

AC 2010-2388: ASSESSMENT OF INSTRUCTIONAL SYSTEMS DESIGN

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Assessment of Instructional Systems Design

Abstract

The principle behind a well-structured *Instructional Systems Design* is to ensure that the *subject matter content* is effectively integrated with the *presentation* format. Simply stated, the task in front of the facilitator will be to blend the content and presentation in theory as well as in practice. However, it is important to acknowledge that recent advances in modern technology provide plenty of opportunities for the instructors to experiment on innovative ideas that can lead to creative as well as effective classroom instructional strategies. To accomplish the task of assessment, the author utilizes a rubric based on *Washington State University's Critical Thinking Rubrics*. While conducting assessment, the author focuses on a well-established fact that student learning is actually an interactive process that takes place in educational environment established specifically to promote and enhance knowledge in a *discovery atmosphere*. Furthermore, scholars are also of the opinion that educators must be able to successfully address the needs of the individual by relating their own teaching style to the learning style of the individual student. Research also points out those problems related to learning most frequently are not related to the complexity of the subject matter. Problems pertaining to learning may actually be a reflection on the level of cognitive process that is absolutely essential to master the material at the appropriate level. In this presentation, the author outlines how he has successfully designed, created and implemented instructional and learning modules that can probably help address certain important criteria specified by accreditation agencies.

Introduction

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.*" In other words, first and foremost, instructors should select a few prominent assessment tasks in their courses (Dick & Carey, 1996). It is also important to observe that all course assignments need not necessarily be identified as assessment tasks. It may be adequate if an instructor can designate one or two tasks from each of the chosen courses (Fallon, 1997). Linn, Baker & Dunbar (1991) have indicated, "*Assessment practices at all levels of local, state, and national education programs are in a state of rapid transition.*" This means that the scholars and instructors in charge of assessment should be able to rise up to the occasion and understand the implications and importance of conducting assessment. Greenwood & Maheady (1997) have said, "*The process of developing a method for assessing this continuous growth requires thoughtful planning.*" Almost all leading colleges and universities have recognized this fact and continuously participating in an ongoing discussion on assessment. Therefore, one recognizes the fact that any strategic plan for *continuous ongoing assessment* should have a clear vision of what the university needs to assess and how the process will be implemented. In reality, the methodology used in designing a continuous assessment plan should actually direct and raise questions about the significance and effectiveness of instructional delivery techniques. Gregorc and Ward (1977) are of the opinion that instructors should have a clear understanding of what

the word *individual* means. Instructional systems must be designed to meet the needs of the individual, whenever possible. The author believes that there are five principles on which instructional systems are designed, created, formulated and implemented. The five principles are:

Define, Design, Develop, Deploy and Decide.
Appendix B briefly outlines these five principles.

Ernest Boyer's research also motivated the author to experiment on new ideas in the classroom. This is because, in the nineties, Ernest Boyer argued in "*Scholarship reconsidered: Priorities of the professoriate*" that knowledge is acquired not only through research, but also through synthesis, practice, and teaching (Boyer, 1990). Boyer's argument has elevated teaching to a level of importance so far not realized. This is because of the fact that academia always focuses, on research. It is important to recognize that Ernest Boyer's proposal actually pioneered the *Scholarship of Teaching and Learning* (SoTL) movement. This has resulted in a number of federally and privately funded efforts to improve teaching in colleges and universities (Atkinson, 2001).

Assessment helps us understand which students learn best under what conditions. Over the past several years, the author has experimented on a wide variety of research projects and has collected lot of data on several topics of interest. He has also reported on his findings at a number of other ASEE conferences as well (Narayanan, 2007, 2009, 2010). As a part of literature survey, some of the paragraphs have been reproduced here for sake of clarity and completeness. It is necessary to emphasize that the basic idea is always to promote active learning in the college classrooms (Meyers & Jones, 1993). In this particular presentation, the author builds on the experience and expertise he has acquired over several years of research. His recommended methodology for conducting assessment is shown in Appendix A.

