. His posters in the areas of Bloom's Taxonomy and Socratic Inquisition have received widespread acclaim from several scholars in the area of Cognitive Science and Educational Methodologies. He has received the Assessment of Critical Thinking Award twice and is currently working towards incorporating writing assessments that enhance students' critical thinking capabilities.

Assessment of Innovative Environments That Address Intellectual Curiosity

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Abstract

Leading scholars in the area of *Cognitive Science* and *Educational Methodologies* have concluded that it is essential that students need to be taught in a learning environment that enables them to acquire problem-solving skills. The 21st century workplace does not need employees who have just mastered a particular body of information, instead it prefers to have liberally educated workforce who have mastered written and oral communication skills in addition to acquiring knowledge in their chosen discipline. (Saxe, 1988; Senge, 1990; Sims, 1995). Educators should not allow the students to wonder whether they have been learning anything that would actually serve them in the workplace, upon graduation. (Barr & Tagg, 1995). It is also important to recognize that state legislatures have introduced demands for outcome assessment (Magill & Herden, 1995). Researchers have shown that systematic use of technology actually helps instructors address perceptual dimensions of learning. Technology should not be viewed just as a growing trend; rather it must be intelligently implemented as a valuable instructional tool that can accommodate diverse learning styles of 21st century students. (Watkins, 2005). It is important to acknowledge that the intellectual curiosity of students can be increased so that they learn better when alternative modes of information processing are made available at college campuses. Dr. Walter B. Barbe, a nationally known scholar and authority in the fields of reading and learning disabilities has shown that perceptual modality styles provides an indication of an individual's dominant learning mode. This is where the intellectual curiosity of the learner thrives. The degree of processing speed, accuracy and retention that an individual is able to accomplish when encountering information depends upon to what extent the medium in which information presented matches his or her learning style. (Barbe & Milone 1980 and 1981). In this presentation, the author describes how he has implemented Barbe's ideas into his classroom activities and has created different learning environments for engineering students. The author also outlines how interactive projects can help the instructor in promoting a learning environment filled with exercises that promote intellectual curiosity. Furthermore, he also provides initial results of his assessment data.

Introduction

In order to motivate students and generate *Intellectual Curiosity,* one can follow the guidelines provided by Gardner. Quarter of a Century ago, in 1983, Harvard University Professor Howard Gardner introduced the theory of Multiple Intelligences The author has presented this at other conferences and he has reproduced the list below. (Narayanan,

2007). Dr. Gardner suggested that the Intelligence Quotient, *IQ* alone should not become the primary basis for measuring human potential. He proposed that there are seven broad areas wherein children and adults can excel and listed them as follows (Armstrong, 1993). It should also be pointed out that there is a possibility of adding three more to this list of seven (Naturalist Intelligence, Spatial Intelligence and Existential Intelligence).

1. Word Smart: Linguistic Intelligence
2. Number Smart: Mathematical Intelligence
3. Picture Smart: Spatial Intelligence
4. Body Smart: Kinesthetic Intelligence
5. Music Smart: Musical Intelligence
6. People Smart: Interpersonal Intelligence
7. Self Smart: Intrapersonal Intelligence

Howard Gardner is the Director of Harvard Project Zero and Professor of Cognition and Education at the Harvard Graduate School of Education. He has received numerous honors and written dozens of books (Gardner, 1983). Howard Gardner was the first American to receive the *University of Louisville's Grawemeyer Award in Education.* Dr. Howard Gardner is best known in educational circles for his theory of multiple intelligences, a critique of the notion that there exists but a single human intelligence that can be assessed by standard psychometric instruments (Gardner, 1993). During the past twenty-five years, he and colleagues at Project Zero have been working on the design of performance-based assessments, education for understanding, and the use of multiple intelligences to achieve more personalized curriculum, instruction, and assessment. (http://www.pz.harvard.edu/PIs/HG.htm)

