AC 2011-1079: ASSESSMENT OF A LABORATORY ORIENTED STUDY CURRICULUM

Mysore Narayanan, Miami University

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 dozens of 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 assignments that enhance students' critical thinking capabilities.

Assessment of a Laboratory Oriented Study Curriculum

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. Wilkerson & Gijselaers have defined Problem-based learning as minds-on, hands-on, focused, experiential learning. The artistic science of measurement and control is normally referred to as *Experimentation and Instrumentation.* The varied attributes of physical systems are usually measured using well designed instruments. A very short list may include the measurement of voltage, current, resistance, inductance, capacitance, frequency, pressure, stress, strain, viscosity, flow, radiation, etc. Instruments are normally modeled as simple input-output devices. The author taught a new laboratory oriented course in the area of *Engineering Instrumentation* during 2005 – 2006 and experimented with several new ideas. He also successfully designed, developed and implemented certain assignments and exercises to enhance student learning and discovery. In this course, the author attempted to move away from a teaching and learning paradigm to a *discovery paradigm.* In this presentation, the author describes how he has utilized the four features of problem solving in the courses he teaches. He also presents assessment data he has collected over the years and analyzes the feedback data he has obtained and suggests guidelines for further improvement. The author also tries to provide some guidelines that pertain to assessment data gathering. Finally, the author describes how to grade holistically and utilize the same data and results to generate an assessment bar chart that can provide useful information for continuous quality improvement.

Introduction

Over the past several decades, the computer classroom has slowly evolved and emerged as a standard matrix for interdisciplinary dialogue. Further, it is of notable importance that this dialogue is not just between the instructor and the learner, but it is also between the learners themselves. Another interesting observation is that the learners are spread across disciplines and across continents. Interactive multimedia technology initially made its impact as a simple information storage-and-retrieval medium. Over the past thirty years this technology has revolutionized the workplace as well as the classroom. Successful accreditation of any program requires proper documentation in two important areas.

Assessment of Basic Components (ABC) and
Primary Trait Analysis (PTA).

The author is of the opinion that instructors must be considered to serve as problem solving colleagues assigned with the responsibility of promoting interest and enthusiasm for learning. Instructors should also be encouraged to act as cognitive coaches who can nurture an environment that can support open inquiry. 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.

Dr. Barbara E. Walvoord is Fellow of the Institute for Educational Initiatives and concurrent professor of English at the University of Notre Dame. She has been the founding director of four faculty development programs and consultant to more than 250 institutions. She is the author of the widely acclaimed book: Assessment Clear and Simple published by Jossey-Bass of San Francisco. Walvoord begins by outlining the three steps of assessment:

First is to articulate one's goals for student learning.

Second, to gather evidence about how well students are meeting the goals, using direct as well as indirect measures.

Third, to use the information collected for continuous improvement. In this paper, the author describes how multimedia applications.

Assessment helps us understand which students learn best under what conditions. In 1992, the American Association for Higher Education generated some guidelines and proposed them in their AAHE Assessment Forum. Assessment requires attention to outcomes but also and equally to the experiences that lead to those outcomes. The important aspect here is to move away from a teaching paradigm to learning paradigm. Clifford O. Young, Sr., & Laura Howzell Young of California State University, San Bernardino argue that a new paradigm for assessment, a learning paradigm, must be constructed to measure the success of new kinds of educational practices (Young & Young, 1994).

Problem Based Learning

A problem-based curriculum is significantly different from the traditional discipline centered curriculum. (Woods, 1994). Instructors are considered to serve as problemsolving 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 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). and equally to the experiences that lead to those outcomes. The important aspect here is to move away from a teaching.

Grading is often mistaken for assessment and many times grading is viewed as a type of assessment by some professors. We all agree that the mechanism of grading may vary largely according to the instructional design of the individual instructors. Although one can argue that the system has evolved over time, one can also observe how much of it has remarkably stayed

the same. Some instructors may reorganize the step-by-step procedure and identify the shortcomings. Regardless no one challenges or disputes the validity of the philosophy underlying the principles. In order to lend credibility to the process as well as results, it is important that one categorizes and classifies the data in an orderly manner.

