

## A Case Study of Students' Motivation in College Algebra Courses

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This paper examines data from a larger study that focused upon students' experiences and motivations in a college algebra course. The study revealed that students failed this course because of various factors and continued to view this course as a “gatekeeper” class. Through a stepwise multiple regression, the analysis of the ARCS instrument showed that Attention, Relevance, and Confidence were strong predictors of Satisfaction in the course.

College algebra is a three credit-hour course in which students enroll for program entry requirements or for completion of the associate degree in arts (AA). Students are placed in the course based on several factors: completion of a developmental mathematics program, completion of algebra I and algebra II in high school, college placement test scores, SAT (Scholastic Aptitude Test) or ACT (American College Test) scores, or dual-enrollment courses. In the fall of 2000, there were more than 400,000 students enrolled in college algebra at community colleges throughout the United States (Small, 2002). Currently, state-led emphasis on higher education has encouraged more people to pursue a college education, and college algebra—as a required course for graduation—has consequently increased enrollments proportionally. However, the passing rate for the course has traditionally been low. Further, a national call to address the high failure rate in college algebra set forth an expectation of improved student performance (Bargagliotti, Botelho, Gleason, Haddock, & Windsor, 2011). These circumstances compel inquiry into how to support student learning of college algebra.

According to Berry (2003), “Students with the ink barely dry on their high school diplomas enroll in college but find themselves back in high school level (or lower) remediation courses. What has gone wrong?” (p. 393). College algebra is a prerequisite course for most majors, but many students fail to earn the credit in the first attempt and view the course as a “gatekeeper” for degree completion (Reyes, 2010, p. 256). Unfortunately, there is an alarmingly large number of students who repeat college algebra three, four, five, or even six times (Reyes, 2010). Retaking the course delays graduation and increases entrance time to four-year institutions (Packard, Gagnon, & Senas, 2012).

It is a challenge to help students earn satisfactory grades. Research suggests an association between students' performance in college algebra and their college readiness in the areas of

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mathematics (Li, Uvah, Amin, & Okafor, 2010). A highly problematic situation for teachers of these courses is that students come from various experiences and educational backgrounds and have different goals. This fact calls for additional research in understanding student needs. At Northeastern Community College (pseudonym), the college algebra course enrollment was 1,500 students for the fall term of 2009. Of these students, 244 withdrew, and only 54% of the remaining students passed the class with a grade of C or above. The passing rate was consistent with comparable national data (Berry, 2003), pointing to the need for course restructuring. With this intention, the researcher conducted a large study to investigate how teachers can understand and influence student motivation in college algebra to support their learning.

The following was the primary research question of the larger project: How do teachers use their knowledge of students to plan tasks that motivate them to engage in meaningful ways with the intended mathematical tasks regarding the concept of function in a college algebra course? Data were drawn from a large study contextualized at a community college in the southeastern United States. This paper reports on the data drawn from the aforementioned larger study focusing on students' experiences and motivations by addressing these research questions:

1. What are students' experiences in the college algebra course?
2. How do students' experiences influence their motivation in the ARCS (Attention, Relevance, Confidence, and Satisfaction) framework?

## THEORETICAL FRAMEWORK

Motivation is the study of "why people think and behave as they do" (Graham & Weiner, 1996, p. 63). Brown (1988) indicated that future research should take motivational and emotional aspects of learning seriously. Any type of instruction can be beneficial from multiple perspectives and enable "researchers and teachers to assume different points of view, in order to better understand students' behaviors" (Zan, Brown, Evans, & Hannula, 2006). Paas, Tuovinen, van Merriënboer, and Darabi (2005) argued that meaningful learning can occur only if it is coupled with motivation. They suggested applying motivational perspective in teaching in order to "identify the task characteristics that motivated students to invest more mental effort and achieve higher performance" (p. 31). Moreover, they indicated that a motivational perspective can broaden the "horizon of cognitive load researchers, and contribute to optimization of learner involvement in instructional conditions" (p. 32). McLeod (1992) asserted, "research in mathematics education can be strengthened if researchers will integrate affective issues into studies of cognition and instruction" (p. 575).

