*Eurasia Journal of Mathematics, Science & Technology Education,* 2014, **10**(6), 609-615

# College Students Attitude and Mathematics Achievement Using Web Based Homework

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*Received 22 January 2013; accepted 12 August 2014*

The goal of this study was to understand how students' attitudes were connected to their mathematics learning and achievement. This investigation of students (n = 78) and their attitudes was specific to web-based homework in developmental mathematics courses in a two-year community college located in a large urban city in the United States. A mixed-methods investigation was utilized to analyze the relationships between students' attitudes and their mathematics achievement. The qualitative findings from the survey questionnaire show mixed responses from participants on the benefits and disadvantages of a web-based homework platform. Additionally, quantitative results, represented through cluster analysis, show the relationship between three groups of students, their attitudes and their mathematics achievement. The results of this study suggest that students with lower and average mathematics achievement hold more positive attitudes toward using a web-based homework platform compared to higher achieving students. Based on these results, it can be noted that web-based homework platforms serve an important role in student learning and attitudes toward mathematics in developmental courses, likely because the immediate feedback given helps to improve student understanding.

*Keywords*: Web-based homework; Attitude; Mathematics achievement; College students

## INTRODUCTION

Students who enroll in college-level mathematic courses are often unprepared to successfully complete the course requirements, especially in college algebra (Hodges & Kennedy, 2004). This perspective is based largely on students' high school grades and the results of college placement examination scores. Some colleges help underprepared students by providing transitional courses; namely, the developmental or remedial mathematics classes required for students often offer zero credit. After completing these compulsory developmental courses with a satisfactory grade, students are often allowed to enroll in credit-bearing college level mathematics courses. However, given the large number of students who are required to take remedial or developmental mathematics courses during their entry years into 4- and 2- year colleges, many mathematics departments have been forced to hire additional staff and generate alternative ways to provide content-based instruction and assessments to students. As a result, the number of web-based homework platforms in use in developmental mathematics courses has increased.

A study conducted by Hoyt and Sorensen (2001) reports that between 30% and 90% of incoming college students require developmental mathematics courses before beginning credit-bearing college level mathematics classes. Even with extensive developmental mathematical courses, a large number of

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doi: 10.12973/eurasia.2014.1220a


ISSN: 1305-8223

***State of the literature***

- In most college algebra courses, the pedagogical framework is traditional. Most lectures are given by instructors for a specified period and homework is assigned on a daily or weekly basis.
- One way to improve the attempt-feedback-reattempt cycle in a traditional lecture-based course is by using a web-based homework platform, a reality we now see in many developmental mathematics courses
- The web-based homework platform or online homework, in general, refers to any system of computerized homework problems made available online to students with automatic answer grading capability and immediate feedback on correctness of student solutions.

***Contribution of this paper to the literature***

- The results from the survey questionnaire resulted in mixed responses from students on the benefits and disadvantages of the web-based homework platform.
- The results of this study suggest that students with lower and average mathematics achievement have more positive attitude toward using a web-based homework system compared to higher achieving students
- This study provides evidence that a web-based homework platform used in developmental mathematics class may be more beneficial to students given that they receive immediate feedback through the automatic grading

students were unable to succeed in these courses, specifically in college algebra, and often receive a grade of D, W (withdraw) or F (fail), grades known as the DWF rate (Brewer, 2009). Within the context of the average passing rate for college algebra in the United States, which is between 40% and 50%, more focused research examining the relationships between web-based homework platforms, student attitudes and their subsequent outcomes is needed (Herriott, 2006).

As a first step to address this issue, reforms in college algebra should be given priority. Nevertheless, large scale reforms in mathematics courses of this type face difficulty as institutions structure programs based on certain theoretical and practical considerations (Baxter Hastings et al., 2006) that will increase, not only passing rates at the course level, but graduation rates at the college and university level. In most college algebra courses, the pedagogical framework is traditional. Most lectures are given by instructors for a specified period and homework is assigned on a daily or weekly basis. If these pedagogical strategies are effective and can fit within traditional lecture-based classes, the college mathematics community would support this change (Brewer, 2009). However, a lack of advancement in this area of research has caused growing concern among higher education researchers, specifically those investigating outcomes at the community college level. This study intends to blend technological interventions in the form of web-based homework within a traditional framework of lecture and paper-based work to explore students' attitudes and connected achievement in developmental algebra courses.

