Attitudes and Achievement in a Self-Paced Blended Mathematics Course

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Blended learning opportunities are expanding for K-12 students in public school settings. As these opportunities increase, researchers and educators seek to discover specific characteristics of the students who are most successful in blended learning environments. The purpose of this study was to investigate the relationship between students' achievement and their attitudes in a self-paced blended mathematics course. A total of 23 high ability eighth grade students participated in the study by completing the Measures of Academic Progress Mathematics Test and the Attitudes Toward Mathematics Inventory to examine the relationship between achievement growth during the course and attitudes at the end of the course. Findings revealed a significant positive correlation between achievement growth and attitudes toward mathematics. Achievement growth was also significantly positively correlated individually with each of the four attitudinal factors studied: value, motivation, enjoyment, and self-confidence. Furthermore, there were significant positive correlations between each of the individual attitudinal factors and overall attitudes toward mathematics. This research demonstrates that high ability students with the most positive attitudes toward mathematics may be more successful in self-paced blended mathematics courses. This is an important step in discovering which students are best suited for this learning environment.

ATTITUDES AND ACHIEVEMENT IN A SELF-PACED
BLENDED MATHEMATICS COURSE

Digital learning has grown rapidly for many years. Recently, this growth has shifted from online learning to blended learning, which fuses online and face-to-face formats. As K-12 blended learning quickly expands, it becomes increasingly important to determine which students are best suited for the blended learning environment. When determining which students will be most successful in blended learning, it is important to consider students' attitudes. This is because students' attitudes are critical to learning in mathematics (Kim, Park, & Cozart, 2014). Studies suggest attitudinal factors, such as self-efficacy, enjoyment, and boredom, significantly contribute to a student's success in a course (Tempelaar, Niculescu, Rienties, Gijselaers, & Giesbers, 2012; Kim et al., 2014), and can also affect a student's memory and recall of knowledge pertaining to a course (Kim et al., 2014). Although these previous findings suggest a relationship between attitudinal factors and academic success, further research is needed to explore the relationship between attitudes toward mathematics and success in math courses (Deshler & Fuller, 2016), especially for high ability students.

The purpose of this study was to investigate the relationship between achievement and attitudes toward mathematics in a self-paced blended course designed for high ability eighth grade students. This study included two research questions:

1. What is the relationship between achievement growth during a self-paced blended mathematics course and high ability middle school students' attitudes toward mathematics?

2. What is the relationship between achievement growth during a self-paced blended mathematics course and high ability middle school students' value of mathematics, motivation, enjoyment of mathematics, and self-confidence?

The study used the following null and alternative hypotheses:

H_0: There is not a statistically significant correlation between achievement growth and attitudes toward mathematics.

H_A: There is a statistically significant correlation between achievement growth and attitudes toward mathematics.

H_0: There is not a statistically significant correlation between achievement growth and individual attitudinal factors: value, motivation, enjoyment, and self-confidence.

H_A: There is a statistically significant correlation between achievement growth and individual attitudinal factors: value, motivation, enjoyment, and self-confidence.

THEORETICAL FRAMEWORK

This study was guided by self-efficacy theory. *Self-efficacy* is the way people perceive their own abilities and their level of confidence in those abilities (Bandura, 1977). Self-efficacy is formed by experiencing successes and failures (Bandura, 1993). People's belief in their own abilities has significant effects on their perseverance with academic tasks (Bandura, 1977). When people with high self-efficacy fail, they believe it is due to lack of effort; when those with low self-efficacy fail, they believe it is due to lack of ability (Bandura, 1993). Furthermore, self-efficacy can determine an individual's level of motivation and academic achievement (Bandura, 1993), and students with greater motivation tend to perform better in math (Kim et al., 2014). Self-efficacy is a significant factor that mediates the relationship between motivation and math achievement (Skaalvik, Federici, & Klassen, 2015). Therefore, the implication is that students who are able to improve academic achievement in mathematics tend to view that subject with a more positive attitude. The following literature further describes the connection between self-efficacy and achievement.

