

Student Preferences for Learning College Algebra in a Web Enhanced Environment

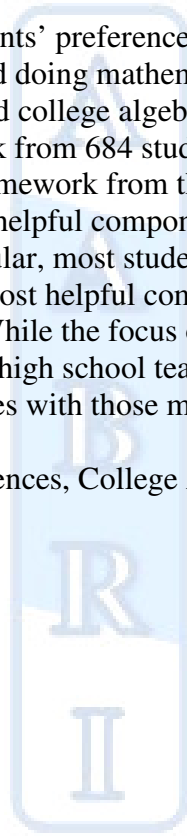
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Abstract

It is important to determine students' preferences if we hope to engage them better in the processes of learning, understanding, and doing mathematics. Responses collected from high school students enrolled in web enhanced college algebra courses from Fall 2004 through Spring 2008 are reported in this study. Feedback from 684 students responding to survey questions on end-of-course evaluations shows that homework from the book, computer laboratories, and online quizzes are chosen most often as helpful components in assisting with student understanding of mathematics. In particular, most students enrolled in the Spring 2008 semester chose homework from the book as the most helpful component, while over time, the online quizzes were chosen most frequently. While the focus of this study is on student preferences for learning algebra, responses made by the high school teacher facilitators in the project are included in order to compare their choices with those made by the students.

Keywords: Mathematics, Student Preferences, College Algebra, Web Enhanced, High School



Introduction

It is important to determine students' preferences if we hope to engage them better in the process of learning, understanding, and doing mathematics. What components of a course do students choose as most helpful with respect to understanding? Knowing the answer will help teachers better prepare to facilitate learning. Though it can be argued that students may not have a realistic or accurate sense of what is actually most effective for their learning, finding out what they think is important. In their study undertaken to improve performance in high school algebra, Kortering, DeBettencourt and Braziel concluded that research needs to incorporate student feedback as to what interventions or accommodations are most effective for given subjects and settings (2005). Dr. David Bressoud, president elect of the Mathematics Association of America, challenged in an April 2008 meeting, "We need more current and comprehensive data about what happens to students as they cross the divide from high school to college." In response to Dr. Bressoud's call for current data, this study reports feedback from high school students enrolled in web enhanced college algebra courses from Fall 2004 through Spring 2008 and in particular, explores in depth the data collected from the Spring 2008 semester. Such data add to the existing knowledge base regarding how we can help students succeed in mathematics as they transition from high school to college level mathematics by offering insight into their preferences.

In their study, Kortering et al found that little knowledge exists about what students say regarding their algebra classes (2005). This study analyzed survey results given to 46 high school students with learning disabilities who were enrolled in mathematics classes. Forty-six students responded to the question, "What is the best part of the class?". Twenty percent of the responses pertained to group work and 17% pertained to learning. In particular, quotes about liking the class when they knew how to do and understand mathematics were documented. To the question, "How can we help students to be more successful with the work, quizzes, or tests?", the greatest number of responses pertained to bookwork (16 responses), quizzes (18 responses) and chapter tests (17 responses). Most of the associated responses showed that students wanted more help through the support of such things as tutoring or individual help from the teacher. Finally, 43 students responded to the question, "What is the most important thing we could do to improve student performance in algebra?" Once again the dominant theme in the responses was related to getting help through support services, tutoring and encouragement. Strong themes could also be found pertaining to teaching styles and group work. In their discussion, Kortering et al report that students in the study suggest they require alternative formats for learning and that such things as group work and software programs may be helpful accommodations that can provide additional support or assistance (2005).

Schoenfeld (1989) explored the beliefs and behaviors of 230 high school students enrolled in a plane geometry course by the use of a questionnaire. Unlike the study performed by Kortering et al, this study was performed in highly regarded schools with participants who were enrolled in Regents', college bound mathematics classes. A high correlation was found to exist among students' overall academic performance, expected performance in mathematics, and sense of their own mathematical ability. From this finding, it can be surmised that students with a good sense of their mathematical ability, who expect to perform well, will. It is reasonable to expect that such students will also have a good sense of what formats are best suited to assist them with learning and understanding mathematics. However, it is interesting to note that the students in the study believed they could succeed if they worked hard, but at the same time expected typical

homework and test problems to be completed in only a minute or two.