One fundamental goal of the larger project, from which the data for this article were obtained, was to look at students' experiences and their motivation; therefore, motivational perspective is an appropriate framework for analysis on how students' experiences could influence their motivation. Particularly, the researcher employed Keller's (2010) ARCS framework that originated from a set of first principles of motivation that Keller developed in 1979. In 1983, Keller (2008a) elaborated on these first principles in four primary areas; (a) gaining learner attention, (b) establishing the relevance of the instruction to learner goals and learning styles, (c) building confidence in regard to realistic expectations and personal responsibility for outcomes, and (d) and making the instruction satisfying by managing learners' intrinsic and extrinsic outcomes. The ARCS model was later expanded to include volition and self-regulation (Keller, 2008b):

1. Motivation to learn is promoted when a learner's curiosity is aroused as a result of a perceived gap in current knowledge. It became important to use a variety of instructional materials such as interesting graphics and animation. Also, teachers must maintain attention after capturing it. After gaining attention, it must be sustained.
2. Motivation to learn is promoted when the knowledge to be learned is perceived to be meaningfully related to the learner's goal. This idea falls in the relevance category, which emphasizes content, teaching strategies, social organization, learners' goals, learning styles, and experiences.
3. Motivation to learn is promoted when learners believe they can succeed in mastering the learning task. Mastering the learning task is in the confidence category, which relates to students' feelings of personal control and expectancy for success.
4. Motivation to learn is promoted when the learner anticipates and experiences satisfying outcomes to a learning task. The fourth category is satisfaction. Satisfaction is necessary for learners to have positive feelings about their experiences and to develop continuing motivation to learn.
5. Motivation to learn is promoted and maintained when learners employ volitional (self-regulatory) strategies to protect their intentions. After becoming motivated to achieve a goal, we have to persist in the effort to achieve; the focus of the fifth principle. At this point, people are able to overcome different obstacles and maintain their attention. This ability tends to employ volition or self-regulatory ability.

Keller (2008a) asserted that the learning environment is maximized only when the motivational characteristics of the students are identified and, subsequently, methods for strengthening their areas of weakness are determined. Keller (2010) developed ARCS instruments from the ARCS Model. The Course Interest Survey (CIS) is one of two distinct ARCS instruments. The CIS measures students' motivations in terms of attention, relevance, confidence, and satisfaction. The intent of the instrument is to identify how the teacher motivates students by capturing and maintaining their attention, presenting the content so that it is relevant to their lives, and it builds students' confidence levels and the achievement of students, which leads to increased satisfaction.

## METHODOLOGY

The researcher used intrinsic case study as a method of inquiry to get a good concentration of information. As a result of the researcher's interest in this particular course and what can be learned about students in college algebra courses, the study focused upon this population. The researcher chose case study as a main method of inquiry with the intention of learning from each case. Stake (2005) stated, case study "draws attention to the question of what specially can be learned about the single case" (p. 443). Stake (2005) also suggested that "optimizing the understanding of the case requires meticulous attention to its activity on: issue of choice, triangulation, experiential knowledge, contexts, and activities" (p. 444).

This case study is characterized by the researcher spending extended time on-site at the community college observing students (Stake, 2005). In this way, researchers are personally in contact with activities and operations of the case, reflecting and revising descriptions, and continually discovering meaning in what is observed. Intrinsic case design draws the researcher toward understanding "what is important about that case within its own world" and aims to develop

what is perceived to be the case's own issues (p. 450). Stake (2005) also stated that researchers conducting intrinsic case studies do not avoid generalization: "they cannot" (p. 450). Researchers engaged in intrinsic case study expect their readers to comprehend their interpretations and also draw conclusions on their own. Understanding of the case could be optimized by addressing the five requirements: issue of choice, triangulation, experiential knowledge, context, and activities (Nguyen, 2011).

The researcher employed a qualitative mixed methods design to address the two research questions. The study was conducted at Northeastern Community College ([NCC], a pseudonym). The NCC student population was approximately 13,000. During this study (summer of 2010), 613 students were enrolled in college algebra. Eleven full-time and part-time faculty members instructed the various course sections. After securing the support of the Dean of the Department of Science and Mathematics, the author contacted all the college algebra teachers by e-mail and in-person to recruit participation. All teachers agreed to assist with survey administration to students. Three teachers agreed to allow access to their classes for observations and to grant interviews. Data collected from the study included surveys, interviews, classroom observations, and artifacts. This research protocol was approved by a university Institutional Review Board.

