
AC 2012-2949: ASSESSMENT OF LEARNING USING FLEMING & MILLS' VARK LEARNING STYLES

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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 thirty five papers at various assessment institutes. His posters in the areas of assessment, 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 Learning using Fleming & Mills' VARK Learning Styles

Abstract

VARK is an acronym that stands for *Visual, Auditory, Read* (includes writing), and *Kinesthetic* sensory modalities that humans employ for learning and processing information. 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. In this, *follow-up* presentation he presents his latest findings and compares them with the data he had 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. His tips are to train faculty in alternative forms of instruction if they are expected to use diverse instructional methods. He recommends administering a *learning styles inventory* to students as a regular assessment process. In this presentation, the author presents his findings and compares them with the results of Hunter Boylan.

Introduction

Fleming & Mills' *VARK Learning Styles* lists only four categories whereas Howard Gardner lists seven styles and suggests humans can be: (Source: Armstrong, Thomas 1993. *Seven Kinds of Smart*. New York: Plume).

- 1 WORD SMART: Learners prefer to express themselves using verbal communication skills and they learn by reading and writing.
- 2 PICTURE SMART: Learners who learn faster when information is provided to them utilizing visual communication skills.
- 3 NUMBER SMART: Some other learners are very good in their ability to present logical arguments and possess excellent mathematical skills.
- 4 MUSIC SMART: These learners have musical talent and are focused on their talents pertaining to voice culture.
- 5 BODY SMART: Learners who prefer "Hands-on" experience and those who excel in the areas of sports or performing arts such as ballet or dance.
- 6 PEOPLE SMART: These individuals possess excellent interpersonal skills and can lead and motivate a team of people and be productive.

- 7 SELF SMART: A learner who has outstanding intrapersonal skills and has the drive to self-motivate towards impressive accomplishments.

Howard Gardner was the first American to receive the *University of Louisville's Grawemeyer Award in Education*. 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. 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. During the past twenty 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. (Gardner, 1993). (<http://www.pz.harvard.edu/Pis/HG.htm>)

Implementation and Assessment

For purposes of assessment, the author requires and mandates that the students create a systematically organized student course portfolio that clearly documents every activity in its complete detail. Whether it be a group discussion or an e-mail communication or cost estimating spreadsheet, it shall be found the portfolio at an appropriate place. These portfolios are gauged, graded, evaluated and assessed using a variety of rubrics and assessment tools. The author has previously presented some of these results in a form at the 114th ASEE Annual Conference in Honolulu, Hawaii.

The author plans to generate and utilize a similar rubric for purposes of assessment. Furthermore, it should be recognized that each topic or subject matter may be 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 (Narayanan, 2007).

The principles of *VARK* as outlined by Fleming and Mills could also be used to document assessment activities (Fleming and Mills, 1991). The author has not listed out the complete mechanics of the *VARK* methodology in this paper. He has presented and published this in another paper. As mentioned earlier assessment of *VARK* learning styles was carried out using a scheme based on *Washington State University's Critical Thinking Rubric*.

The author has carried out important research in the area of educational methodologies and has generated a set of chosen characteristics that would be useful in assessing *VARK* learning styles. The author recognizes that another instructor may choose to select a different set of characteristics for assessing *VARK* learning styles. Each instructor's style is different and one should respect individuality. Anthony F. Gregorc is best known for his theory of *Mind Styles Model* and its associated

Gregoric Style Delineator. Anthony F. Gregorc is president of Gregorc Associates, Inc., in Columbia, Connecticut. Gregorc is of the opinion that:

The instructional materials and techniques used by teachers have a direct effect on many students ... If the approach fit the preferred learning mode, the learner usually reacted favorably. If, on the other hand, the methods were mismatched, the student “worked hard to learn,” “learned some and missed some material,” or “tuned out.”

Four learning styles have been proposed by Anthony F. Gregorc and this has been reproduced in Appendix F.

Analysis

A collection of the data gathered and the results have been presented in an excel format in Appendix C. A bar chart based on likert scale was generated based on the data collected using the VARK principles of Fleming and Mills. This bar chart is shown in Appendix D.

Referring to the bar chart:

It can be seen that the **Visual** category recorded an acceptable value of **3**. This is not great, but does indicate that the students like visual mode of learning techniques. Principles of Manometer and related instruments were taught using this technique. There is an absolute need for improving this to a level of **4** at least.