In a review and synthesis of 33 research studies on personal epistemology and mathematics, Muis (2004) found that mathematical instructional environments were inferred to influence the development of students' beliefs about mathematics. Significant relationships were found among beliefs and cognition, motivation, and academic achievement which supports the findings of Schoenfeld (1989). All studies reviewed by Muis show that attempts to change students' beliefs, explicitly or implicitly, significantly modified students' learning strategies. Muis concludes that according to studies, changing beliefs of students is possible and can be attributed to changes in instructional style. From this, it can be hypothesized that changes in instructional style can modify students' learning strategies.

Stiggins (2005) points out that students' perception of formal and informal assessments may stem from their emotional strength and their previous success on such types of measures. He also points out that assessment has traditionally been used in schools to motivate students via such things as pop quizzes and final comprehensive exams. His work describes the newer dual role for assessment being used in schools today. This includes a summative role, the type of assessment used in the past to inform primarily the teacher about student learning, and a formative role. Formative assessment is a way to use assessment for learning and is meant not only to inform the teacher, but also the student.

Are the course components preferred by students aligned with formative or summative assessment? This study provides insight into which formats high school students perceive as most helpful to their learning of algebra. Unlike Kortering et al (2005) who worked with high school students with learning disabilities and Schoenfeld (1989) who studied highly motivated students in highly regarded schools, the participants in this study were those seeking to attend college, but were not enrolled in the typical *Advanced Placement* courses offered at their rural schools. The *WvEB Algebra Project* used in this study was funded in part by the National Science Foundation project number 0339117. The project allows high school students to dual enroll in Algebra III in high school and College Algebra via a web enhanced offering. High school students enrolled in *WvEB Algebra* perform better than students enrolled in on-campus sections with respect to grades earned in the course and success rates attained in next courses (Author, in press).

Method

Participants

Participating in this study were 1,322 students in the *WvEB Algebra Project* in West Virginia. The students attended 19 high schools throughout the state from Fall 2004 to Spring 2008. All student participants had at least a 3.0 overall high school grade point average and a "C" or better in Algebra I, Algebra II, and Geometry. In addition, high school mathematics teachers participated as facilitators at each of the schools.

Procedure

Course content is made available to high school students via lectures on a CD, homework assigned from the book, laboratories done with partners using a computer and student manual,

reading assignments, and online quizzes that allow multiple attempts and the use of books notes and peers for help. For college credit, students are required to meet three hours per week for fifteen weeks with high school mathematics teachers who serve as facilitators. Facilitators often reinforce the CD lectures with mini lectures of their own. As with the on-campus course, tests are given to the high school students on-line. Tests are password protected and proctored by the facilitators. Ninety percent of all grading for the College Algebra course is done directly through the university, whether "by hand" or through on-line assessments designed by the faculty instructor. Facilitators contribute points worth up to 10% of the college grade. Most of the facilitator points come from the grading of homework assignments from the text book. Anonymous surveys were given at the end of each semester and were submitted by the mail or in later years via the web.

There are five primary course components associated with helping the students learn the content in the *WvEB Algebra Course*. The CD lectures are professionally recorded sessions that resemble typical lecture meetings. The homework from the book is the assignment of problems focusing the student toward the major content objectives of the lesson. These problems are mostly procedural in nature though many require the student to apply conceptual understanding and problem solving abilities. The computer laboratories are group assignments where students are asked to use applets and laboratory sheets to answer procedural, conceptual and problem solving questions. These assignments are focused primarily toward enhancing conceptual understanding. In each laboratory assignment, students are required to write about mathematics after communicating in a group. A group grade is assigned for laboratory work. Online quizzes are composed of 10 multiple choice questions. The questions are chosen randomly from banks of questions. The quizzes may be repeated up to three times with the highest score used in the grade. The student is encouraged to use books, notes and peer tutoring while working on a quiz. Facilitators do not answer questions about quizzes until they are graded. Quizzes may be completed from any computer with internet access at any time during the day or night. Students are asked to complete quizzes that are associated with an exam before taking the exam. The reading assignments are from the text book and are associated with the content objectives of the lesson.