LITERATURE REVIEW

The present study explores the relationship between achievement and attitudes toward mathematics of high ability middle school students in a self-paced blended course. *Blended learning* involves a thoughtful combination of traditional, face-to-face teaching and online instruction (Staker & Horn, 2012). Blended learning can involve many formats including traditional pacing or self-pacing. Instruction is *self-paced* when students learn different objectives at different times determined by readiness. In order to examine mathematics attitudes and achievement in this specific self-paced blended learning context, it is important to understand the purposes and effectiveness of online learning and the goals and use of blended learning. It is also crucial to examine research on attitudes toward mathematics, focusing specifically on how different attitudinal factors are interrelated and how they are related to achievement.

Online Learning

Reasons for taking online courses

Students give various reasons for taking online courses. Public schools frequently use supplemental online courses to serve populations that have smaller enrollment numbers, including high ability students (Olszewski-ki-Kubilius & Corwith, 2010). Reasons for taking these courses most often involve credit recovery or expanded course opportunities (Sanderson & Greenberger, 2011). In one study conducted by the National Center for

Education Statistics (NCES), 62% of districts reported having students enrolled in distance education for the purpose of credit recovery, 47% reported having students in dual enrollment college courses, and 29% reported having students enrolled in Advanced Placement (AP) courses (Queen & Lewis, 2011). Acceleration has long been considered best practice for high ability students (Sanderson & Greenberger, 2011), but small enrollments can make it difficult for schools to offer advanced courses (Howley, Rhodes, & Beall, 2009). Online learning is allowing these students to take courses that their schools are otherwise unable to offer, which is especially important for high ability students (Olszewski-Kubilius & Corwith, 2010; Sanderson & Greenberger, 2011). If online learning is seen as a solution that can expand course opportunities, it is important to ensure that it is as effective as traditional, face-to-face learning.

Effectiveness and appropriateness of online learning

Educators do not agree on the effectiveness, appropriateness, and quality of online education (Rice, 2012). While there are many proponents of online learning (e.g., Edwards, Rule, & Boody, 2013; Headden, 2013; Howley et al., 2009), some believe that this type of education is easier and lower quality than traditional courses (Brown, 2012; Sanderson & Greenberger, 2011). In one study, undergraduate students' most frequently cited reason for choosing an online course over a face-to-face course was the perception that it would be less difficult (Brown, 2012). Sanderson and Greenberger (2011) agree that these perceptions are common; they explain that many K-12 students, parents, and administrators believe online courses require less work and time than face-to-face courses.

Even though some perceive online courses as being easier, studies have shown that students perform similarly in comparable online and face-to-face courses at the undergraduate (Brown, 2012) and high school (Taylor et al., 2016) levels. Research with middle school students has led to similar results. Edwards et al. (2013) found no significant differences in achievement of middle school students between learning mathematics online or face-to-face. Although some studies have found similar performances in these different learning environments, many students are unsuccessful in online mathematics courses (Kim, 2012; Taylor et al., 2016). Thus, it is important to not only measure the success of students in online and blended learning environments, but to also discover the characteristics of students who are most likely to be successful in these types of courses.

The reasons people believe online learning is inferior to face-to-face learning vary. Issues with technology, low levels of motivation for students, and isolation are some of the perceived negative effects of online learning (Rice, 2012). Some say the lack of socialization involved in online

education is a concern (Kim, 2012; Rice, 2012), and research has shown that students receiving personal support in online courses perform better (Taylor et al., 2016). Headden (2013) suggests that blended learning alleviates many concerns presented by online learning's opponents, including the lack of face-to-face contact with a teacher. Blended courses offer more opportunities for collaboration among students and communication with the teacher (Headden, 2013), and Edwards et al. (2013) consider it to be an ideal alternative to fully online or traditional education.

Blended Learning of Mathematics

The goal of blended learning is to combine the advantages of face-to-face and online learning. Online components help to individualize learning and provide the opportunity for all students to be successful (Horn & Staker, 2011). Face-to-face components allow for more collaboration among students and enable them to better interact with their instructor (Headden, 2013).