## WEB BASED HOMEWORK

Homework is traditionally assigned to students by instructors to be completed at home, regardless of instructional level or location. This homework and subsequent practice is particularly relevant and necessary in mathematics classes given the need for students to increase their content knowledge and quantitative literacy. Students require as many opportunities to practice the skills they learn in their mathematics classes, especially when they had previously struggled to successfully pass a specific course—such as Algebra. Observing examples provided by instructors in mathematics classes provides some but insufficient time-on-task to help students acquire the necessary procedures in a specific mathematical concept or skill. Further, students require feedback after completing any assigned homework. This step is crucial, for instructors especially, in knowing whether students' understanding is at a level to connect content in the course when solving problems or completing future assignments. As a result of this instructor feedback, students are then able to adjust their approaches to learning after realizing any errors made from the feedback obtained. This process is known in the mathematics education community as the attempt-feedback-reattempt cycle (Zerr, 2007).

However, at the college-level, and more readily at two-year institutions, some students do not attempt the homework problems provided by their instructors. This lack of practices causes them to miss the opportunity to complete any self-directed learning and solve homework questions on their own. Without this important component, students are unlikely to know the correct or useful ways to generate solutions; further, they fail to obtain the necessary feedback from their instructors. Some instructors might be unable to collect students' homework and grade them due to time constraints (Brewer, 2009) and a host of other issues. Finally, even though a first attempt may have been graded, students might not receive timely feedback and further fail to re-adjust their understanding of any specific mathematical concepts (Jacobson, 2006). In short, the students may not obtain the maximum benefits of completing homework assignments in an algebra class.

One way to improve the attempt-feedback-reattempt cycle (Zerr, 2007) in a traditional lecture-based course is by using a web-based homework platform, a reality we now see in many developmental mathematics courses. The web-based homework platform or online homework, in general, refers to any system of computerized homework problems made available online to students with automatic answer grading capability and immediate feedback on correctness of student solutions (Jacobson, 2006; Kinney, 2001). In the current study, the web-based homework used follows closely the aspect of this definition. The homework system contains similar, sometimes identical, questions made available to students in an algebra textbook; further, questions with different degree of difficulty are arranged in varying order. Questions are presented in different forms; for example, true or false questions, open ended questions, unique solutions questions and challenging questions that require lengthy thought or solutions. Completed problems and their solutions are automatically graded by the web-based homework system once answers are submitted. Students have the option to save any answers and complete a section of an exercise before submitting them. To assist students having problems solving the homework, a few examples similar to the questions asked are shown. This helps the student understand the steps involved in answering the questions. Short video lectures are also provided to detail the included algebra concepts. Thus, most online homework systems are able to generate focused practice on a set of similar questions from a particular concept from the large item database of algebra questions.

**Attitude in Mathematics**

Attitudes in mathematics generally refers to an "affective responses that involve positive or negative feelings of moderate intensity and reasonable stability" (McLeod ,1992 , p. 581). In 1992, McLeod pointed out that attitude is placed somewhere in between beliefs and emotions. Most educators used attitude as one of the reasons determining the success or failure of students in mathematics. In addition, the ability to assist students in improving their mathematics achievement had also been attributed to attitude. (Martino & Zan, 2009, 2010). Several definitions of attitudes could be found in mathematics education but there is still some ambiguity in the actual meaning. Martino & Zan (2009) argues that the different definition of attitudes is actually good for researchers since many research problems require different interpretations. However, there is no significant correlation between attitude in mathematics and mathematics achievement (Ma & Kishor, 1997). Although this is the case, one of the main factors students take advanced mathematics has been attributed to both attitude in mathematics and achievement in mathematics (Ma, 2001). A well known instrument in mathematics education is the Fennema & Sherman (1976) Attitude Test. This instrument contains attitude constructs such as success in mathematics, confidence in mathematics, usefulness of mathematics, perception of the teacher, mathematics anxiety, and gender roles.

**Objectives**

The aim of this study was grounded in the researcher's goals to understand how students' attitudes are connected to both their mathematics learning and achievement. This investigation was specific to a web-based homework platform in a developmental courses (i.e., remedial) in a community college environment. Some of our initial questions, answered using mixed-methods, centered on gaining a better understanding of how the mathematics attitudes of community college students impeded progress in developmental mathematics courses. Findings from this study suggest that attitudes about web-based homework have significant implications on how students engage with and use web-based homework in online learning environments, thus the re-development of positive attitudes about mathematics at this late stage is essential.