Results

An analysis was performed to determine which course components were chosen as helpful in student understanding of course material. In addition, each participant was asked to select the component that most helped with student understanding. In the Spring 2008 semester, participants were also asked to briefly explain why the choice was made.

Table 1 shows results from the end of course survey given to students as a part of the course evaluation from Fall 2004 through Spring 2008. Of the 1,322 students asked to respond, 684 submitted forms. This yields an approximate 52% return rate.

Table 1

Results from 684 students Fall 2004 - Spring 2008 Web Enhanced College Algebra Course

Component	All that helped		Helped the most	
	Total	Percent	Total	Percent
CD Lectures	76	5.0	38	5.5
Book homework	458	30.2	195	28.5
Laboratories	409	27.0	122	17.8
Online quizzes	534	35.3	316	46.2
Reading	37	2.4	13	1.9

For example in Table 1, of the 684 respondents, 76 chose the CD Lectures as a helpful component accounting for five percent of the responses. The CD Lectures component was chosen by 38 respondents as the most helpful component accounting for five and one-half percent of the responses.

Table 2 shows results from the end of course survey given to teachers as a part of the course evaluation from Fall 2004 through Spring 2008. It should be noted that the Algebra course is offered once per year at most schools in either the fall or spring semester. These data reflect the responses from the same teachers over time with some teachers joining the project later than others. Of the total of 60 opportunities for all teachers to submit over time, 39 responses were collected. This yields an approximate 65% return rate.

Table 2

Results from high school teachers Fall 2004 - Spring 2008 Web Enhanced College Algebra

Component	All that helped		Helped the most	
	Total	Percent	Total	Percent
CD Lectures	6	5.9	1	2.6
Book homework	32	31.7	18	46.2
Laboratories	29	28.7	14	35.9
Online quizzes	29	28.7	5	12.8
Reading	5	5	1	2.6

For example in Table 2, of the 39 responses, six chose the CD Lectures as a helpful component accounting for approximately six percent of the responses. The CD Lectures component was chosen once as the most helpful component accounting for approximately two and one-half percent of the responses.

Table 3 shows results from the end of course survey given to students as a part of the course evaluation from in the Spring 2008. Of the 70 students asked to respond, 45 submitted forms. This yields an approximate 64% return rate.

Table 3

Results from 45 students Spring 2008 Web Enhanced College Algebra Course

Component	All that helped		Helped the most	
	Total	Percent	Total	Percent
CD Lectures	9	7.5	3	6.7
Book homework	38	31.7	27	60.0
Laboratories	33	27.5	5	11.1
Online quizzes	36	30.0	10	22.2
Reading	4	3.3	0	0.0

CD Lectures

Of the 45 students completing the Spring 2008 evaluation, nine chose the CD as being helpful with 3 choosing it as the most helpful component. Reasons given were that the lectures were a good start in helping one understand the problems and that it was much easier to learn from watching rather than reading before doing. "I chose to watch the computer lectures because it is much easier for me to learn by watching someone else giving examples, rather than just reading and trying to do them myself."

Homework Assignments

Of the 45 students completing the Spring 2008 evaluation, 38 chose the homework assignments from the book as being helpful with 27 choosing it as the most helpful component. Reasons given were the repetition required in doing all of the assigned problems, the book having examples similar to the homework problems, the problems in the book allowing for trial and error, and the assignments promoting self learning. Also noted was that the assignments allowed one to ask questions from peers and the teacher without penalty, and that students could learn things well through explanation. Students felt that the problems helped prepare them for the tests and quizzes. "I made this choice because I believe that a student has to do work on his or her own in order to truly understand the materials, and with the homework assignments... a student doesn't get penalized for not knowing the material, and they get another chance to

discuss with the teacher what they don't understand."