Studies examining the effectiveness of blended learning indicate mixed results. Research shows no significant differences in achievement for high ability middle school students in a traditional mathematics course versus a self-paced blended course (Balentyne & Varga, 2016). However, studies of other populations have shown blended learning to be more effective than traditional mathematics (e.g., Bottge, et al., 2014; Deshler & Fuller, 2016). Blended learning was more effective with middle school students with disabilities than traditional instruction, and the students who received blended instruction outscored their peers who were enrolled in face-to-face courses (Bottge et al., 2014). Moreover, self-paced blended learning was more effective than traditional instruction for college students taking remedial mathematics courses (Deshler & Fuller, 2016). Several studies have compared outcomes for students in traditional courses to those in blended courses to examine the effectiveness of blended learning (e.g., Balentyne & Varga, 2016; Bottge et al., 2014; Deshler & Fuller, 2016), but few studies have determined the specific characteristics of the K-12 students who will be most successful in blended learning.

Attitudes Toward Learning Mathematics

Attitudes toward learning mathematics are important to consider, especially for middle school students. This age group often experiences negative attitudes toward mathematics (Martinez & Martinez, 2003), making it important to find ways to improve their attitudes. A previous study revealed that high ability middle school students' attitudes toward mathematics significantly improved from the beginning to end of a self-paced blended course (Balentyne & Varga, 2016). These findings agree with Martinez and Martinez's (2003) claims that the use of technology and self-pacing can

promote more positive attitudes toward mathematics in middle school students.

Research has shown that enjoyment and boredom have a significant effect on students' performance in blended undergraduate mathematics courses (Tempelaar et al., 2012) and fully online high school mathematics courses (Kim et al., 2014). Edwards and Rule (2013) conducted a quasi-experimental study comparing middle school students' attitudes in online and face-to-face learning environments. When comparing online instruction and traditional instruction, students reported significantly higher levels of enjoyment from learning online, but there were no significant differences in enjoyment of mathematics between the two modes of learning. This agrees with the study conducted by Balentyne and Varga (2016), which found no significant differences between middle school students' enjoyment of mathematics before and after a self-paced blended course. However, Kim et al. (2014) found a significant correlation between enjoyment and final scores in a fully online high school math course. Furthermore, enjoyment of mathematics positively predicted achievement for upper level elementary students (Garcia, Rodriguez, Betts, Areces, & Gonzalez-Castro, 2010).

Motivation is another attitudinal factor that is crucial for students' academic success. Skaalvik et al. (2015) discovered that Norwegian middle school students with higher intrinsic motivation also had higher grades in their traditional mathematics class. Likewise, research has shown that students with especially high levels of motivation displayed higher achievement than their peers in elementary, middle, and high school (Gottfried, Cook, Gottfried, & Morris, 2005). More research is needed to determine if this relationship between motivation and achievement transfers to the high ability population and the self-paced blended learning environment.

Self-efficacy is another important attitudinal factor to consider, because middle school students often experience a decline in mathematical self-efficacy (Martinez & Martinez, 2003). Skaalvik et al. (2015) discovered self-efficacy to be a strong predictor of grades in mathematics for Norwegian middle school students. Kim et al. (2014) found a significant correlation between final scores and self-efficacy in a fully online high school mathematics course. However, in previous research using pre- and post-attitudes, Balentyne and Varga (2016) did not find a significant improvement in students' self-confidence as a result of self-paced blended learning. These studies provide valuable findings about the relationship between attitudes and performance, but because attitudes toward learning are interrelated (Kim et al., 2014), it is important to look at the relationship between these attitudes as well.