Authentic Assessment

Research by Moira Fallon and colleagues indicate that on-demand and portfolio tasks be co-dependent and supplement each other to achieve *authentic assessment*. 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. The author would also like to cite Walter Barbe, a nationally known authority in the fields of reading and learning disabilities, who has shown that perceptual modality styles do indeed provide an indication of an individual's dominant learning mode (Barbe & Milone, 1980).

Fallon, Hammons, Brown and Wann (Fallon, 1997) define *authentic assessment* tasks are those that

- (a) are meaningful to both students and the teacher,
- (b) are individual to each student's experience in order to demonstrate his or her achievement,
- (c) require students to locate and analyze information as well as to draw conclusions about it,
- (d) require students to communicate results clearly, and
- (e) require students to work together for at least part of the task.

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 twenty-first 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). In his 2004 publication, “*Another New Paradigm for Instructional Design*” Reuben Tozman says that a major goal of good instructional design is to marry content with presentation both physically and theoretically (Tozman, 2004).

According to Reuben Tozman,

Instructional systems design (ISD) is the reference used to describe a systematic approach to the design of instruction. A systematic approach implies a logical application of discovery, testing, and creating solutions. It also refers to the methodical application of a process each and every time the creation of instruction is required.

Learning Paradigm & Problem Based Learning

The author would like to recommend that *Instructional Systems* should be *Designed* and built on the principles of *learning paradigm* and *problem based learning*. 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 and Young, 1999).

1. The participants should be capable of selecting an assessment plan best suited for their discipline and execute the chosen plan using a methodical approach.
2. The participants should be capable of developing a set of rubrics that can be effectively utilized in administering their assessment procedures.
3. The participants should finally be able to generate a set of graphs that provide them with appropriate, productive feedback pertaining to student learning capabilities.

A problem-based curriculum is significantly different from the traditional discipline centered curriculum (Woods, 1994). This is because problem-based learning has been defined as minds-on, hands-on, focused, experiential learning (Wilkerson & Gijsselaers, 1996). Modern teaching techniques should be combined with knowledge acquisition along with an activity-centered socio-economic approach. In other words, students should walk down the path of

building knowledge by structurally requiring them to co-create and re-create the communities they are studying. Students should quickly move beyond observation and rehearsal into participation and performance (Hershberger, 2009). This active participation is particularly crucial in scientific and technical disciplines, because the field demands practitioners who can actually deliver the product desired within a reasonable time frame (Leslie, 2002). Educational psychologists and scholars of cognitive science have recognized that *learning* is actually an interactive process that has three important components.

The Learner,
The Instructor and
The Learning Environment.

James W. Keefe is the president of *Learning Environments Consortium International* and is an educational writer who has taught at the University of Southern California and Loyola Marymount University. Keefe indicates that these three activities show a wide variation in behavior pattern, instructional quality and delivery styles. Educators must be reformulating *teaching styles* so that they can closely relate to *learning styles* in order to successfully address the needs of the student (Gregorc and Ward, 1997). One may also mention the famous case of Tinker vs. Des Moines Independent Community School District, which concerns itself with students' rights. Keefe also suggests that instructors should be creative to base the programs on the differences that exist among students. It is incorrect to assume that everyone learns in an identical manner (Keefe, 1987).

Methodology and Implementation

Assessment of *Instructional Systems Design* was carried out using the principles of VARK as outlined by Fleming and Mills. 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). The procedure followed by the author for conducting assessment is indicated in Appendix A. Washington university's critical thinking rubric was utilized while collecting, tabulating and analyzing data. This rubric is shown in Appendix C. Quizzes were graded on a holistic basis and the data was recorded and tabulated on an excel spreadsheet. This spread sheet is shown in Appendix D. A bar chart was generated based on the obtained data and this chart is shown in Appendix E. The detailed analysis of the bar chart is recorded in Appendix F.

The author proposes that learning activities generated based on the principles of Fleming and Mills should provide a strong background for the understanding of fundamental knowledge. The instructor should take up the responsibility of designing and developing different activities that can be delivered in multiple *perceptual* modes for the benefit of the learner. 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).