Laboratories

Of the 45 students who completed the evaluation, 33 chose the laboratories as being helpful with five choosing it as the most helpful component. Reasons given included liking the step by step guidance. They felt the laboratories provided the best examples for understanding and that they provided a challenge. Some students noted that it was the only thing the instructor helped with and that the time constraint forced one to work quickly. "The laboratories seem to give the best examples to better understand the properties of the math."

Computer Quizzes

Of the 45 students who completed the evaluation, 36 chose the computer quizzes as being helpful with 10 choosing it as the most helpful component. Reasons given were that the quizzes tested for understanding and allowed them to know what they did not understand. It was felt that the quizzes forced them to understand. They liked the retries and felt that quizzes allowed them to gain confidence in their ability. "I made this choice because I could take the quizzes more than once, and every time I did that I could understand why I always got one wrong and actually try and figure out how I got it wrong."

Teachers

Of the two out of five teachers who responded in the Spring 2008, both chose the homework, laboratories, and computer quizzes as being helpful. Only one chose the reading assignment and neither one chose the CD. Both teachers chose the homework as being the most helpful. "The homework assignments allow the student and the facilitator to see if the student understands the concepts taught." "I would use the homework assignments as examples in class for preparing students to take the quizzes and tests. I also recommended that the students keep a homework notebook. I used the notebook to help me give bonus points for the end of the year high school grade."

Discussion

Over time, as seen in Table 1, all five components were selected by students as being both helpful and most helpful to their understanding. Therefore, it is likely that by having the CD lectures, the homework from the book, the computer laboratories, the online quizzes, and the reading assignments available, some students were accommodated that might not have been if all of the components had not been available. Table 2 shows that over time, teachers have also selected each of the components at least once as being both helpful and most helpful components for student understanding. Unlike the student data that reflect unique student responses over time, the teacher data reflect the variation of individual opinions over time. Upon further investigation, it was determined that teacher selection of CD lecture and reading assignments were chosen during semesters when there were new high school sites added to the project. It could be that the high school teachers found these resources helpful in their own preparation to

facilitate the course for the first time.

As indicated by Tables 1 and 2, both students and teachers chose the homework, laboratories, and quizzes as the three primary components that helped with student understanding. This finding could reflect the findings of Muis (2004) that instructional environments can influence the development of student beliefs about mathematics. However the students chose the online quizzes as the most helpful component with 46.2% of the responses as compared to 12.8% of the teachers. This could be because the students are focusing on the similarities of the quizzes to the online exams. While the online quizzes most resemble the regular exams and comprehensive final in both appearance and delivery, only half of the questions on an exam are pulled from the same bank of questions as those used on the quizzes. In addition, at least one question on a 20-question exam is asked that is directly connected to a laboratory question. Based on the responses from the Spring 2008 surveys, it does not seem to be the case that students are choosing the quizzes primarily because of the similarity to the exams. Instead, perhaps the students are more digitally inclined and prefer to work in a digital environment as suggested by Prensky (2001). This may also contribute to their choice of the laboratory as a helpful component though the use of technology was never specifically mentioned in a student response.

Due to the large number of students taking College Algebra, it has been necessary for the regular exams and comprehensive final to be administered as online multiple choice exams that are password protected and proctored. This administration is the same for all of the approximate 1,750 students who take College Algebra per academic year whether on or off campus. These assessments were designed to be used primarily for summative assessment. However, the homework from the book, laboratory assignments, and online quizzes are components that were designed to be used for both summative and formative assessment as described by Stiggins (2005). Upon further investigation, it was found that over time, students and teachers have consistently chosen the homework from the book, the computer laboratories and the online quizzes as those components that help the most with the understanding of mathematics.