A demographics survey was designed to describe the student population. The survey included both multiple choice and short response items. The short response questions allowed students to share their experiences and views of learning mathematics (Nguyen, 2011). Of all the students who were notified of the study, 72% returned a completed demographics survey. The researcher also interviewed students to gain an in-depth understanding of their comprehension of the content in college algebra as well as their experiences, educational backgrounds, and motivations. A course interest survey was administered soon after students completed the first unit test in the course.

## Participants

Data were drawn from a large study contextualized at a community college in southeastern United States with an enrollment of approximately 13,000 students. There was an average of 1,500 students enrolled in college algebra in the fall and spring semesters. At the time of the study, 613 were students enrolled in college algebra, and they were instructed by 11 teachers. Student ages ranged from 18 to 57. Fifty-three percent of students were between 18 and 22 years old. Thirty-three percent of the students responding were older than 22 but younger than 30 years old. Eight percent of the students were between 30 and 40 years old. Fifty-four percent of students reported they were female, but only 25% reported they were male.

## Survey instruments and administration

### *Demographics survey*

The researcher developed a demographics survey to study student background, age, enrollment status, time gap between the last mathematics course and college algebra, as well as the course that each student planned to enroll in next (Nguyen, 2011). Additionally, a list of short questions was asked that related to the four components of the ARCS model. The survey was sent to all college algebra teachers for distribution to their students, but one teacher did not participate. A total

of 467 students from participating teachers were informed about the survey, and 336 responded: a response rate of 72%.

### *Course interest survey*

The purpose of the course interest survey was to measure student reactions to the course. It could be used in face-to-face classroom instruction or in both synchronous and asynchronous online courses that were facilitated by a teacher (Keller, 2010). The internal consistency estimates, based on Cronbach's alpha, were satisfactory: Attention (.84), Relevance (.84), Confidence (.81), and Satisfaction (.88). The CIS survey has 34 questions that were categorized into the four components of Attention, Relevance, Confidence, and Satisfaction of the ARCS framework. Sample items from the survey are listed below:

1. The students in this class seem curious about the subject matter (Attention, Item # 15).
2. The things I am learning in this course will be useful to me (Relevance, Item # 3).
3. I feel confident that I will do well in this course (Confidence, Item # 2).
4. I feel that this course gives me a lot of satisfaction (Satisfaction, Item # 12).

Students completed the course interest survey at the beginning of the semester after they had completed the first exam in the course. In addition to administering the survey, three teachers had allowed the researcher to observe their classes and have their students complete the course interest survey in addition to the demographic survey. All surveys were administered through a university's online survey database.

### *Student interview instrument*

The student interview items were divided into three sections: (a) student background; (2) mathematics content questions related to functions (Carlson, 1998); and (c) student motivation in mathematical tasks created by the teachers. Related to the survey items of the third section, Ryan and Deci (2000) postulated that students are motivated to learn if the teacher meets their psychological needs to learn. Interview questions focused on student background were constructed with an attempt to understand the students' psychological needs, their understanding of mathematical concepts, experiences, and motivation.

### *Classroom observations*

Classroom observations took place throughout the semester, an ongoing process. For each new note, the researcher electronically compiled and used in vivo coding. These codes were then arranged into categories using an Excel spreadsheet. From this category, the researcher further identified themes that emerged, for example, how a teacher built material in a way that made the material relevant to students. The researcher used multiple data sources that were comprised of what students shared (Nguyen, 2011). The researcher then combined the field notes or memos from the teacher. Additionally, if anything was not clear, the researcher would member check participants during classroom visits.

## Data analysis

Completed demographic surveys were analyzed by predefined category, and short answer responses from the survey were constantly compared with other data sources (Miles & Huberman, 1994). The results from all data sources were analyzed with open coding (Strauss & Corbin, 2003). During this process, data were read line-by-line, assigned codes, and recorded in an Excel spreadsheet. If a response appeared not to fit the codes, a new coding scheme was created. After all the data were coded, the researcher related these codes into categories and grouped these categories to find a common theme to describe the phenomenon. Later in the analysis, quantitative data were analyzed to align with the qualitative results for triangulation. Because data were interpreted from the researcher's perspectives and experience, which might be different from those of participants, the researcher employed member checks with participants through follow-up interviews and debriefings. According to Tobin (2000), the purpose of member checks is to test the accuracy of the researcher's interpretation.