In this case, the author identified and delivered four different topics in four different modes. The subject discussed was fluid mechanics. The subject matter chosen were not exactly identical. However, they were fairly similar in their complexity (Examples: Viscosity, Manometers, Piezometric Head and Buoyancy).

Each delivery took place during 50-minute lecture class periods.

- Topic **V:** **Visual:** Visual Aids such as Power Point Slides were used to discuss Viscosity and Reynolds Number.
- Topic **A:** **Aural:** This was delivered in the traditional lecture format. Subject matter was manometers and pressure calculations.
- Topic **R:** **Reading:** Students were required to read and submit their findings. The Topic assigned was piezometric head.
- Topic **K:** **Kinesthetic:** Laboratory setting was used that included demonstrations. Students conducted experiments to discover the principles of Buoyancy, center of pressure and metacenter.

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. It is important to recognize the fact that students were 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 various appendices.

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

The five principles of I.S.D. are shown in Appendix B.

Rubrics used by the author is shown Appendix C.

EXCEL spreadsheet used for collecting data is shown in Appendix D.

Bar chart generated is shown in Appendix E.

Analysis of bar chart is shown in Appendix F.

Author's data has been compared with those of Hunter Boylan in Appendix G.

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

Howard Gardner's Theory of Multiple Intelligences is shown in Appendix I.

Analysis

This study involved a classroom experiment wherein the author delivered instruction using four different mediums. In other words, the *instructional system* followed four different *design* methodologies. These four design methodologies were based on Fleming and Mills' research. Washington State University's critical thinking rubric and Likert scale analysis was used to record, tabulate and document assessment data that was collected in the classroom. The author also utilized the *ACORN* model of Hawkins and Winter to ensure there was adequate communication between the instructor and the learner (Hawkins and Winter, 1997). Feedback from the students was documented so that the instructor could reflect and take appropriate action that was deemed necessary. The author would like to state that he was also helped to a very large extent by Howard Gardner's theory of multiple intelligences (Gardner, 1993).

Mainly, the author wanted to know how students reacted to multiple modes of instructional delivery styles. 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. Furthermore, Boylan continues to say that only one of them is lack of academic preparedness (Boylan, 2001). Leading scholars in the area of cognitive science and educational psychology are of the opinion that factors such as personal autonomy, self-confidence, ability, study behaviors, social adjustments, diversity and discrimination may also play a vital role in the recorded grades (Astin, 1977, Chickering, 1969 and Sedlacek, 1987). Students must be encouraged to take ownership of their own learning (Mintz, 1998). The author has used many of these principles in various other ASEE publications as well (Narayanan, 2007, 2008, 2009, 2010). The author's data compares favorably with those of Hunter Boylan and this is documented in Appendix G.

The author would like to suggest that all instructors should utilize these helpful hints and build on the knowledge base created by these scholars. This wealth of knowledge is extremely useful while developing and designing instructional systems. It is thus possible to create assessment procedures that may eventually lead to implementing the necessary changes at their educational establishments. Furthermore, the author would like to stress the fact that the process of developing and designing an instructional system requires careful planning and thoughtful leadership. One must also recognize that faculty involvement is a vital part and it is essential that it be made meaningful and productive. A thorough discussion of a methodology of *designing instructional systems* should establish a strong foundation, that plans and outlines the goals should actually drive the institutional instructional philosophy.

