Students Perceptions of Learning College Algebra Online using Adaptive Learning Technology

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Adaptive learning technology was used in the teaching of an online college algebra course. As students worked on the mastery goals set for them, the technology helped students identify content that they already understood and other content that they had yet to master. Goal orientation theory suggests that when learning is mastery-oriented, a student's motivation to learn may improve (Ames & Archer, 1988). Qualitative methodology was used to describe how students perceived the instruction of their college algebra course and their learning in the course. Preliminary findings suggested that an adaptive teaching approach may help build students' confidence because they can control the pace of instruction and chose where to focus their effort without drawing negative attention to themselves.

Keywords: adaptive learning, college algebra, blended learning

High failure rates in entry level mathematics courses continue to be problematic across college campuses in the United States (Haver, 2007). Low student motivation has been identified as a factor contributing to this high failure rate (Thomas & Higbee, 1999; Walter & Hart, 2009). Since most college students are required to take college algebra and many need additional mathematics courses such as trigonometry and calculus, it is important to design, implement, and evaluate instructional strategies that can increase a student's motivation to learn mathematics.

Theoretical Perspective

In order to combat low motivation, goal orientation theorists advocate interventions that utilize a mastery-oriented or goal-oriented learning approach (Ames & Archer, 1988). A goal oriented approach to learning focuses achievement on mastering a task, the learning process, and self-improvement, whereas a performance oriented approach emphasizes normative standards or getting the highest grades. Ames and Archer (1988) found that when a mastery goal oriented approach was perceived by students, students reported using more learning strategies, enjoying their class, and having willingness to tackle challenging problems.

Literature Review

Universities have continued to increase the number of online course offerings each year in an effort to accommodate the needs of today's student (Allen & Seaman, 2014). Adaptive learning technologies have emerged in online courses as a means to customize instruction to learners' backgrounds, experiences, and prior knowledge. Adaptive learning technologies have provided students with an opportunity to self-pace instruction and an opportunity to focus instruction on their individual needs rather than the collective needs of the whole class (Vandewaetere, Desmet, & Clarebout, 2011). As researchers have begun to evaluate the effectiveness of adaptive learning technologies, findings have suggested that adaptive learning has positively impacted

both student learning and satisfaction (McKenzie, Perini, Rohlf, Toukhsati, Conduit & Sanson, 2013). The implementation of an adaptive teaching approach may provide instructors an opportunity to design an online college algebra course that addresses individual learner needs, supports a mastery oriented learning approach, and in turn motivates students to learn college algebra.

In order to effectively examine the efficacy of this teaching approach as a way to bridge the gap between perceived ability and actual mathematical ability, this study was conducted as part of a larger design and development research study. This paper focused on the outcomes of the study specifically relating to student perceptions of the adaptive teaching approach used in their college algebra course. The research question guiding this study was: What are the students' perceptions of the adaptive teaching approach used in their college algebra course?

Instructional Approach

For the purposes of this study, an adaptive learning courseware was implemented as the primary source of instruction for one section of an online college algebra course at Northeast University in the United States. The courseware implemented was an artificially intelligent assessment and learning system that used adaptive questioning to determine which topics students already knew and which topics students needed to learn.

Before the course began, the instructor identified which topics to include in the college algebra course. On the first day of class, students completed a pre-test in the courseware. Student performance on the test determined how many college algebra topics each student had yet to master. As students worked through topics in the courseware they were able to take advantage of several online resources. These resources included lecture videos, an e-version of the textbook, worked examples, and written explanations. In addition, the instructor held weekly office hours online and on-campus.

Mastery goals were set to encourage students to maintain an appropriate pace (see Table 1). By the end of week 1, students were to have mastered 20% of all topics in the course and by the end of week 6 they were to have mastered 100%. Grades were awarded each week. For example, if a student mastered 19% of the topics in week 1, his grade would be 95% for total mastery for week 1.

Table 1

Summary of Weekly Mastery Goals

Mastery goals	**Total course mastery**
Week 1	20%
Week 2	40%
Week 3	60%
Week 4	75%
Week 5	90%
Week 6	100%

The students' final grade was determined by their progress on specific mastery goals, a time goal, and two exams (see Table 2). Total mastery was worth 30% of their final grade and

reflected the number of topics the student mastered out of the total number of topics (403 topics). Mastery of each objective was worth 35% of the final grade and reflected the number of topics mastered within each of the five objectives (Equations and Inequalities, Graphs and Functions, Polynomial and Rational Functions, Exponential and Logarithmic Functions, and Systems of Equations). The weekly time requirement was worth 10% of the final grade. Students were required to spend ten hours a week working in the courseware. A comprehensive midterm and final exam were given and worth 25% of the final grade.

Table 2

Components of Students' Final Grade

Component	**Percentage of final grade**
Total Mastery	30%
Mastery of each objective	35%
Weekly Time Spent	10%
Midterm/Final Exam	25%

Methodology

Participants included 27 undergraduate students and the instructor of record. The instructor was also the researcher and has been teaching algebra for the last 15 years. Qualitative methodology was used to analyze the empirical materials (Miles & Huberman, 1994).