After all the data were coded, the researcher related these codes into categories (axial coding) and then grouped these categories to find the common theme to describe a phenomenon. Later in analysis, the researcher compared qualitative findings with the quantitative results to enhance validity. The researcher employed ongoing data collection to ensure the opportunity to obtain information that the researcher might have missed during the collection process. Case studies include many data sources; hence, the researcher used a research design of constant comparison method (Strauss & Corbin, 2003). Strauss and Corbin (2003) suggested that this method enables the researcher to identify variations that could be found in the data under different conditions. This method was used early in the study and continued until nearly the end of the data collection (Bogdan & Biklen, 2003; Miles & Huberman, 1994). Interpretation of the result was triangulated with a faculty member of the community college who held a doctorate in mathematics education and with a doctoral student of educational psychology.

### *Statistical analysis of the course interest survey instrument*

The course interest survey was organized by the four categories of the ARCS model: Attention, Relevance, Confidence, and Satisfaction before using the stepwise multiple regression. According to Keller (2010), the survey is a situation specific measure, so there is no expectation of normal distribution of the responses. All raw scores were reserved based on Keller's (2010) scoring rubrics. Because there are an uneven number of questions in each of the four categories: Attention (8), Relevance (9), Confidence(8), and Satisfaction (9), the researcher found the sum of each category. The Relevance and Confidence categories had a different number of questions, so they were weighted differently.

## RESULTS AND DISCUSSION OF KEY FINDINGS

By examination of the age group data, the researcher found that 53% of students completed an algebra course in secondary schools, but they did not have the prerequisite knowledge to be enrolled in the college algebra course. Consequently, they viewed the course as a "gate keeper." Additionally, the following were found:

- Approximately 50% of students passed the course with a C- or above.
- Students have negative experiences in this course due to various factors: time constraints, volume of assigned work, lack in prerequisite knowledge.
- The majority of students enrolled in this course in order to complete their AA degree and complete their program entry. Failing this course will delay their graduation.
- Student satisfaction in the course depends on how a teacher captured their attention, built the content so it is relevant to their lives, and helped maintain their confidence.

The following sections report the highlights from the two research questions.

### Question 1: What are students' experiences in the college algebra course?

The demographic survey results revealed that a large group of students repeated the course. Only 56% of students reported that they were enrolled in the course for the first time. Thirty-one percent were enrolled for the second time, and 3% were enrolled for the third time. [Figure 1](#) summarizes these data.

Of this group of students, 40% intended to take an additional mathematics course, thus demonstrating the criticality of improved performance (see [Figure 2](#)). Fourteen percent planned to enroll in trigonometry, 17% planned to enroll in precalculus, 11% planned to enroll in business calculus, and the remaining students planned to take liberal arts mathematics.

Students' grade expectations and their actual grades were not aligned (see [Figure 3](#)). Fifty-four percent of students expected to receive a letter grade of A in the course, 37% expected to receive a B, and 9% expected to receive a C. A failing rate exceeding 50% is not uncommon for college algebra (Berry, 2003).

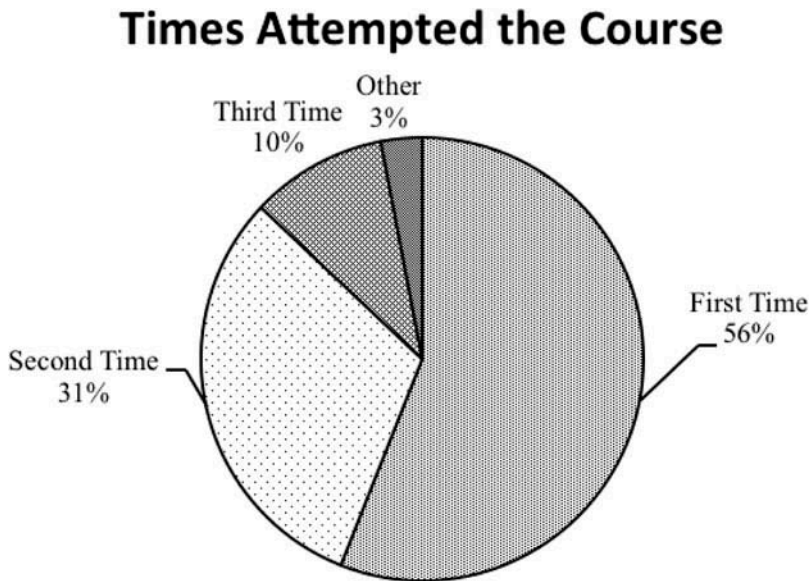


FIGURE 1 Number of times students enrolled in college algebra.