Conclusions

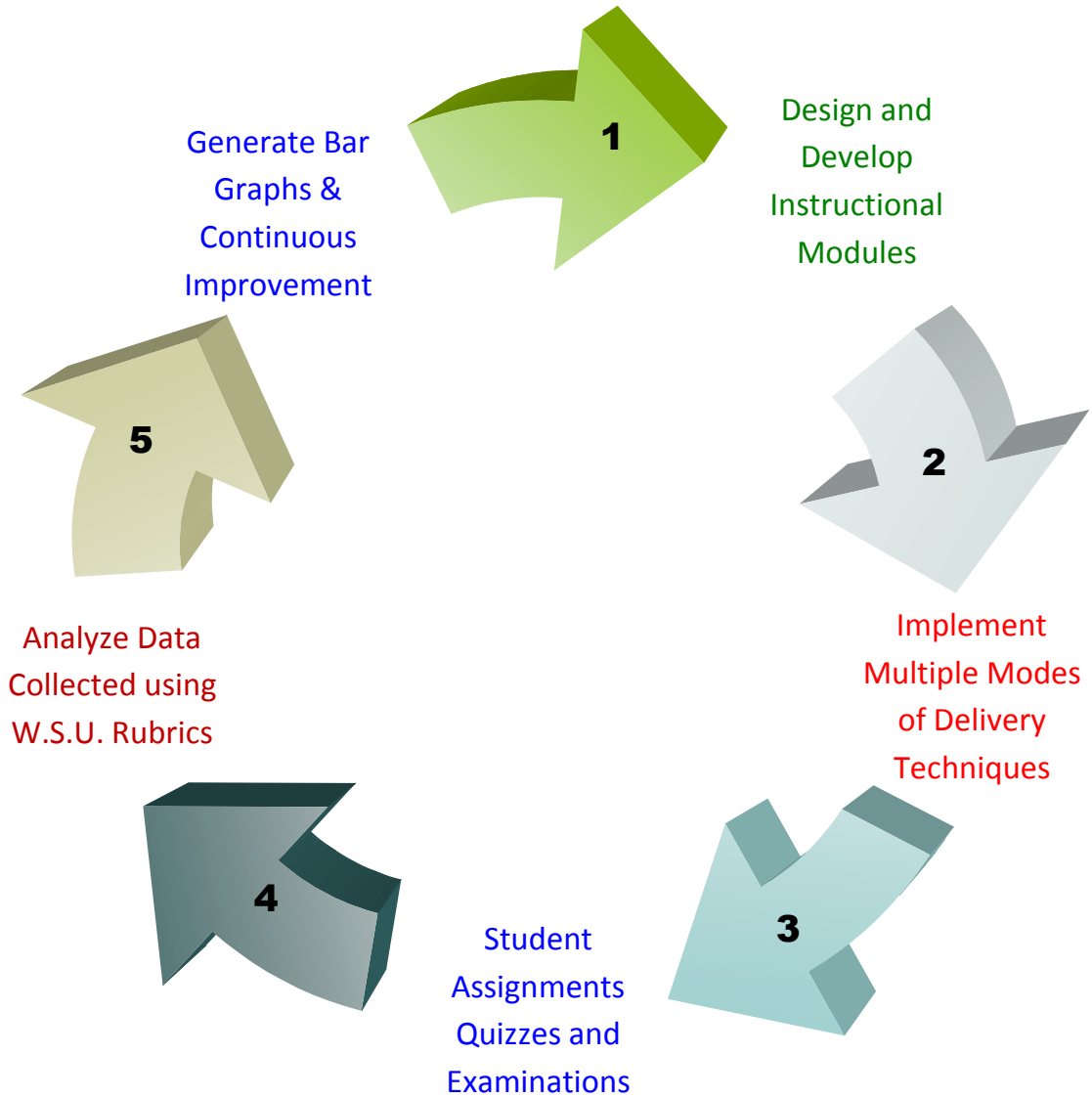
The author is of the opinion that *instructional system design* must be implemented *correctly* and in a creative manner in order to maximize the yield. The author acknowledges that more research is required to examine in detail the benefits students actually receive. One can observe, from the data collected, that students are indeed much more receptive to the kinesthetic mode of learning. Simply stated, *learners prefer hands-on-training*. The data collected by the author strongly supports this theory. One can also observe that audio-visual

aids do indeed help; however, lectures have very little impact. One can say that, in the twenty first century, proper design of instructional systems is extremely important, useful and productive. 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 (Narayanan, 2010). Instructional systems should contain interaction between the learner and the instructor because these lively classroom discussions always lead to greater student participation dynamics.