VARK is an acronym that stands for *Visual, Auditory, Read* (includes writing), and *Kinesthetic* sensory modalities that humans employ for learning and processing information. (Fleming and Mills, 1992). If instructors want to accentuate student performance in a particular topic, or a chosen field of expertise, they have to provide multiple outlets for experimentation and learning exploration. In their paper published in 1992, Fleming and Mills suggested four categories that seemed to identify most students' learning behavior. The author has previously worked on a similar project and has presented his initial findings in a paper entitled *"Assessment of Perceptual Modality Styles"* at the 2007 ASEE National Conference at Honolulu, Hawaii. (Narayanan, 2007).

In this, *follow-up* presentation the author presents his latest findings and compares them with the data he procured previously. Hunter R. Boylan is the Chairperson for American Council of Developmental Education Associations. In his book, *What Works: Research-Based Best Practices in Developmental Education,* Dr. Boylan gives tips for accommodating diversity through instruction. (Boylan,1999). His tips are to train faculty in alterative forms of instruction if they are expected to use diverse instructional methods. (Boylan, 2002). He recommends administering a *learning styles inventory* to students as a regular assessment process. He also indicates that one should share the learning styles information with the faculty to encourage faculty to accommodate dominate learning styles. (Narayanan, 2007). Boylan is also of the opinion that students learn best when they have a visual representation and can manipulate objects associated with the concepts.(Appalachian State University's NCDE: National Center for Developmental Education)

Implementation and Assessment

The procedure used by the author is outlined in Appendix A. The author has successfully utilized this very same procedure to conduct assessment in many other courses. He has reported this in his previous ASEE Conference proceedings and presentations.

The rubrics used was obtained from Washington State University. This rubric has been reproduced in Appendix B. Rubrics offer help and challenge the user to determine the levels of growth and learning that would be assessed as well as the methods to assess student learning at various stages (Bresciani, 2003).

A sample matrix is shown in Appendix C. Likert scale was utilized to tabulate the data. The objective is identify the desired characteristics and assess those traits.

Several *"Primary Traits"* or *"Characteristics"* were identified and assessed. These are the major topics that are to be covered in any *Laboratory Oriented Study Curriculum.* The author chose seven, however another instructor may choose more or less.

Appendix D documents this using a bar chart. It is desirable to achieve mode values of **5** on all the seven characteristics; however this is probably unrealistic in an undergraduate environment. The author has successfully utilized similar techniques for assessment analysis in many of his previous publications and presentations. The author would also like to thank *Washington State University* for providing him with guidance and Rubrics to prepare this document. *Washington State University's Critical Thinking Rubric* has proved to be an extremely valuable in documenting teaching effectiveness. The author has used this rubric multiple times in his research and other publications (Narayanan, 2005, 2006, 2007 & 2009).

This has helped the instructor address and assess perceptual dimensions of learning and thereby giving the learning environment facilitators appropriate guidance for proceeding in the right direction. The ultimate goal is to deliver information to students, not just in plain lecture format. But to provide the material in the best possible manner that suits the receiver's optimum learning style. The author likes to move away from *a teaching or learning paradigm.* Instead, the author prefers that the students follow a *Discovery Paradigm.*

Conclusions

Referring to the bar chart shown in Appendix D:

One observes that only out seven traits selected has achieved the maximum possible Likert scale score of **5.**

Characteristic # 4 (Challenges and Motivates Active Learners) shows an excellent mode value of **5.** This indicates that the instructor is really interested and is excited about the learning accomplishments of his students.

However, two other characteristics show respectable mode values of **4** indicating that there is room for improvement. While it may be difficult, attempt should be made, however, to achieve the maximum possible value of **5.** These two characteristics are:

Characteristic # 2: Develops application of knowledge
Characteristic # 7: Creates Supportive Physical Environment

Two other characteristics have attained an average mode value of **3** indicating that the results are not adequate enough. One should strive hard to improve this to an acceptable level of **4.** These two characteristics are:

Characteristic # 1: Emphasizes Content and Delivery of Instruction
Characteristic # 5: Develops appropriate learning experiences

Two other characteristics have recorded an unacceptable mode value of **2** indicating that there is plenty of effort is needed. One should take a closer look as to why these two show such poor values. Consulting with other colleagues may be of help in this case. These two characteristics are:

Characteristic # 3: Integrates across disciplines
Characteristic # 6: Incorporates Diverse Strategies

In conclusion, the data provides the instructor with ideas that may necessitate changes in *Instructional Delivery Styles.* Regardless, each instructor's delivery style is different and one may even arrive at two different sets of data for the same subject or same topic when two different instructors are involved. Furthermore it should be recognized that each discipline is different and the difference may be huge and significant (Keefe, 1991).