Principles of Good Practice

Gardner's seven principles help in developing *Intellectual Curiosity* in any given group of individuals. It is important to recognize that some learners may be curious to learn when they *'see'* something interesting (Narayanan, 2007). Some others may be inclined to develop curiosity when the *'read'* about a new subject matter. Gardner suggests that one should consider all the types of *'intelligence'* if one wants to observe an individual's potential. Furthermore, researchers say that *Intellectual Curiosity* can be introduced to the students simply by following the *nine principles of good practice,* detailed below. http://www.fctel.uncc.edu/pedagogy/assessment/9Principles.html

Authors, Alexander W. Astin, Trudy W. Banta, K. Patricia Cross, Elaine El-Khawas, Peter T. Ewell, Pat Hutchings, Theodore J. Marchese, Kay M. McClenney, Marcia Mentkowski, Margaret A. Miller, E. Thomas Moran and Barbara D. Wright developed a document in 1996 under the auspices of the AAHE (American Association for Higher Education) Assessment Forum with support from the Fund for the

Improvement of Postsecondary Education with additional support for publication and dissemination from the Exxon Education Foundation. These nine authors have generated a list of nine principles that the readers can obtain from the website given below (Narayanan, 2007).

American Association for Higher Education
Principles of Good Practice for Assessing Student Learning

1. The assessment of student learning begins with educational values. Intellectual Curiosity is all about enhancing educational values.

2. Assessment is most effective when it reflects an understanding of learning as multi dimensional, integrated, and revealed in performance over time. Intellectual Curiosity is embedded in the learner's mind when any given subject matter is presented with a multi dimensional focus.

3. Assessment works best when the programs it seeks to improve have clear, explicitly stated purposes.

4. Assessment requires attention to outcomes but also and equally to the experiences that lead to those outcomes.

5. Assessment works best when it is ongoing not episodic.

6. Assessment fosters wider improvement when representatives from across the educational community are involved.

7. Assessment makes a difference when it begins with issues of use and illuminates questions that people really care about.

8. Assessment is most likely to lead to improvement when it is part of a larger set of conditions that promote change.

9. Through assessment, educators meet responsibilities to students and to the public.

Design

In order to develop intellectual curiosity among students, Instructional Systems *need to be well structured and designed* so as to ensure that the *subject matter content* is effectively integrated with the *presentation* format (Narayanan, 2007, 2008, 2009). The task in front of the facilitator will be blend the content and presentation in theory as well as practice (Dick and Carey, 1978). Modern technology provides ample opportunities for the instructors to experiment on innovative ideas that can lead to effective classroom instructional strategies (Dick and Carey, 1996). Instructional Systems Design (ISD) was

made popular by Walter Dick and Lou Carey whose famous quote is: *"You can't provide a solution until you know what the problem is."* One can conclude that learning has taken place when the instructor observes a change of learner behavior (Keefe, 1988). This learner behavior must be the result of what has been experienced in the process of instruction (Pascarella & Terenzini, 1991). One can also recognize that the learning style of an individual student only by observing his/her overt behavior (Keefe 1987). Baxter Magolda's research has also shown that it is also important to identify that in order to develop a sense of agency, student affairs professionals must possess four dimensions of learning that specify desired outcomes:

The principle behind a cognitive competence, intrapersonal competence, interpersonal competence, and practical competence is extremely useful while creating innovative environments that address intellectual curiosity (Baxter Magolda, 1999). 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. (Narayanan, 2007, 2008, 2009). Regardless, a problem-based curriculum is significantly different from the traditional discipline centered curriculum. (Narayanan, 2009). 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. (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 the four features in the courses he teaches. He also presents analyses of the feedback data he has obtained and suggest guidelines for further improvement.

1. **Learning must be cumulative:**

   Cultivate Curiosity by exposing the students to the subject matter in a systematic manner. 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:**

   Cultivate Curiosity by Correlation. The subject matter is must not introduced with a stand-alone approach. Topics are always discussed as they correlate to a real world problem.