The **Auditory** mode of learning recorded the highest possible score of **5**. Fundamentals of Fluid Mechanics was delivered in the traditional lecture format and the students seem to learn the necessary techniques in a *routine* manner.

The third category, **Reading** mode of learning recorded a low score of **2**. This indicates that the students need help from the instructor. A solid understanding of Bernoulli’s Equation and related mathematical techniques require quite a bit of effort from the students.

Finally, a very good mode value of **4** was recorded for **Kinesthetic** style of learning. Viscosity and related topics were handled like a laboratory, demonstration. The students learn better in a laboratory setting. This should be improved to document a score of **5**.

The above analysis shows that *lectures and labs* are the preferred and perhaps the best possible venue for engineering students, at this level. Hydraulics and Fluid Mechanics is a Junior level course and is heavily *content-driven*. There is a need to cover a lot of material and this must be viewed in proper perspective, while designing the syllabi. The author uses problem solving techniques extensively in his lecture classes. Regardless, one should recognize that in reality learners are actually *multimodal*.

In other words, many learners may prefer *multiple* modes, instead of a single one. In addition, some students may be *context specific*. This indicates that they prefer to select the mode best suited to a given discipline. Some may take longer time to gather and absorb from a chosen mode. This will ultimately lead to a better understanding in depth as well as breadth. Some other learners may insist that they need to receive information in all of their preferred modes (Narayanan, 2007 – 2011).

The author has also drawn from Hunter Boylan's research and has tried to compare his data with those of Boylan. Hunter Boylan also concludes that only about eleven percent of learners are auditory learners. This comparison chart is shown in Appendix G. The author acknowledges that his engineering discipline is completely different from that of Dr. Hunter Boylan. However, the data gathered by the author is strikingly similar to the data presented by Boylan.

In a recent publication, Hunter Boylan indicates that:

Many state universities might decide or be forced to decide to take only the top 60% or so of current applicants. This would certainly reduce the number of underprepared students in college and the subsequent need for developmental courses and programs. As a result, however, most such institutions would be dramatically downsized while diverting thousands of students to less selective private institutions. Furthermore, although white students are still the majority of those served by most developmental programs, minority students represent a disproportionate share of developmental education clients. Minorities, therefore, would be among those most adversely affected by such a solution. Substantial numbers would either not be admitted or, if admitted, would have no services available to help them overcome the academic effects of prior racism and discrimination. Under such circumstances, it is entirely possible that what little progress has been made in the educational attainment of people of color in this country could be completely erased within a decade.

Underprepared students might be forced to attend community colleges in order to obtain developmental education. This would overwhelm these institutions with underprepared students and make it even more difficult for developmental courses and services to be provided effectively. At the same time, this would result in a general reduction of baccalaureate degree attainment in those states where such a policy might be implemented. Since underprepared minorities are among the least likely to attain associate degrees and transfer to baccalaureate institutions (Boylan, Bonham, & Bliss, 1992; Grubb, 1991), this, too, would have chilling effect on educational opportunity.

[Source: Making the Case for Developmental Education by Hunter R. Boylan. In Research in Developmental Education, 12 (2), 1-4.]

Conclusions

The instructor can make appropriate changes in the curriculum design utilizing such assessment. This will obviously influence the manner and methodology as to how the course is developed and may necessitate changes in *Instructional Delivery Styles*. However, it is very important to recognize that the author's data is significantly different from those of Hunter Boylan's research. Furthermore it should be recognized that each topic or subject matter may be 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. (Narayanan, 2007 – 2011).

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APPENDIX A : IMPLEMENTATION OF VARK LEARNING STYLES.

The instructor delivered four “content material” in four different modes.

Subject matter discussed: Hydraulics and Fluid Mechanics.

Fundamentals of Fluid Mechanics was delivered in the Traditional Lecture Format.
(Aural)

Principles of Manometer and related instruments utilized Power Point Slides.
(Visual)

Bernoulli’s Equation was left for the students to read, write and submit their findings.
(Reading)

Viscosity and related topics were handled like a laboratory, demonstration, etc.
(Kinesthetic)

Later, the students were examined on all the four topics.

Instructor graded the test on a holistic basis.

No quantitative grade points or percentages were recorded.

Grading was recorded based on student’s perception, grasp and depth of understanding of the topic.