Acknowledgements

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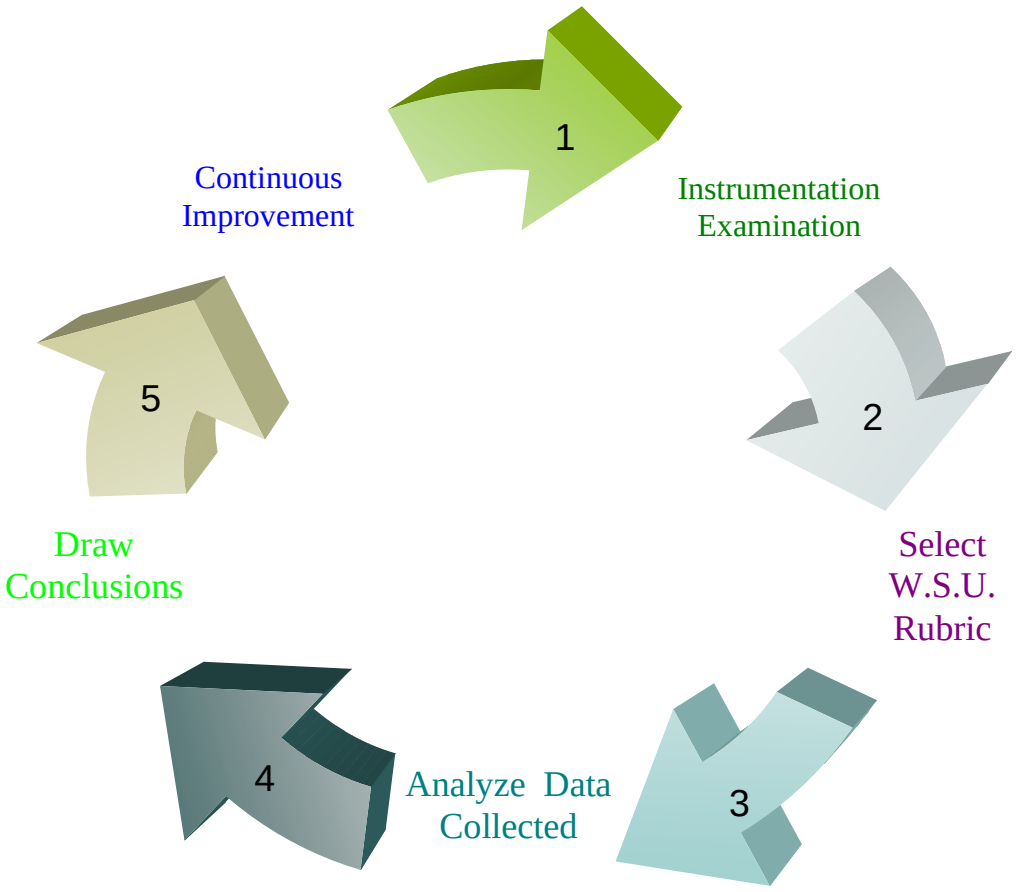
APPENDIX A: Methodology for Conducting Assessment

The author has previously used this *'cycle'* in other research and publications, as well.



APPENDIX B: 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.

APPENDIX C : Matrix Generated using W.S.U. Rubrics

Laboratory Oriented Study Curriculum

	Laboratory Curriculum TOTAL xx STUDENTS #	A	B	C	.	.	.	.	X	Y	Z	MEDIAN	MODE	AVG.
1	**Emphasizes Content and Delivery of Instruction**	4	4	3	.	.	.	.	4	3	3		3	
2	**Develops application of knowledge**	3	4	5	.	.	.	.	5	5	5		4	
3	**Integrates across disciplines**	5	4	3	.	.	.	.	3	4	5		2	
4	**Challenges and Motivates active learners**	3	3	5	.	.	.	.	4	3	4		5	
5	**Develops appropriate learning experiences**	3	3	5	.	.	.	.	5	4	4		3	
6	**Incorporates Diverse Strategies**	4	4	5	.	.	.	.	5	4	5		2	
7	**Creates Supportive Physical Environment**	4	3	2	.	.	.	.	3	4	2		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)

Data Collected by : Mysore Narayanan.