Acknowledgements

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APPENDIX A: Methodology used by the author.



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

APPENDIX B: The Five Principles of I.S.D.

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 essential for a group of students who may be quite competent in English literature. Another example would be to suggest that scientists, mathematicians and engineers should take a technical writing course that could help with their journal publications.

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.

APPENDIX C: Rubrics for conducting assessment

	Rubrics based on Likert Scale	Courtesy of W.S.U., Pullman, WA. 99164
5	<p>Has demonstrated excellence. Has provided documentation. Evidence of Creativity Exists. Very good performance</p>	<p>Has analyzed important data precisely. Has answered key questions correctly. Has addressed problems effectively. Has evaluated with proper insight. Has used deductive reasoning skills. Has used inductive reasoning skills. Has employed problem-solving skills. Discusses consequences of decisions. Has been consistent with inference.</p>
3	<p>Has demonstrated competency. Adequate documentation. Creativity can be improved. Acceptable performance.</p>	<p>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.</p>
1	<p>Poor, unacceptable performance. Lacks Creativity.</p>	<p>Absence of analytical skills. Answers questions incorrectly. Addresses problems superficially. Lacks documentation. Inability to evaluate material. Shows no deductive reasoning power. Inductive reasoning power nonexistent. Poor problem solving skills Unaware of consequences of decisions. Unable to draw conclusions.</p>

APPENDIX D : EXCEL spreadsheet used for collecting data

Assessment of
Instructional Systems Design

TOTAL xx STUDENTS #	A	B	C	D	E	F	G	H	I	J	K	X	Y	Z	MEDIAN	MODE	AVG.
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RUBRIC COURTESY OF W. S. U.
WASHINGTON STATE UNIVERSITY
PULLMAN, WA. 99164.
LIKERT SCALE WEIGHT DISTRIBUTION
(1: Strongly Disagree; 5: Strongly Agree)

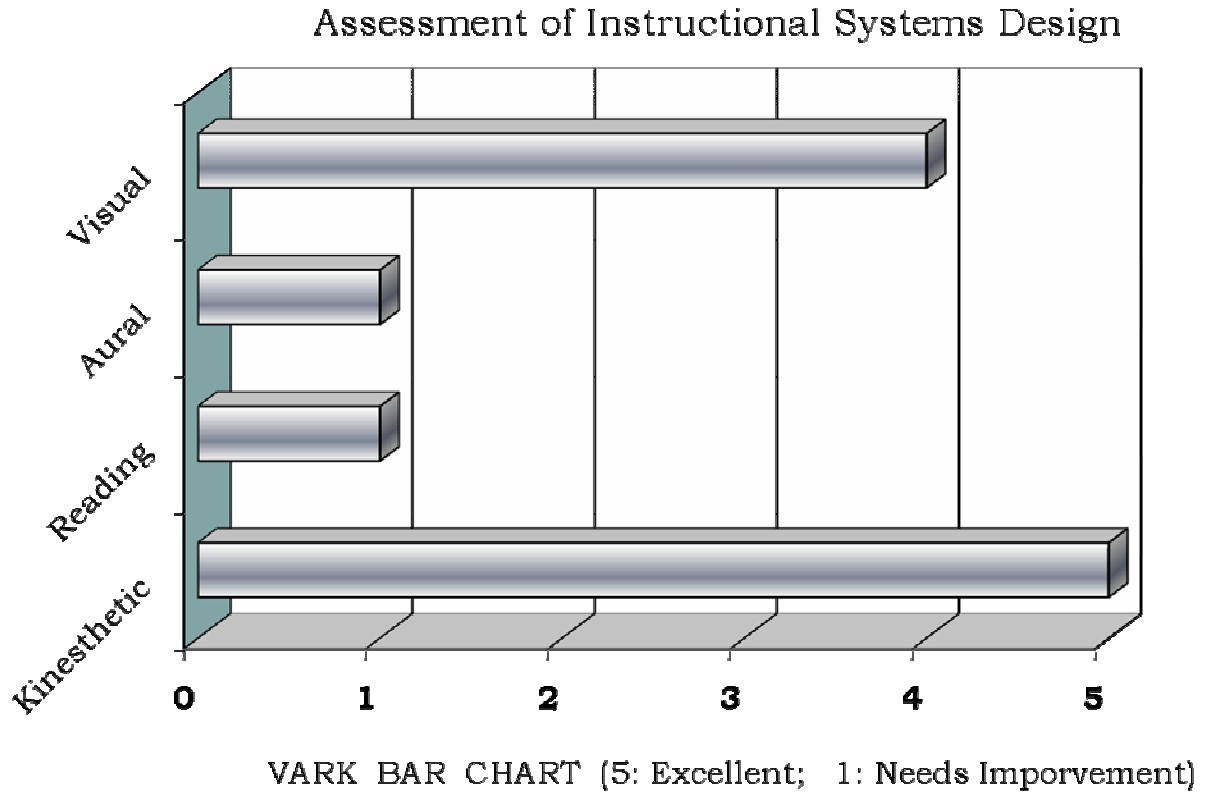
1	Visual	4	4	3	4	3	3	4	3	2	4	2	2	3	2	2	4	3	4	4
2	Aural	1	2	1	2	1	2	2	2	1	2	1	2	1	2	1	2	3	1	1
3	Reading	1	1	2	1	2	1	2	2	2	1	2	1	2	1	2	2	1	1	1
4	Kinesthetic	5	4	4	5	5	5	4	5	4	5	4	4	4	4	5	5	5	4	5