Kortering et al (2005) found that students requested help in learning algebra through support, tutoring and encouragement. They also suggest that students require alternative formats for learning such as group work and software programs. All of these findings support the selection of the quizzes, laboratories and homework from the book as helpful components. The quizzes make use of software and supply immediate results once submitted. Students are encouraged to get help from peers when completing quizzes. A quiz is not timed and may be opened and printed off. When ready, the student can re-open the quiz and submit answers. Once submitted, the quizzes are immediately scored. Students only find out if the question was correctly or incorrectly answered. No solutions are given. They are encouraged to seek help about missed questions. The laboratory assignments significantly differ from the quizzes and homework from the book. The laboratory assignments are graded by hand and are often embedded with comments by the grader that can be viewed as encouragement and support. Conceptual understanding and problem solving are being assessed in the laboratory assignments and collaborative group work is encouraged by the way points are awarded for a grade. Any student working alone does not receive communication points for the assignment which are worth up to 10% of the grade. Finally, the homework from the book is a component that allows for significant interaction between the student and the high school facilitator. Student comments from the Spring 2008 survey indicate that students have the opportunity to discuss their work

with the teacher facilitator and the teachers indicate that the homework gives them a chance to find out if the students understand the material before the test and quiz is administered.

It is interesting that the data in Table 3 show that students in the Spring 2008 semester overwhelmingly chose the homework from the book as the component that helped them understand mathematics the most. Of the two out of five teachers who responded that semester, both chose the homework as the most helpful component. Could this reflect the findings of Muis (2004) that instructional environments can influence the development of student beliefs about mathematics? Further semester by semester analysis was conducted from Fall 2004 to Spring 2008 surveys and it was found that the Spring 2008 semester was the only semester where there was a one-to-one relationship between the most helpful component chosen by the students and high school facilitators. However, in three other semesters, the selection alignments were such that one component of a tie for most helpful choice of one group matched the one most helpful choice of the other.

In conclusion while students in this study had one common instructor from the university, there were as many as 19 high school teacher facilitators working in the project. It is cautioned that students' perceptions of the course components most likely were influenced by possible confounding variables at individual sites. Though approximately 90% of the students enrolling in the algebra course earn an "A", "B", or "C", responses on the end-of-course evaluations in this study were anonymous and were unable to be linked directly to student performance. Further study should be devoted to the connection between the teaching environment and student beliefs and consequently student performance. Would the enhancing of the teaching environment and individual assessments with more occurrences of materials directed toward conceptual understanding and problem solving influence the preferences that students have for components that help with their understanding of mathematics? Would student performance be significantly affected? Are there other course components that can be developed or used that would accommodate student understanding?

References

- Author (in press) *Proceedings of The Nineteenth Annual International Conference on Technology in Collegiate Mathematics, USA*.
- Bressoud, D. (2008, April 12). Retrieved October 7, 2008, from http://www.macalester.edu/~bressoud/talks/Allegheny/Calculus_in_HS.pdf
- Kortering, L. J., DeBettencourt, L. U., & Braziel, P. M. (2005). Improving performance in high school algebra: What students with learning disabilities are saying . *Math and Learning Disabilities* . Vol. 28, No. 3, 191-203.
- Muis, K. R. (2004). Personal Epistemology and mathematics: critical review and synthesis of research. *Review of Educational Research*. Vol. 74, No. 3, 317-377.
- Prensky, M. (2001). Digital Natives, Digital Immigrants. *On the Horizon*. 9 Nol 5, 1-6.
- Schoenfeld, A. H. (1989). Explorations of students' mathematical beliefs and behavior . *Journal for Research in Mathematics Education*. Vol. 20, No. 4, pp. 338- 355 .
- Stiggins, R. (2004). From formative assessment to assessment for learning: A path to success in standards-based schools. *Phi Delta Kappan*. 87, No. 04, 324 - 328.