An online anonymous survey with eight open-response questions was administered to all students during the last week of class. These surveys were used to provide students' an opportunity to assess their learning and the course. Twenty students completed the survey. In addition, a university course evaluation questionnaire was administered to all students during the last week of class. Question formats included Likert scale questions (both university-developed and instructor-developed) and open-response questions. Twenty-one students completed university evaluations.

Data analysis is still in a preliminary stage, however; the following steps have been taken. First, an initial reading of student responses was conducted. Starter themes emerged as the researcher was able to organize the responses into categories. Next, responses were coded according to each category. Sub-themes in each category were identified because of their frequent occurrence.

Results

Findings are described according to the themes and sub-themes that emerged during data analysis. Student responses were categorized into two themes: instructional approach and self-evaluation of learning. Sub-themes for theme one were: Adaptive learning technology, course structure, opportunity to self-pace instruction, and suggestions for improvement. Sub-themes for theme two were: self-discipline and overall learning in the course. Each theme and sub-theme is explained in detail in the following paragraphs. Specific quotations from the student surveys are provided to exemplify each theme.

Theme one: Instructional approach

Theme one included student responses from the anonymous survey and university course evaluations that specifically referred to the instruction of the course.

Sub-theme one: Adaptive learning technology

Students overwhelming felt that the adaptive learning courseware enabled them to work at their own pace. When asked, "What do you like best about the course?", 65% of the students mentioned that they liked working at their own pace. One student wrote, "I was able to move through the program at a pace that worked best for me." Another student wrote, "I like that it is self-paced." Thirty percent of the students provided comments related to how the adaptive nature of the instruction positively impacted their learning. One student commented, "I like the adaptive structure because it measures us on what we know instead of the class as a whole and I think this is an easier way to learn instead of having to keep up with everyone."

When asked directly, "Do you like the adaptive nature of the course?", 80% of the students answered "yes." Comments included, "yes, because I can spend more time learning things that I actually already need to work on and less time learning things I already know" and "yes, I struggle with math so I'm not holding anyone back." Five percent of students answered "no." Comments included, "no, there isn't enough time to work diligently on a topic you're struggling with otherwise you fall completely behind in the course." Fifteen percent of students answered "yes and no" citing reasons such as, "I like that it is online, but I struggle to learn all of this on my own."

Sub-theme two: Course structure

Students were asked, "What would you like to change about the course?" Twenty-six percent responded nothing. Seventy-four percent provided comments related to the structure of the course. Responses included references to pacing (the course took place during a 6-week summer session), lowering the weekly time goal, requiring office hours, providing more lecture videos, and not requiring the final exam to be taken on campus. Illustrative comments included, "I wish I was required to meet with my instructor once a week" and "If the course is only going to be in a 5-6 week time span, some of the material should be left out. If that can't happen, the course should be longer. Monday-Friday I spend an average of 5 hours a day working on the [Aleks] pie, yet I still struggle to meet the deadlines."

Theme two: Self-evaluation of learning

Theme two included student responses from the anonymous survey and university course evaluations that specifically referred to the instruction of the course.

Sub-theme one: Self-discipline

Students were asked, "What steps could you take to improve your own learning in this course?" Seventy-five percent admitted that they need to spend more time working on the course material. For example, one student said, "I should have invested more time and focused more and taken the opportunities to get help." Ten percent said that they were satisfied with their learning", and 15% identified resources that they did not take advantage of such as "office hours" and "online lecture videos".

Sub-theme two: Overall learning

The majority (81%) of students rated their overall learning in the course as good (19%) or excellent (62%). On the university course evaluations, students were asked to identify how much knowledge they have gained in the subject matter during the summer session. Forty-eight percent of students chose "quite a lot", 24% chose "more than average", 24% chose "some", and 4% chose "very little".

Implications

The purpose of this study was to describe students' perceptions of the adaptive teaching approach used in their online college algebra course. Preliminary results indicated that students felt that the teaching approach allowed them to adjust the pace of the course to accommodate their individual learning needs. In addition, students liked that they could focus their energy on topics that they found difficult but did not have to spend time on topics that they already knew. However, many students still wanted their instructor to control the learning environment to some extent as they admitted to not taking the initiative to seek help or study on their own when it was not required.

Students appreciated the opportunity to work on topics while not feeling as though they were holding other students back. This outcome is consistent with findings from (Ames & Archer 1988) which found that when students were engage in the learning process and were working toward their own mastery goals rather than competing for high grades and out-performing other students, their motivation to learn improved. By focusing on mastery-goals, the instructor can provide an environment where potentially less motivated students feel safe. The incorporation of adaptive learning technologies should be studied more rigorously. Although this study has provided a glimpse into student perceptions regarding its use, more work is necessary to further examine a possible relationship between student motivation and the use of adaptive learning technologies in the instruction of undergraduate mathematics courses.

Questions for Audience

1. Do you have experience using adaptive learning technologies in your undergraduate mathematics courses? If so, do you have any recommendations for implementation?

2. Do you know of other studies that discuss the use of adaptive learning technologies in mathematics courses?

3. Do you know of other studies that connect the use of adaptive learning technologies with mastery-goal orientation?

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