### Sequential Course

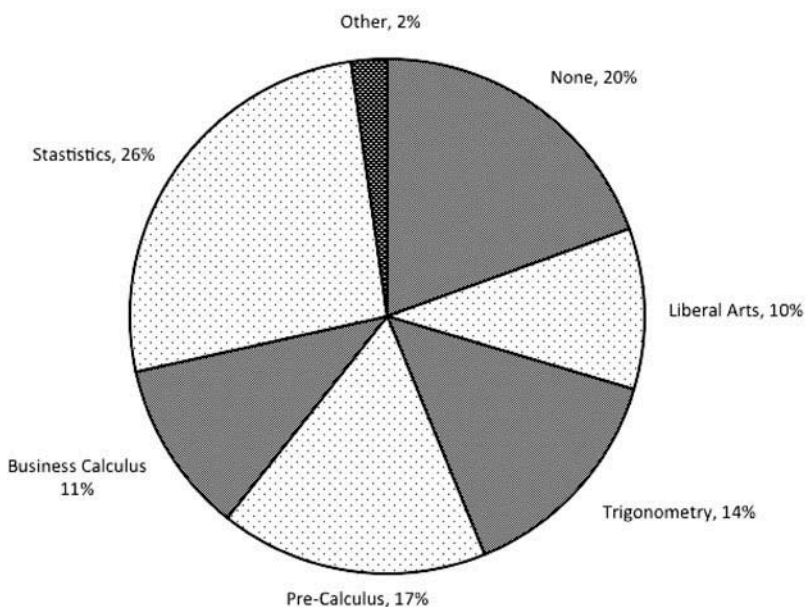


FIGURE 2 Sequential course after passing college algebra.

### Grade Expectation

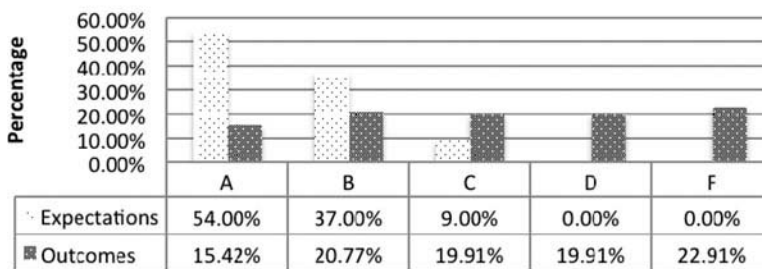


FIGURE 3 Grade expectation of college algebra students (Summer 2010).

At NCC, college algebra was designed as a prerequisite for other mathematics courses including precalculus, trigonometry, and business calculus. However, a large population of the college algebra students was enrolled to fulfill the liberal arts mathematics requirement. The researcher observed many students enrolled in the course instead of the liberal arts mathematics course. Similarly, the demographic survey results showed college algebra to be the “last math course” for a majority of the students.



College algebra was taught in various formats. Most of the courses were taught face-to-face with online homework and quiz components. These courses were also taught as hybrid, online, or self-paced. Some course sections were offered in a six-week session rather than the full summer semester. Students of the short-term sections reported frustration because they had more to learn in a shorter time. In the free response section of the demographics survey, researcher provided students opportunities to offer additional comments about the college algebra course.

Students reported that they were overwhelmed with the pace of the course. They were concerned about the amount of material “jammed” into a short period of time. They reported that there was too much work for the amount of time they were able to devote to the course and that they were unable to learn as a result of the workload. One student made the following remarks: “It’s almost ridiculous to expect that we are fully capturing all that we need to learn.” Consequently, students felt their teachers just “threw [around] the material and could[n’t] care less most of the time.” Students suggested that the course not be offered as a six-week section. One student stated the school was “ripping off” students by offering the course in this impossibly short time frame. Students viewed this college algebra course as difficult mainly as a result of the time constraint. They felt the need for “more simple ways to recognize formulas and how to apply them.” One student shared the following statement about his experience in college algebra:

I am a combat veteran of both Iraq and Afghanistan. During this time I had some of the most frightening experiences of my life coupled with the most miserable living conditions tolerable by sane human beings. Often, while daydreaming in college algebra the thought occurred to me that I enjoyed those experiences much more than I do sitting in front of a math teacher.