Data Collection
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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 cannot be a histogram, because the data is not continuous).

APPENDIX E : Bar Chart of Data Collected

Likert Scale Analysis. Rubrics courtesy of Washington State University, Pullman, WA.



[Copyright for VARK version is held by Neil D. Fleming, Christchurch, New Zealand and Charles C. Bonwell, Green Mountain, Colorado, USA].

APPENDIX F : Analysis of the Bar Chart and Conclusions

Topic V: **Visual:** Visual aids such as power point slides were used.

Topic A: **Aural:** This was delivered in the traditional lecture format.

Topic R: **Reading:** Students were required to read and submit their findings.

Topic K: **Kinesthetic:** Demonstrations and Laboratory setting was used.

Topic V: **Visual:** In this format, the subject matter of *viscosity and Reynolds Number* was discussed using power point slides and figures in addition to descriptive overhead transparencies. Students have shown keen interest in learning the subject matter and have demonstrated a good understanding the topic in question. This shows a very good score of **4** on Likert scale.

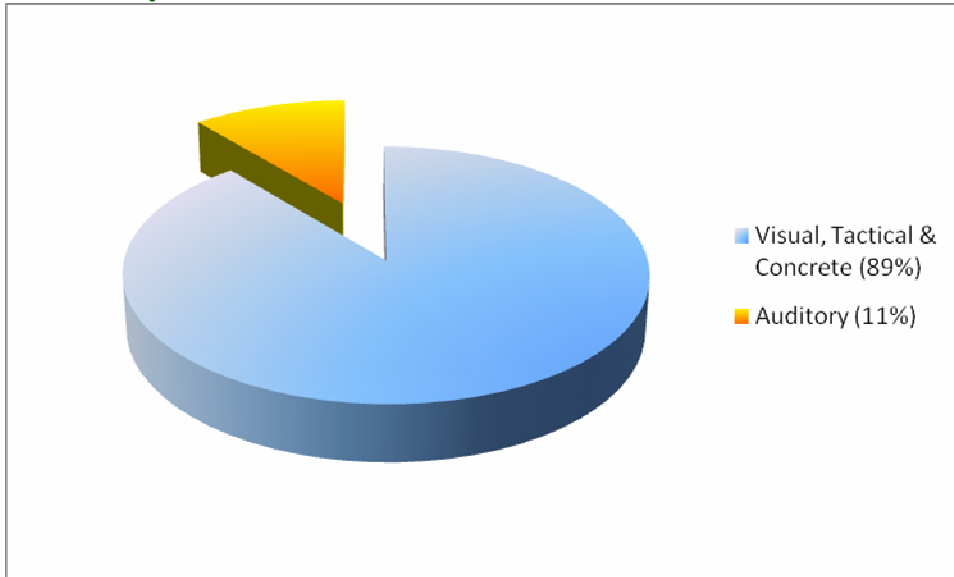
Topic A: **Aural:** In this format, the subject matter of *manometers* was delivered in a traditional lecture format. Students do understand what a manometer is used for. Regardless, they are unable to understand and learn the complexity of pressure calculations, on their own. When an actual situation is presented to them, they are having difficulty in analyzing the problem in depth on their own. This shows a very unacceptable score of **1** on Likert scale.