3. Learning must be progressive:

Cultivate Curiosity by Changing Continuously. The student's learning keeps changing continuously. Learners begin acquiring specific skills 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:

Cultivate Curiosity by having Consistency. 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.

Implementation, Assessment and Conclusions

At Miami University, the author has also utilized a variety of modern instructional tools to promote intellectual curiosity. In addition to simple and routine lectures and laboratory exercises, he uses creative research topic assignments, open ended problem-solving tutorials, group discussions, classroom interactive brain-storming sessions, etc.

Students are exposed to information available from various sources that practice using modern technology. The author has tried to implement ideas generated by some of the leading scholars in the area of Cognitive Science. (Narayanan, 2007). This includes the use of World Wide Web in addition to the regularly and routinely used standard audio visual techniques, such as power point slides and overhead transparencies. Miami University also used I.V.D.L. (Interactive Video Distance Learning). The students also make use of other resources such as the *Writing Center, Ohio LINK (Ohio Library and Information Network).* The author believes that this would help the instructor communicate with those selected group of students who may prefer to respond to a different learning style (Narayanan, 2007).

Appendix A shows how *Assessment using VARK* was carried out. The grading was administered using Washington State University's Rubric. The data obtained was tabulated using a Likert Scale. (Narayanan, 2007). Four *"Primary Traits"* or *"Characteristics"* were identified and assessed.

Appendix B documents this using a bar chart. It is desirable to achieve mode values of 5 on all the characteristics; however this is probably unrealistic in an undergraduate environment.

It is easily seen from the bar chart that the three "traits"

Appendix B shows a *"VARK"* bar chart, based on Fleming and Mills' ideas. It can been seen that an excellent mode value of 5 was recorded for "Kinesthetic" style of learning. "Reading" style recorded a low score of 1. "Aural" also has a value of 2, which is relatively low. "Visual" had a modest and acceptable value of 4. The author agrees and understands that these data may *vary significantly* depending upon subject matter, instructor's delivery styles, material content, discipline etc. It is possible that *Kinesthetic Mode* of learning may be preferred by students engineering disciplines. In Art, perhaps the *Visual Mode* may record impressive values, whereas *Reading or Aural Mode* of learning may be best suited for students in English literature.

It is very important to recognize that the author's data is significantly different from Hunter Boylan's research. A comparison chart is shown in Appendix C. Furthermore it should be recognized that each discipline is different and the difference may be huge and significant. 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, because each may chose different delivery styles. The author is of the opinion that such assessment data can provide the instructor guidance as to make appropriate changes in the manner in which the course is developed and may necessitate changes in *Instructional Delivery Styles.*

The author would like to thank *Washington State University for the use of Washington State University's Critical Thinking Rubric.* This proved to be extremely valuable in documenting intellectual curiosity and also in recording the effectiveness of systematic use of technology. This Rubric has helped the instructor address and assess perceptual dimensions of learning and thereby giving the learning environment facilitator the needed guidance for moving in the right direction. The ultimate goal is to deliver information to students in the best possible manner that suits the receiver's optimum learning style. This is what promotes intellectual curiosity among learners.

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APPENDIX A

TOTAL NUMBER OF STUDENTS = XX 1 2 3 4 . . . . . .