Who would have imagined that students could claim their experience in a class was more frightening than serving during war? Unfortunately, many students had negative experiences with college algebra. One student perceived the teacher’s attitude to be dismissive and, therefore, felt that the teacher was unapproachable. The student reported, “My last college [algebra] teacher was very unapproachable and made me feel like I was as dumb as a rock on the ground . . . NOT GOOD.” Another student who was not fully satisfied with his experience in the college algebra course and who also repeated the course made this statement:

[I] was not very satisfied except for instruction in MAT 1033 [Intermediate Algebra]. Previous attempts of 1105 [College Algebra] at NCC were with instructors . . . in addition to personal issues, led to my withdrawal from the classes.

Students’ experiences perpetuated the view of college algebra as a gatekeeper course. They argued that students took the course to get their associate of arts degree with little care about the content. Another student shared, “I just want to pass this class. This is my last class before I get my AA and I just want to move on to other things in my life.”

Beyond the heavy workload of the course, some students reported they simply were not prepared to be in the course. They felt that college algebra was too large a leap from MAT 1033 Intermediate Algebra (the prerequisite course). As a result, students also felt that teachers should teach the college algebra course as if college algebra were students’ first mathematics course instead of “assuming that students know everything.” One student shared this concern:

Well, this class is exceptionally fast-paced [sic] which scares me. I hope that most of the material we cover in this class was covered in Intermediate Algebra. But, one thing that our instructor keeps saying, “This is review.” It isn’t for me. I have never in my life seen some of the equations and

formulas that we are now working with already. So, [sic] I just plan on asking questions and doing the best I can.

The teachers reported high absenteeism rates but had to continue presenting course material in order to cover the course curriculum. The curriculum mandated the quantity of the work, and teachers felt pressured to persist in the rapid pace of the course. One of the teachers was asked if he considered students' knowledge in his planning and he answered "no." Another teacher shared this response:

You consider it as much as you can, but we have a departmental curriculum. I mean it is not a choice; there is a certain place that you have to get these kids to [sic]. What you can't do is . . . go back for five people, review a course, and not complete the current course for the other 35 people. So, you have to reach your point and say, "Ok, this is where I know we need to get, based on the departmental curriculum. We have to get here . . . if students come up to me the first day in and said "I had no idea what you did," a lot of time I would say "when did you take [Intermediate Algebra]? Oh? Ten years ago . . ." I tried to give them suggestions, but you can't slow down for those people.

Students' lack of prerequisite knowledge for the course influenced their views of mathematics. Their tolerance for mathematics was limited, and they wanted a quick way out. One student commented, "I just need problems worked out for me; when I write down the steps, I remember how it was worked out." Best practice suggests that students should be taught problem-solving and critical thinking skills over rote-memorized routines. The comment is indicative of the student's low motivation and possibly high frustration.

Some students reflected positively on the course. One student shared:

I've often felt that if I could understand how these proofs, formulas, and processes were discovered, I'd understand the entire idea much better. When the professor in my current class, instead of just throwing the distance formula at us, walked us through how it was DERIVED, I was ecstatic. I still remember it, [sic] since I understand why the different elements of the formula go where they do. Also, the fact that Dr. Mathews [pseudonym] seemed to care more about us learning the math than testing us was a huge boon.

## Question 2: How do students' experiences influence their motivation in the ARCS framework?

Although this previous student's response does not represent the majority of students' feelings, it does provide substantiation that teachers of college algebra can influence students' motivation toward learning mathematics (Nguyen, 2012). Nguyen analyzed multiple cases (five students) for insight on how they believed their teachers had motivated them to learn. Those five are; (a) an A student, (b) a B student, (c) a C student, (d) a student who had previously withdrawn from the course, and (e) a student who had previously failed the course. These five students had negative experiences in mathematics from grade school and had given up their motivation to learn mathematics for years, a change which traced back to elementary school. However, their college algebra teachers had the power to "renew" their motivation to learn mathematics through enactment of motivational strategies (Nguyen).