Kim et al. (2014) discovered that enjoyment, confidence, and anxiety are closely related to motivation in mathematics. *Math anxiety* is a student's fear and anxiety associated with the subject area of mathematics. Kesici and Erdogan (2010) discovered that middle school students with higher

motivation displayed increased math anxiety, and they also found that those with low self-efficacy in mathematics displayed increased math anxiety. Furthermore, Skaalvik et al. (2015) determined that self-efficacy was a mediating factor in the relationship between motivation and achievement of middle school students. Students with higher levels of motivation display increased self-efficacy (Gottfried et al., 2005; Skaalvik et al., 2015). Moreover, students with increased self-efficacy and those who value the subject more also report higher levels of enjoyment (Kim et al., 2014).

Although several studies have examined attitudinal factors in mathematics courses (e.g., Kesici & Erdogan, 2010; Kim et al., 2014; Skaalvik et al., 2015), more literature is needed in the area of self-paced blended mathematics for high ability students. A few of these studies were conducted with students outside of the United States (e.g., Kesici & Erdogan, 2010; Skaalvik et al., 2015) where the education system is very different. Additionally, much of the research examining attitudes in mathematics courses has looked at traditional courses (e.g., Garcia et al., 2010; Gottfried et al., 2005; Kesici & Erdogan, 2010; Skaalvik et al., 2015) or fully online courses (e.g., Kim et al., 2014). Edwards and Rule (2013) compared traditional and computer-mediated instruction, but they did not study the effects of blending the two modes of learning. Moreover, few studies have looked at achievement and attitudes in self-paced mathematics courses (e.g., Balentyne & Varga, 2016). Although Balentyne and Varga's (2016) research examined changes in students' attitudes and achievement during a self-paced blended course, the two variables were observed separately, and they did not investigate the relationship between attitudes and achievement.

Some studies have examined the relationship between achievement and attitudes toward mathematics (e.g., Kim et al., 2014; Skaalvik et al., 2015), but they used final grades as an achievement measure, which can have questionable reliability and validity. The present study used an achievement measure with proven reliability and validity. The same instrument was administered both before and after the course to more accurately measure growth. The purpose of this study was to examine the relationship between achievement growth and attitudes toward mathematics during a self-paced blended course designed for high ability eighth grade students. Specific attitudes studied were value, motivation, enjoyment, and self-confidence.

RESEARCH METHODS

This study employed a quantitative research design. Participants were a group of high ability middle school students taking a self-paced blended mathematics course. Since pre- and post-attitudes and achievement have been previously examined (Balentyne & Varga, 2016), this study focused on exploring the relationship between achievement growth and attitudes

towards mathematics at the end of the course. Scores at the end of the course were used to show how students' achievement growth correlated with their attitudes after participating in self-paced blended learning of mathematics.

In order to determine the relationship between achievement growth and attitudes toward mathematics, students' achievement growth scores were compared with their scores on the Attitudes Toward Mathematics Inventory (ATMI) using Spearman's Rank-Order Correlation. Achievement growth scores were calculated by finding the difference between scores on the fall administration of the Measures of Academic Progress (MAP) Mathematics Test and the spring administration of the test. Additionally, change scores on the MAP Test were compared with scores on each specific factor of the ATMI using Spearman's Rank-Order Correlation. Factors included value, motivation, enjoyment, and self-confidence.

Sample

The sample for this study included high ability eighth grade students enrolled in a pilot self-paced blended mathematics course. *High ability* mathematics students receive above-average scores on mathematics achievement tests. Students were located at a small suburban middle school in the Midwestern United States. Of the 26 students enrolled in the study, 23 students fully participated by completing all assessments. The average age of the participants was 13.5 years; 53.8% were male ($n = 14$) and 46.2% were female ($n = 12$). Ninety-two point three percent (92.3%) of the participants were Caucasian ($n = 24$), 3.8% were Asian ($n = 1$), and 3.8% were multiracial ($n = 1$). There were two sections of the course, and a different teacher taught each section. One of the teachers was male and one was female. Both were early-career teachers. Although neither teacher had taught this program before, both of them had taught advanced mathematics to eighth-graders in previous years.