Topic R: **Reading:** In this format, the author asked the students to read and understand the subject matter of *Piezometric Head*. Later, the students were asked to solve problems pertaining to the reading assignment. While the students do understand the basic concepts of piezometric head, they were unable to apply the principles while solving practical problems. This again shows a very unacceptable score of **1** on Likert scale.

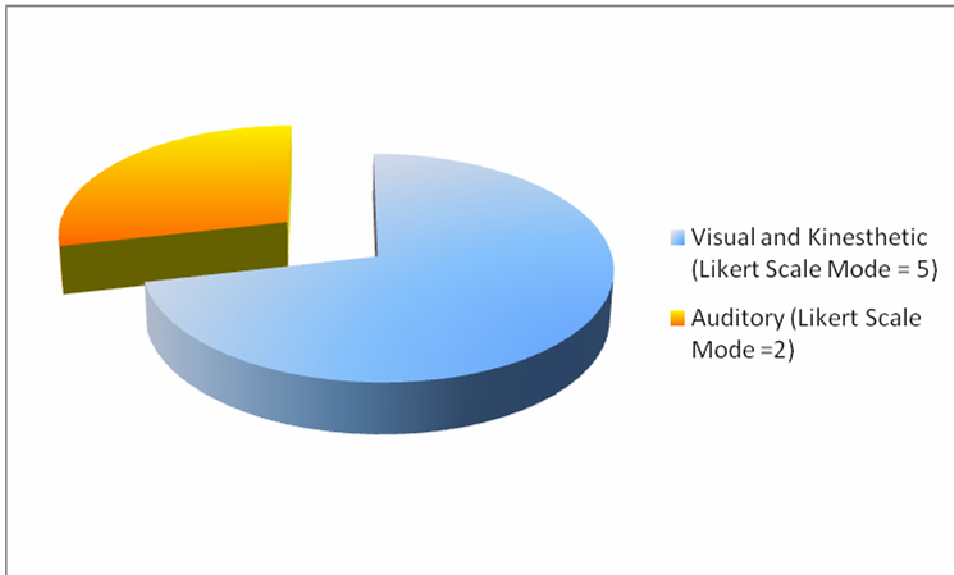
Topic K: **Kinesthetic:** In this format, the author had a laboratory demonstration that outlined the principles of center of pressure, metacenter and buoyancy. In addition, the students were asked to perform experiments, take data and perform calculations. The author observed that the students learnt it fast while conducting experiments. When examined in a quiz, students were able to provide very good answers. This shows an excellent score of **5** on Likert scale.

APPENDIX G: Comparison between Hunter Boylan's Research and Author's data

Hunter Boylan's Research



Author's Data



Source:

Boylan, H. R. (2002). *What Works: Research-Based Best Practices in Developmental Education*. Boone, NC: National Center for Developmental Education.

Narayanan, Mysore. (2010). *Assessment of Environmental Education*. ASEE 117th Annual Conference and Exposition, Louisville, KY. June 24–27, 2007.

APPENDIX H: 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.