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

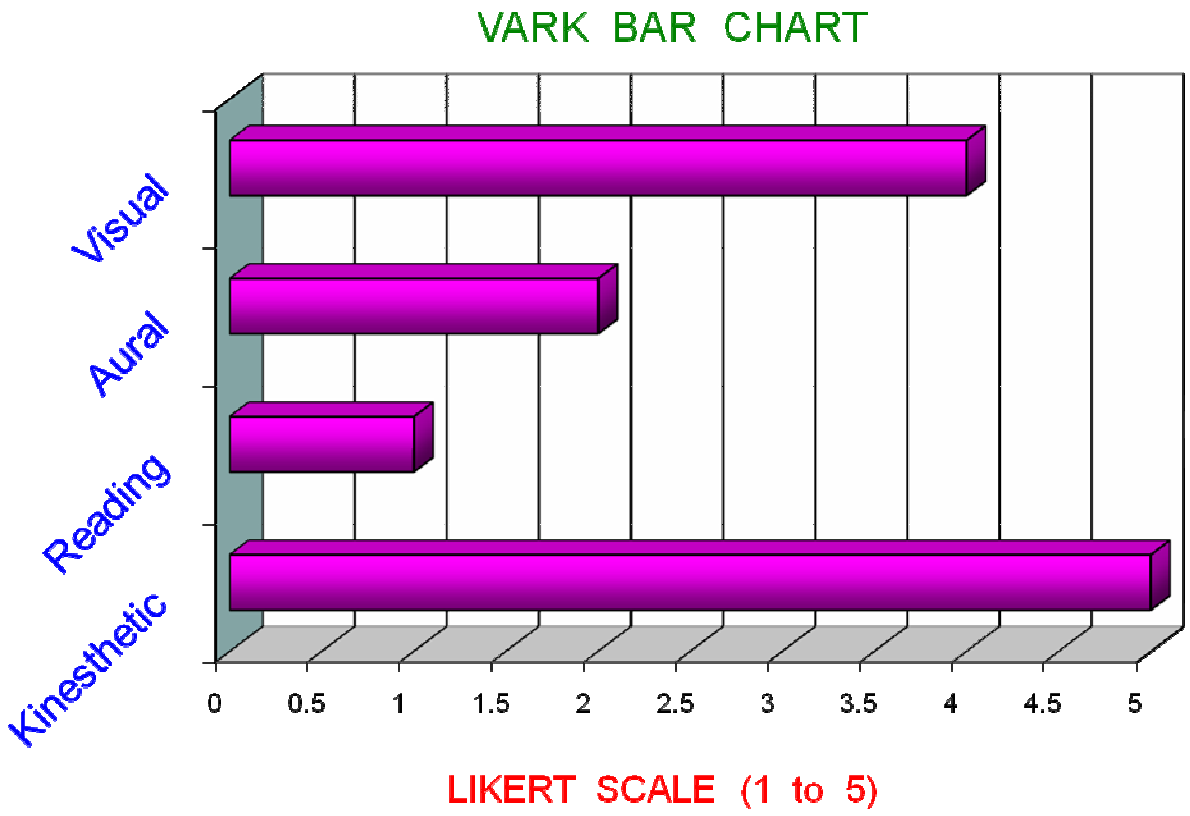
Kinesthetic	4	4	5	5	4	5	5	4	5	5	5	5	4	4
Reading	3	3	3	1	3	2	1	1	5	1	4	2	3	4
Aural	3	4	5	5	3	4	4	5	4	2	4	2	3	2
Visual	4	3	5	5	4	4	4	4	4	4	4	5	3	3

Data Collected by : 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
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 B

Innovative Environments That Address Intellectual Curiosity



Observations:

It can be easily seen that a *Kinesthetic Environment* addresses the needs of *Intellectual Curiosity* best. However, *Visual Environment* also provides the learner with good opportunities to promote *Intellectual Curiosity.*

APPENDIX C

Comparison between Hunter Boylan's Research and Author's data, 2007 - 2008

Source: Fleming, N. D. & Mills, C. (1992).*VARK a guide to learning styles.*

http://www.vark-learn.com/English/index.asp

Research by Dr. Hunter R. Boylan (Boylan 2002)	Intellectual Curiosity	Author's Data (2007 - 2008)
86%	Visual	Mode = 4
11%	Auditory	Mode = 2
	Reading	Mode = 1
	Kinesthetic	Mode = 5
3%	Tactical-Concrete	

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