The course content included a web-based curriculum, Accelerated Math©. The goal of the course was to individualize the rate of instruction for each student. Students worked on one objective at a time using sample problems and instructional videos. Once they had learned three new objectives, they were given an assignment, which was either online or on paper. Students were tested after completing five objectives. If a student did not pass a particular test, then he or she had to go back and relearn the material for the unmet objectives.

This course was *blended* because students completed work independently online both at school and at home. Students spent time in the classroom five days per week receiving direct instruction from a certified mathematics teacher and working in small groups. Each student was required to complete at least 120 minutes of online work at home each week. The classroom

setting was one-to-one, as each student was provided his or her own laptop to use in class each day. During class, students were either working independently on new objectives, testing, working collaboratively in small groups on the same objectives, receiving direct instruction from the teacher, or receiving remediation from the teacher. The self-paced nature of the course allowed students to take different courses; the majority of students were taking Algebra I, and a few were taking Geometry. Some students completed more than one course during the school year, and some completed two full courses.

Instrumentation

Mathematics achievement was measured using the MAP Mathematics Test, a product of the Northwest Evaluation Association (NWEA). The test measures four mathematical domains: Operations and Algebraic Thinking, The Real and Complex Number Systems, Geometry, and Statistics and Probability. Scores fall into six ranges: 201-210, 211-220, 221-230, 231-240, 241-250, and above 250. It is a 50-item computerized adaptive test with demonstrated construct validity (Wang, McCall, Jiao, & Harris, 2013). The test has shown marginal reliabilities of .94 or greater in studies with over 25,000 participants. It has also shown high test-retest reliabilities between .83 and .94 for fall to spring administrations in studies with more than 10,000 participants (NWEA, 2004). Concurrent validity using the Illinois Standards Achievement Test (ISAT) was high ($r = .87$) with a large number of participants ($N = 957$) (NWEA, 2004).

The first administration of the MAP Mathematics Test was in September 2014, and its purpose was to determine students' level of achievement at the beginning of the self-paced blended course. The second administration of the MAP Mathematics Test was in May 2015, and its purpose was to determine students' level of achievement at the end of the self-paced blended course. The researchers calculated achievement growth by taking individual students' May scores and subtracting their September scores.

Attitudes toward mathematics were measured using the ATMI. The researchers obtained permission to use this instrument from its author (M. Tapia, personal communication, February 26, 2014). This instrument contains 40 items covering four measurement categories revealed by a factor analysis: value, motivation, enjoyment, and self-confidence (Tapia, 1996). Each item is a statement about students' attitudes toward mathematics, and they choose their level of agreement with each statement on a five-point Likert scale with the following response choices: 1 (*strongly disagree*), 2 (*disagree*), 3 (*neutral*), 4 (*agree*), and 5 (*strongly agree*). Some items were reversed, and the researchers changed scores accordingly prior to conducting any descriptive or statistical analyses.

Attitudes toward mathematics include four different attitudinal factors: value, motivation, enjoyment, and self-confidence. The instrument measured students' *value* of mathematics through phrases like "Mathematics is a very worthwhile and necessary subject." It measured students' *motivation* through phrases like "I want to develop my mathematical skills." The ATMI measured students' *enjoyment* of mathematics through phrases like "I get a great deal of satisfaction out of solving a mathematics problem." Finally, the instrument measured students' *self-confidence*, which can be used interchangeably with self-efficacy, through phrases like "Mathematics does not scare me at all."

Students took the ATMI in May at the end of the self-paced blended course. The researchers selected this instrument due to its proven reliability ($a = .97$) and demonstrated content and construct validity (Tapia, 1996). Each of the four factors also demonstrated high levels of reliability: value ($a = .86$), motivation ($a = .89$), enjoyment ($a = .88$), and self-confidence ($a = .95$) (Tapia, 1996).

Limitations

The small sample size in this study represents a major limitation. As blended learning becomes more common, future studies could use larger sample sizes. There were also threats to internal validity in this study, including the curriculum and teachers. It is possible that different results could be obtained from students using a different curriculum or those receiving instruction from different teachers, but these threats were unavoidable. Transferability of the findings in this study could be difficult for this reason.