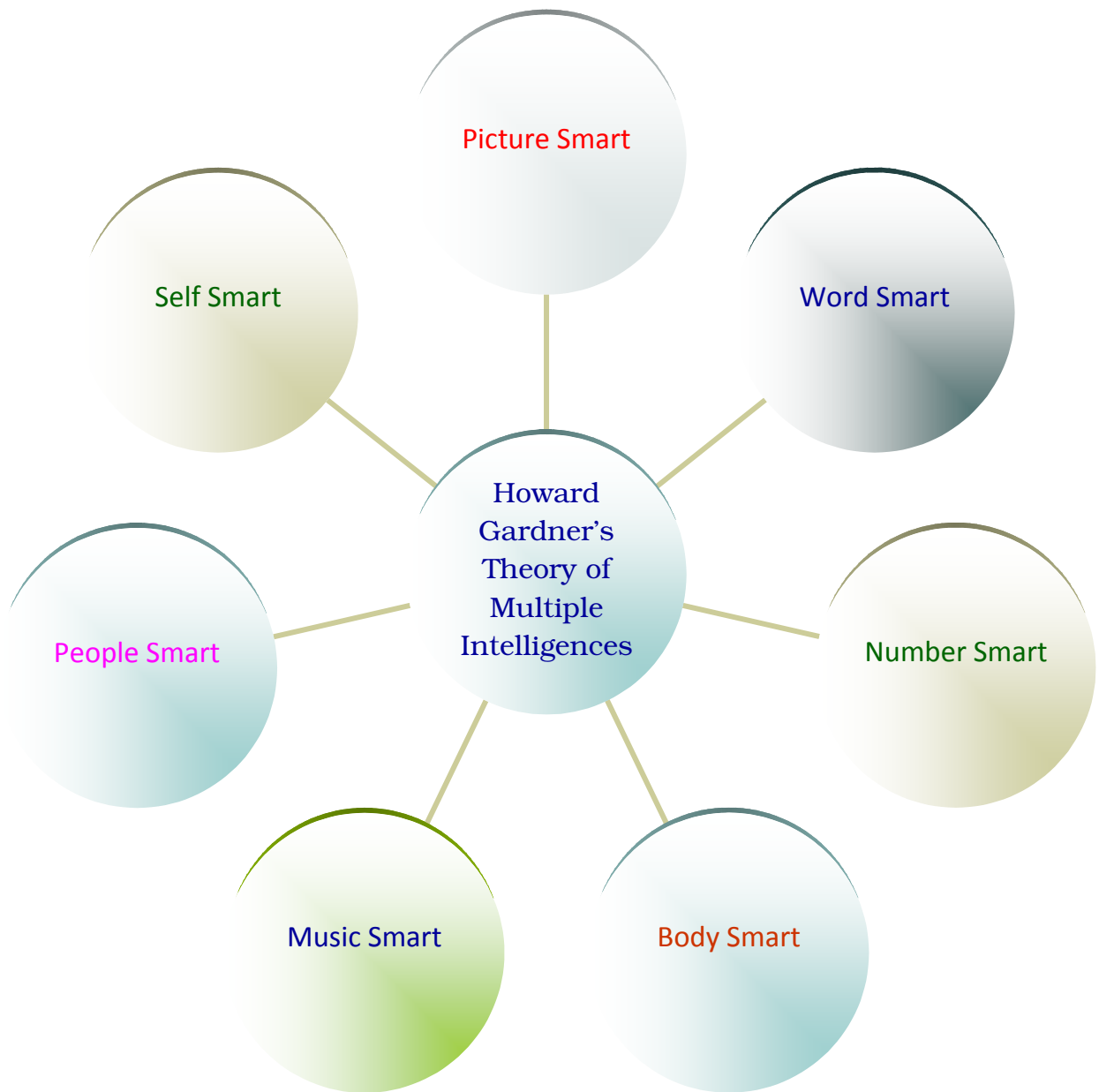
Reflection : Feedback from students, industry, faculty and administration helps towards thoughtful evaluation of the changes implemented. *Only* reflection can provide a tool for continuous improvement. Constant updating should always receive priority billing and the entire university should *reflect*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

APPENDIX I: HOWARD GARDNER'S THEORY OF MULTIPLE INTELLIGENCES

It is all too well known that Harvard University Professor Howard 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 (Gardner, 1993).



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