The author has utilized these types of assessment techniques in his previous ASEE conference proceedings and publications (Narayanan, 2007, 2009 & 2011).

Rubrics based on Likert Scale (Courtesy of W.S.U.) is shown in Appendix B.

A sample of grading scheme, *Master Spreadsheet* is shown in Appendix C.

Results gathered are represented in a bar chart shown in Appendix D.

APPENDIX E draws a comparison between Boylan’s Research and Author’s data.

Appendix F documents *Four learning styles*. Gregoric Style Delineator.

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

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](http://wsuctproject.wsu.edu/ctr.htm), P.O. Box 644530, Pullman, WA 99164 - 4530 USA.(2005) <http://wsuctproject.wsu.edu/ctr.htm>

APPENDIX C: Assessment using VARK principles : Master Spreadsheet

Subject Studied: Fluid Mechanics.

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

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

These techniques have been previously used by the author in other ASEE proceedings and publications.

Assessment of Four VARK Styles (Fluid Mechanics)

TOTAL xx STUDENTS #	A	B	C	D	E	F	G	H	I	J	K	L	M	N	.	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 (Manometer)	4	5	3	4	3	3	2	3	5	4	2	2	3	5	2	5	2	5		3
2	Aural (Fundamentals)	3	2	2	2	3	2	2	2	3	2	3	2	3	2	3	3	3	3		5
3	Reading (Bernoulli)	3	2	2	3	2	3	2	2	2	3	2	3	2	3	2	2	3	3		2
4	Kinesthetic (Viscosity)	5	4	4	5	5	5	4	5	4	5	4	4	4	4	5	5	5	4		4

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 can't be a histogram, because the data is not continuous).

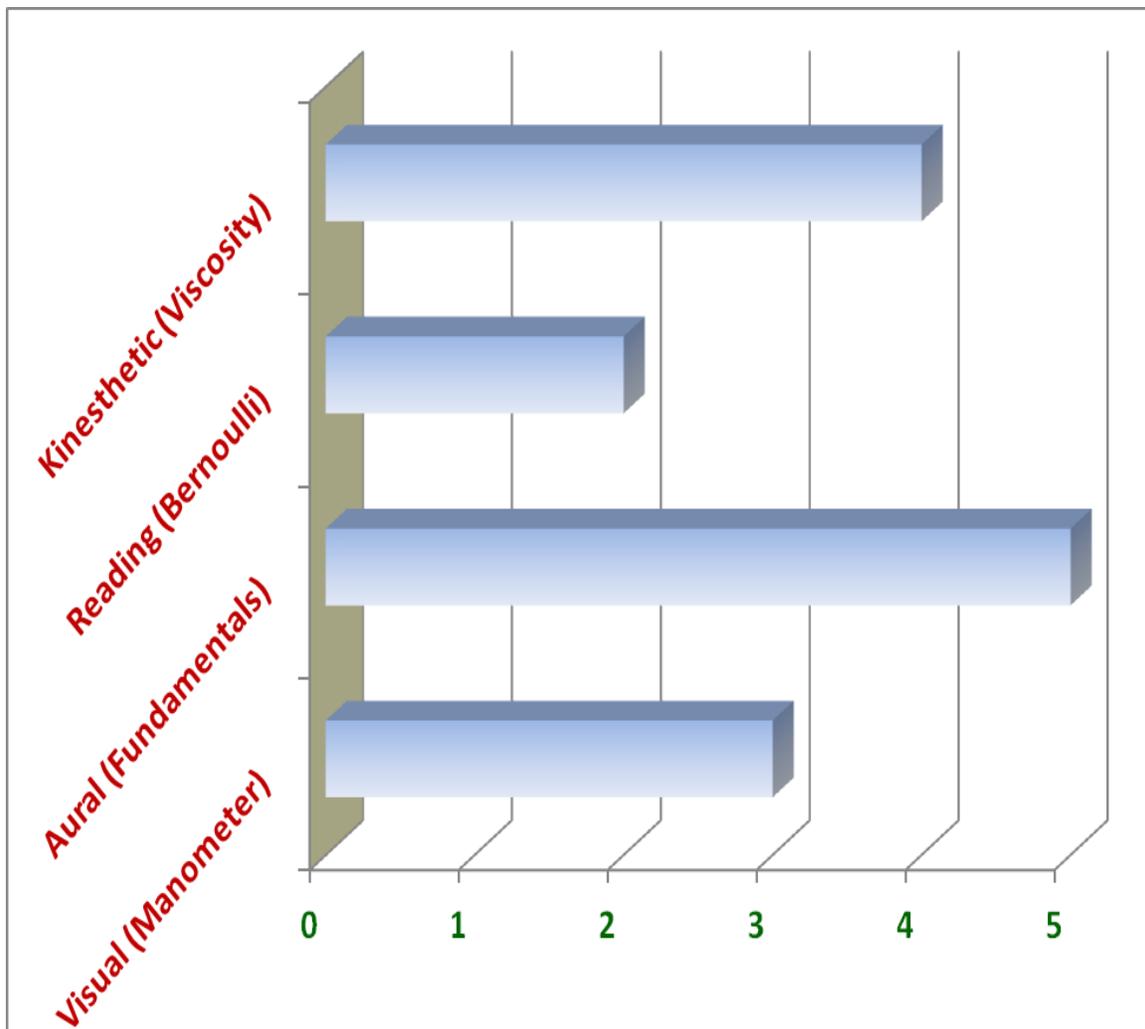
APPENDIX D: Bar Chart Representation of Data Collected