RESULTS

Summary statistics were calculated for each student's mean score on the ATMI as well as their mean scores for each of the four attitudinal factors: value, motivation, enjoyment, and self-confidence. Response values for each question ranged from 1, representing the lowest attitudes toward mathematics, to 5, representing the highest attitudes; therefore, the lowest possible average scores for attitudes toward mathematics and each individual factor was 1, and the highest possible score was 5. Summary statistics were also calculated for each student's change in achievement from the beginning to the end of the self-paced blended course. These data are displayed in Table 1.

Table 1
Achievement Growth and ATMI Descriptive Statistics

	Achievement Growth	Attitudes Toward Mathematics	Value	Motivation	Enjoyment	Self-Confidence
N	26	23	23	23	23	23
Mean	8.0000	4.11	4.36	4.10	3.89	4.09
Std. Deviation	5.960	.50	.42	.54	.63	.60

Cronbach's alpha was calculated for results of the ATMI to determine internal consistency. The analysis revealed a very high level of reliability ($a = .96$) for this instrument (Creswell, 2015).

Spearman's Rank-Order Correlation coefficient was computed to assess the relationship between students' achievement growth and students' overall attitudes toward mathematics as well as the four attitudinal factors: value, motivation, enjoyment, and self-confidence (Table 2). These data met the assumptions required to calculate Spearman's rho: all variables were ordinal or interval and the relationship between each pair of variables was monotonic. A correlation is an appropriate test for measuring the strength and direction of the relationship between two numerical variables (Creswell, 2015).

Table 2
Spearman's Rank-Order Correlations

		Attitudes Toward Mathematics	Value	Motivation	Enjoyment	Self-Confidence
Achievement Growth	Spearman's rho	.52	.47	.45	.45	.42
	Sig. (2-tailed)	.012	.023	.030	.029	.045

Note. *N* = 23

The first research question for this study sought to assess the relationship between achievement growth during a self-paced blended mathematics course and high ability middle school students' attitudes toward mathematics at the end of the course. Results indicate that achievement growth and ATMI scores were moderately positively correlated ($r_s = 0.52$) with a p-value of 0.012. This p-value fell below the acceptable alpha level ($p < 0.05$);

therefore, the researchers rejected the null hypothesis and accepted the alternative hypothesis, which indicates that achievement growth is positively correlated to attitudes toward mathematics at the end of the course.

The second research question examined the relationship between achievement growth during a self-paced blended mathematics course and high ability middle school students' value of mathematics, motivation, enjoyment of mathematics, and self-confidence. Results revealed significant correlations between each of these factors. There were moderate positive correlations between achievement growth and value ($r_s = 0.47$, $p = 0.023$), motivation ($r_s = 0.45$, $p = 0.030$), enjoyment ($r_s = 0.45$, $p = 0.029$), and self-confidence ($r_s = 0.42$, $p = 0.045$). All p-values fell below the acceptable alpha level ($p < 0.05$); therefore the researchers rejected the null hypothesis and accepted the alternative hypothesis, which indicates that achievement growth is positively correlated to value, motivation, enjoyment, and self-confidence at the end of the course.

The researchers also compared attitudinal factors to each other to determine if there were statistically significant correlations. Spearman's Rank-Order Correlation was calculated between and among overall attitudes, value, motivation, enjoyment, and self-confidence. Overall attitudes toward mathematics showed very high positive correlations with each of the other factors: value ($r_s = 0.82$, $p < 0.000$), motivation ($r_s = 0.76$, $p < 0.000$), enjoyment ($r_s = 0.93$, $p < 0.000$), and self-confidence ($r_s = 0.90$, $p < 0.000$). There were significant correlations between value scores and scores for motivation ($r_s = 0.76$, $p < 0.000$), enjoyment ($r_s = 0.68$, $p = 0.001$), and self-confidence ($r_s = 0.58$, $p = 0.004$). There were also significant correlations between motivation and enjoyment ($r_s = 0.75$, $p < 0.000$), motivation and self-confidence ($r_s = 0.50$, $p = 0.014$), and enjoyment and self-confidence ($r_s = 0.84$, $p < 0.000$).