Promoting and sustaining student motivation in the learning process has four components (Keller, 2010): Attention, Relevance, Confidence, and Satisfaction. Achieving the first three motivational goals motivates students to learn; but for them to have a continued desire to learn,

they must feel satisfaction with the learning process and the results of the learning experience. Extrinsic factors, such as grades and opportunities for advancement, could result in satisfaction. The study results showed that only 54% of students completed the course with a letter grade of C or higher, a fact which could have diminished the satisfaction level in students. This result confirmed the historically low passing rate in the course.

On the contrary, intrinsic factors, including sense of accomplishment, competence, and mutual respect, enhanced some students' feelings of self-esteem. If a teacher's actions and behaviors fulfilled the first three categories, students completed the course with satisfaction. In exploring the relationship between these categories, there was a statistically significant positive correlation between the three motivational categories (Attention, Relevance, and Confidence) and Satisfaction.

To further understand underlying constructs contributing to students' motivation levels in the college algebra course, the researcher used a stepwise multiple regression to determine significant predictors of students' satisfaction levels as measures of motivation. The researcher used the four components of the ARCS instrument for the statistical analysis. The scoring for each of the four components was based on Keller's (2010) scoring rubrics. Each of three independent variables (Attention, Relevance, and Confidence) was considered individually and in combination for performing the multiple regression analysis (Meyers, Gamst, & Guarino, 2013). Specifically, Attention, Relevance, and Confidence were used in the analysis to predict Satisfaction. The correlations between each of the variables were statistically significant (see Table 1).

Results of the stepwise multiple regression analysis are presented in Table 2. The prediction model contains all three of the predictors (Attention, Relevance, and Confidence) and was reached in three steps with no variable removed. The resulting multiple  $R$  value for the regression model was found to be  $R = .86$ . The model was statistically significant, and accounted for approximately 73% of the variability in Satisfaction ( $R^2 = .730$ ,  $F(3, 71) = 64.099$ ,  $p < .001$ ).

Satisfaction was primarily predicted by the three categories. In this model, Relevance received the strongest weight followed by Confidence and Attention. The unique variance explained by each of the variables indexed by the squared semipartial correlations was relatively low: Relevance, Confidence, and Attention accounted for approximately 6%, 7%, and 2%, respectively (see Table 2). The dependent variable was Satisfaction,  $R^2 = .855$ , Adjusted  $R^2 = .73$ .  $SR^2$  is the squared semipartial correlation.

In a learning context, Attention relates to how teachers manage and direct learners' attention. Therefore, the motivational concern is capturing and sustaining attention (Keller, 2010). Keller suggested that students need to believe instruction is related to their personal goals and must

TABLE 1  
Correlations Between ARCS Categories

<i>Measure</i>	<i>Attention</i>	<i>Relevance</i>	<i>Confidence</i>
Attention		0.753**	0.535**
Relevance	0.753**		0.667**
Confidence	0.535**	0.667**	
Satisfaction	0.698**	0.798**	0.738**

Note. ( $n = 75$ ), \*\* $p < .001$

TABLE 2  
Stepwise Multiple Regression

<i>Model</i>	<i>b</i>	<i>SE-b</i>	<i>Beta</i>	<i>Pearson r</i>	<i>sr<sup>2</sup></i>
Constant	-3.919	2.876			
Relevance	0.409	0.106	0.411	.798	0.057
Confidence	0.433	0.100	0.359	.738	0.071
Attention	0.186	0.089	0.196	.698	0.016

feel connected to the setting before they are motivated to learn. Similarly, if students believe the course content is relevant, then they are invested in the learning process. On the other hand, their motivation to learn may be depressed or nonexistent as a result of a low level of confidence to perform or low expectations of success. Students could have a well-established fear of the topic that prevents them from learning effectively. Conversely, they may believe that they already know the content, and consequently, overlook important details in the learning activities. For these situations, Keller suggested that teachers must design instructional materials and learning environments to address students' behavior and reinforce learner self-efficacy.

## IMPLICATIONS AND FUTURE RESEARCH

This study contributes to the relevance of theories of motivation and to the understanding of student success and motivation in college algebra. It is hoped that such information will lead to increased instructional effectiveness. According to Ryan and Deci (2000), the three constructs for success in promoting student self-determination to learn in school are the essential psychological needs of competence, autonomy, and relatedness..