Likert Scale Analysis. 5: Strongly Agree 1: Strongly Disagree

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

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

SUBJECT STUDIED: HYDRAULICS AND FLUID MECHANICS



PLEASE SEE PAGE 3 FOR AN ANALYSIS OF THE BAR CHART.

APPENDIX E (Comparison between Hunter Boylan's Research and Author's data)

<p>Research by Dr. Hunter R. Boylan (Boylan 2002)</p>	<p>Author's Data (Fluid Mechanics)</p>	
86%	Visual	Mode = 3
11%	Auditory	Mode = 5
	Reading	Mode = 2
	Kinesthetic	Mode = 4
3%	Tactical- Concrete	

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

Making the Case for Developmental Education by Hunter R. Boylan.
In *Research in Developmental Education*, 12 (2), 1-4.

APPENDIX F: Gregoric Style Delineator: Four learning styles

The following represents a brief description of each of the four learning styles.

Concrete Sequential (CS) These learners prefer direct, hands-on experience. They exhibit extraordinary development of their five senses. They like touchable, concrete materials, and orderly presentations. CS's actually enjoy faculty meetings! They are adverse to change and do not oppose tradition. They are habitual, punctual, and desire perfection. You would not see a CS wear flashy colors or mismatched outfits. They are organized, desire perfection, and give "practical" gifts.

Abstract Random (AR) These learners have a capacity to sense moods, and they use intuition to their advantage. They prefer to learn in an unstructured environment such as group discussions and activities. Faculty meetings are viewed as a time to socialize! They prefer not to be restricted by unnecessary rules and guidelines. Because AR's continuously discharge energy, they may appear "hyper" when indeed they are not. AR's use hand and body movements when communicating. They dislike routine activities and cold, unemotional people.

Abstract Sequential (AS) These learners have excellent abilities with written, verbal, and image symbols. They like to read, listen, and use their visual skills. They are highly verbal; therefore, you will never have a short conversation with an AS. They prefer a sequential presentation that is rational and substantive or they consider meetings a waste of time. AS's are "fence straddlers" and highly skeptical.

Concrete Random (CR) These learners like to experiment using trial-and-error approaches. They tend to jump to conclusions and prefer to work independently or in small groups. They are gamblers and risk takers. CR's may arrive late to meetings and leave early if they feel the meeting is boring or going nowhere. Concrete Random individuals are leaders, not followers. They love to take charge and be in charge. They refuse to accept the words "don't" or "can't." They thrive in a competitive atmosphere. CR's are not overly concerned with making impressions or going out of their way to win over people. They are often the prime movers of change.

Source:

1. Gregorc, A. F., & Ward, H. B. (1977). *Implications for learning and teaching: A new definition for individual*. NASSP Bulletin, 61, 20-26.
2. Gregorc, A. F. (1979). *Learning styles: Differences which the profession must address*. Reading through content, 29-34.
3. Gregorc, A. F. (1979). *Learning/teaching styles: Their nature and effects*. Student learning styles: Diagnosing & prescribing programs, 19-26.
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5. Gregorc, A. F., & Ward, H. B. (1977, February). *A new definition for individual*. NASSP Bulletin.

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