DISCUSSION

There were several significant findings in this study. First, there was a significant positive correlation between achievement growth and attitudes toward mathematics. Second, achievement growth was significantly correlated to each of the four attitudinal factors: value, motivation, enjoyment, and self-confidence. Finally, each of the four attitudinal factors were correlated to overall attitudes toward mathematics and to each other.

Students' self-efficacy and attitudes toward a subject are important factors to consider due to their impact on student learning. This study revealed a statistically significant positive correlation between achievement growth and attitudes toward mathematics at the end of the course. Research has shown that attitudes are a significant factor in student learning in online and

blended environments (Edwards & Rule, 2013; Kim et al., 2014; Tempelaar et al., 2012). The findings in the present study agree with this prior research with a specific focus on the high ability population in a self-paced blended learning environment. Furthermore, these findings indicate that students who experience greater achievement in a self-paced blended course have more positive attitudes toward mathematics at the end of the course.

This study also found a statistically significant positive correlation between achievement growth and value of mathematics. This finding agrees with other research indicating a relationship between intrinsic value and final grades in an online high school mathematics course (Kim et al., 2014). Therefore, it may be possible to transfer the findings of this previous research to the high ability student population in self-paced blended learning environments. High ability students who experience more significant increases in achievement place a higher value on mathematics at the end of the course.

Similar to previous studies (e.g., Gottfried et al., 2005; Skaalvik et al., 2015), results revealed a positive correlation between achievement growth and motivation in mathematics. This agrees with scholars' claims that motivation is an important factor in academic achievement (Bandura, 1993; Gottfried et al., 2005; Kesici & Erdogan, 2010; Kim et al., 2014; Skaalvik et al., 2015). The findings in the present study confirm this relationship for the high ability population in the self-paced blended learning environment. Previous research with this group indicates that students' self-confidence does not significantly increase during a self-paced blended mathematics course (Balentyne & Varga, 2016), but the present study helps shed light on which students exhibit higher motivation after the course. High ability students who experience more significant increases in achievement have higher levels of motivation at the end of the course, indicating that increases in achievement may improve students' self-confidence.

The relationship between achievement growth and enjoyment of mathematics revealed a significant positive correlation. This finding agrees with previous research indicating that enjoyment is an important factor in blended mathematics (Tempelaar et al., 2012) and that enjoyment and achievement are correlated in mathematics courses (Garcia et al., 2010; Kim et al., 2014). However, previous studies have also indicated that enjoyment of mathematics may not significantly change during a self-paced blended mathematics course (Balentyne & Varga, 2016), and students' enjoyment of mathematics is not significantly different in face-to-face and online courses (Edwards & Rule, 2013). Therefore, it is possible that students who already enjoy mathematics will be more successful in a self-paced blended course than those who do not. It is also possible that the success students see in their course increases their enjoyment of the subject.

Finally, this study revealed a positive correlation between achievement growth and self-confidence in mathematical abilities. This finding is in line with other research indicating a relationship between self-efficacy and grades in both online and face-to-face mathematics courses (Kim et al., 2014; Skaalvik et al., 2015). These findings also align with self-efficacy theory, which suggests a relationship between self-confidence and academic ability (Bandura, 1977, 1993). However, as a whole, high ability middle school students in a self-paced blended course do not see significant improvements in self-confidence (Balentyne & Varga, 2016). Therefore, the results of the present study may indicate that students who see higher levels of achievement in self-paced blended learning also exhibit higher levels of self-confidence at the end of the course. This may signify that their success improves their self-confidence.