The examination of the results of students' experiences in college algebra in this study leads to the suggestion that teachers, for the purpose intervention, should determine student motivation early in the semester. Instruments, such as the Course Interest Survey, are available to determine student competence and interest. College algebra curriculum developers should consider modifying the designed curriculum to provide support for student learning. There is evidence from the present study that calls for such modification. Some useful motivational strategies should be enforced to help students overcome difficulties and move forward in the course or to the next level (Nguyen, 2012). However, it is possible that interventions based on the survey results might provide students with advisement on their degree program choices and, as well, the degree of commitment necessary for success. Student information collected early in a course empowers the teacher with critical knowledge of students, knowledge that can be used to meet students' needs in a variety of ways.

The results of this study demonstrate that college algebra students have needs that must be addressed. Understanding students' prior experiences can inform mathematics educators and researchers of appropriate actions to support those needs. Meeting students' needs from the beginning of the course helps students to be more self-determined (Ryan & Deci, 2000). Although a teacher cannot alter the course curriculum to consider students' experience and prerequisite

knowledge, they can make appropriate advising decisions in regard to individual student circumstances. It is recommended that professional development designed to address these needs be provided for community college mathematics teachers. Supporting teachers is critical to their ability to support students.

In summary, the students enrolled in this study have provided an indication of the criticality of the problem in college algebra. However, the literature on reform in mathematics education is limited with regard to instruction at the community college level. It is a reasonable assumption that students enrolled at community colleges will transfer to universities to continue their education. The National Science Foundation (NSF) reported that approximately half of the nation's college students pursuing a degree in STEM (science, technology, engineering, and math) fields begin at community colleges (Tsapogas, 2004). Concern about mathematics instruction as a whole necessitates that community college mathematics issues receive equal attention in the research. By preparing students for success in college algebra, mathematics teachers can provide students with sufficient knowledge to progress to the next academic level, whether that level is for academic transfer, vocational school, technical training, or otherwise. These students require intervention to be successful in college algebra, and perhaps, to pursue other mathematics and science related fields (Packard et al., 2012). Hannula (2006) claimed that the realization of needs, as one of the goals in the mathematics classroom, is influenced by students' beliefs about themselves, as well as by their beliefs about mathematics and learning. He suggested using a motivational system as a lens for looking at mathematics behavior. Further, mathematics educators need to look at ways of motivating students to move forward and provide support to help them do well in the course.

This study revealed that there is much more to do to support mathematics students. College algebra is widely considered a gatekeeper course and is a prerequisite for many postsecondary courses and majors. Many of students who participated in this study had to take the course more than once. The frustrations that students experienced call for different types of support as indicated by earlier research (Sierpinska, Bobos, & Knipping, 2008). Understanding students' experience in this course suggested that it is time for researchers to "treat students as partners" (p. 317) in teaching and research (Even & Tirosh, 1995) and that ". . . college creates learners as full partners in the learning process, assuming primary responsibility for their own choices" (O'Banion, 1996, para. 10). Research on teaching and teachers has been following separate tracks for a long time. This study suggests that it is time for colleges to align with O'Banion's (1996) six principles of learning colleges:

1. The learning college creates substantive change in individual learners.
2. The learning college engages learners as full partners in the learning process, assuming primary responsibility for their own choices.
3. The learning college creates and offers as many options for learning as possible.
4. The learning college assists learners to form and participate in collaborative learning activities.
5. The learning college defines the roles of learning facilitators by the needs of the learners.
6. The learning college and its learning facilitators succeed only when improved and expanded learning can be documented for its learners.

Many of the students in this study were not fully motivated because they found the material irrelevant to what they were doing. Furthermore, their confidence may have been diminished

because they did not do well on exams. According to Keller (2010), students are motivated to learn when they believe that the instruction is related to important personal goals and motives and when students feel connected to the learning environment. Keller also suggested students' motivation to learn is enhanced when the teacher achieves the first three motivational goals. However, for students to possess a continuing desire to learn, they must also have a feeling of satisfaction with the process or the result of the learning experience. The stepwise multiple regression showed that Satisfaction was predicted by the three categories of Attention, Relevance, and Confidence.

It is hoped that the present study will provide a foundation for future research aimed at understanding student motivation in college algebra. Understanding student motivation allows the teacher to design tasks and interventions to improve student learning (Keller, 2010), especially at the early college level, where students are more likely to give up. As Schoenfeld (2000) suggested, a primary purpose of mathematics education research is to understand the nature of mathematics thinking, teaching, and learning to guide improved mathematics instruction.

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