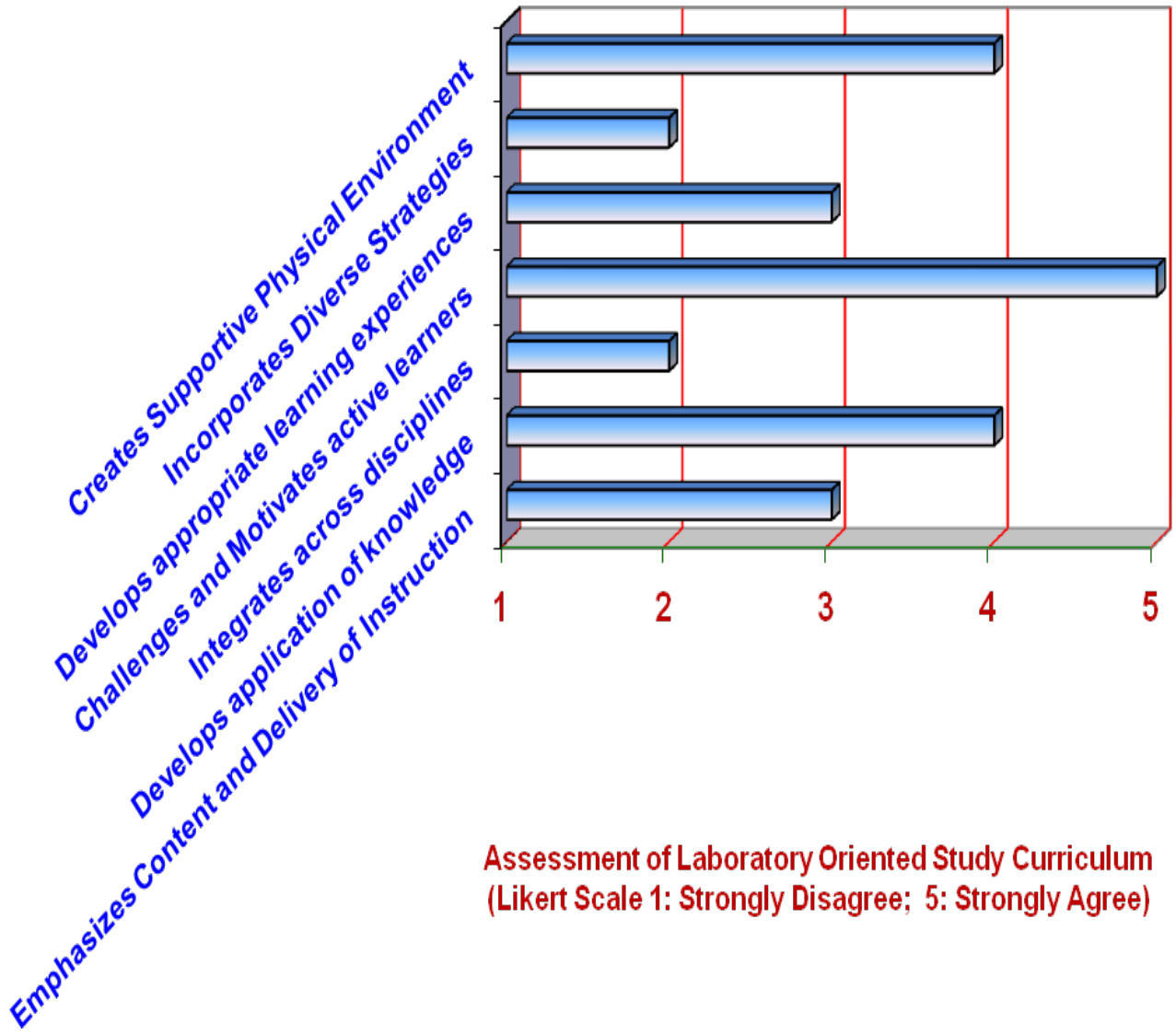
The data collected are ordinal: they have an inherent order or sequence, but one cannot assume that the respondent means that the difference between agreeing and strongly agreeing is the same as between agreeing and being undecided.
Descriptive Techniques (Likert Evaluation Cookbook 2004)
Summarize using 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:

Rubrics courtesy of Washington State University, Pullman, WA.

Partial list of topics observed

Emphasizes Content and Delivery of Instruction
Develops application of knowledge
Integrates across disciplines
Challenges and Motivates active learners
Develops appropriate learning experiences
Incorporates Diverse Strategies
Creates Supportive Physical Environment



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