This study also found statistically significant correlations between overall attitudes toward mathematics and each of the four attitudinal factors: value, motivation, enjoyment, and self-confidence. Moreover, there were statistically significant correlations among each of the four factors. This agrees with previous findings indicating significant relationships among attitudinal factors in mathematics (e.g., Gottfried et al., 2005; Kesici & Erdogan, 2010; Kim et al., 2014; Skaalvik et al., 2015). Although these studies had similar findings, they examined different populations and different modes of learning; the present study extends these findings to high ability students and to the self-paced blended learning environment. The interrelated nature of attitudinal factors implies that researchers should continue to study these factors together. It also implies that changing one attitudinal factor may have an effect on other attitudinal factors, making improving attitudes toward mathematics even more important.

The positive correlation between attitudes toward mathematics and achievement growth becomes significant as educators look for characteristics of students who would be successful in online and blended learning environments. Balentyne and Varga (2016) discovered that self-paced blended learning of mathematics improves students' attitudes toward mathematics, but they did not see a significant change in achievement growth. However, the positive correlation between attitudes toward mathematics and achievement growth found in this study indicate the possibility that over time this improvement in attitudes could lead to more positive outcomes for achievement as well.

Scholars have mentioned the need for research on characteristics of students who will be the most successful in self-paced and/or blended learning environments (Balentyne & Varga, 2016), and the present study provides this information. It also contributes to the knowledgebase on high ability students. Those students who are especially interested, motivated, or confident in mathematics may see significant achievement growth in a self-paced

blended course. Major implications for this study include the fact that students with more positive attitudes toward mathematics are the most successful in a self-paced blended mathematics course.

Recommendations

Given the limited sample size, the findings of this study are not generalizable to other high ability students. A larger study would produce more generalized results. Due to the lack of diversity in the sample for the present study, future studies could look at the use of blended learning with minorities and how it may effect minority students' enrollment in gifted courses. Future studies could also look at more diverse samples, but this may be difficult due to the homogenous nature of the high ability population (Yoon & Gentry, 2009). Future studies could examine the relationship between achievement and attitudes toward mathematics in a blended course using a different curriculum or with different instructors. Additionally, studies could observe the relationship between achievement and attitudes in alternate content areas.

Scholars have expressed the need to study the relationship between achievement and attitudes in blended environments (Kim et al., 2014; Tempelaar et al., 2012). Although previous research has examined the relationship between attitudes and achievement, those studies measured achievement using end-of-course grades (Kim et al., 2014; Skaalvik et al., 2015), whereas the present study used growth on a standardized assessment to measure achievement. Final grades can vary depending on the course, location, and instructor, and reliability and validity can be questionable. In the present study, achievement growth was measured by giving students the same standardized assessment at the beginning and end of the course, which ensured that only what was learned during the course was being measured. Additionally, this study used a measure with proven validity and reliability.

Previous studies examining the relationship between achievement and attitudes in online and blended environments have involved different populations: undergraduates (Tempelaar et al., 2012) and high school students (Kim et al., 2014). Middle school students tend to be an under-researched population (Martinez & Martinez, 2003). The present study contributes to the literature on blended learning of mathematics with middle school students, specifically the use of self-paced blended learning for high ability students. It provides valuable information on the relationship between achievement and attitudes in a self-paced blended mathematics course.

Implications for the field include the fact that students with positive attitudes toward learning may be especially suited to self-paced blended learning. Schools should consider allowing high-ability students with high math self-efficacy to participate in self-paced blended mathematics courses. Teachers should also work to improve the math self-efficacy of their

students by following literature-based strategies and participating in professional development. Furthermore, teachers can implement lessons and strategies that increase students' enjoyment of mathematics, as this factor is positively correlated to students' motivation and self-confidence.

High-ability students in self-paced blended mathematics may also experience significant achievement growth as evidenced by the fact that some students in this course completed two full years of mathematics in only one year. Mathematics teachers should consider integrating self-pacing and blended learning into their classes, especially for high ability populations. During curriculum planning, administrators should consider self-paced and blended learning options for high ability students, especially when the number of students limits course offerings. In this study, self-paced blended learning allowed students in one class to take different courses; therefore, this mode of learning may help to expand course opportunities, especially in rural or financially limited school districts.

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