Empirical and critical perspectives are applied in this research study based on factors surrounding lower-income, immigrant, and racial/ethnic minority student success in community colleges, especially in mathematics courses. In general, students' difficult and often ill-equipped transition from high school to community college (Conley, 2007, 2010), especially lower-income students and urban students of color (Roderick, Nagaoka, & Coca, 2009), positions them on a track for failure or course repetition. With the advent of advanced web-based technology to track and aid students in mathematics, we are required to persistently investigate the usefulness of such platforms in developmental mathematics contexts. The present investigation was situated along three primary areas: (1) examining associations between attitudes and achievement, (2) understanding students' attitudes about web-based homework, and (3) increasing student outcomes. In a larger context, this study also seeks to add to discourses on developmental education in community colleges (Bailey, 2009). As a result, the primary purpose of this study was to understand, in detail, how students' attitudes are connected to mathematics achievement. This study sought to answer the following research questions:

1. *What are the benefits and disadvantages of web-based homework programs in developmental algebra, specifically as they relate to student learning?*
2. *What associations exist between students' attitudes and beliefs about web-based homework and their achievement in developmental algebra?*

*3. What differences exist between higher-, middle-, and lower- achieving students in developmental mathematics courses with regard to their attitudes about mathematics?*

### Theoretical Perspectives

The perspectives and ideas utilized and presented in this study allowed the researchers to approach the current study using former research. Previous research in this area was used as a means to contextualize and outline the modes of inquiry applied in the current study. One additional goal of this study focused on continually challenging notions of "what works" in diverse mathematics classrooms, especially at the community college level, and generating more active discussions about student experiences, their attitudes, behaviors and their resulting achievement in developmental courses. Cooper (2007**)** noted that opinions about homework, not necessarily web-based homework, and the positive effects on their achievement are varied. Brewer and Becker (2010) conducted a quasi-experimental, posttest design study to examine the effectiveness of online homework (OHW) versus traditional-textbook based homework (THW). The results of their study show that lower-skilled students who utilized OHW exhibited higher mathematical achievement than the lower-skilled students who utilized THW.

Within a mission to advance the mathematical learning and increase achievement of struggling, lower income and students of color enrolled in community colleges (Zimmerman et al., 2011), more research focused on supporting beneficial and positive experiences is needed. Given that the use of web-based homework platforms is now becoming standard practice in community college developmental algebra courses, the research described in this study is both important and timely.

## METHODOLOGY

This study made use of a mixed methodology to answer the outlined research questions; phase one focused on quantitative data collection and analysis while phase two focused on qualitative data collection and analysis. A survey questionnaire was utilized to collect quantitative information on the attitudes and beliefs held by student participants regarding the web-based homework platform in their developmental algebra classes. The survey instrument consists of 40 items on a five-point Likert scale (1 – Strongly Disagree, 5 – Strongly Agree). The qualitative component (phase two) asked all participants for their individual thoughts about the web-based homework platform using open ended responses; these survey responses were collected during the distribution of the survey questionnaire. Cronbach's alpha was used to calculate the internal consistency of the survey questionnaire. The alpha value obtained is 0.83. This indicated the reliability of the survey questionnaire. The items in this survey were developed by adapting the main components of attitude by Fennema & Sherman (1976).

To answer the first reseach question, data from the open-ended responses in the survey instrument were analyzed. Students shared thoughts about the benefits of using this web-based homework system. The disadvantages of the homework system were also obtained from the sample.

For the second research question, quantitative methods were used to analyze survey responses. Specifically, cluster analysis and analysis of variance (ANOVA) were used to analyze all data. Cluster analysis identifies sub-groups of a study sample that behave similarly or show similar characteristics based on collected data. In this study, cluster analysis was used to explore the number of student groups from the sample based on achievement and participant beliefs. The ANOVA technique was used to determine whether any significant differences exist among the clusters. The ANOVA technique allowed the researchers to investigate the relationships between students' mathematics attitudes, beliefs and their achievement (as measured by a standardized examination for all study participants). If the ANOVA analysis was significant among the clusters, the researcher conducted a subsequent Tukey post-hoc test to determine where the specific differences existed.

For the third research question, quantitative methods such as discriminant analysis and analysis of variance (ANOVA) were applied. Discriminant analysis is the reverse process of the multivariate analysis of variance (MANOVA). The purpose is to determine variables that would "discriminate" the groups. In this study the independent variables are the survey items while the dependent variables are the clusters/groups.

### Sample

The sample of this study involved 78 students from a community college located in north eastern region of the United States. Students were required to take this developmental algebra class before proceeding to their major courses.

The survey questionnaire was administered to the students at the end of the 15 weeks semester. The web-based homework used in this study is WebAssign. It is an online homework and management system that delivers an automatic grading solution.

## FINDINGS

The results of the first research question, "What are the benefits and disadvantages of web-based homework programs in developmental algebra, specifically as they relate to student learning?," show a mix of responses from participants on the benefits and disadvantages of the web-based homework platform. Students who liked the web-based homework generally mentioned the easy accessibility. In addition, the convenience of accessing the homework online was noted; students also mentioned that they could attempt mathematics problems and homework questions regardless of their location—and without the hassle of a mathematics textbook; the web-based platform has a student log-in so that students can access their assignments from any computer with internet connection.

Some students noted that they preferred to attempt questions late in the night or early in the morning depending on their internet connection availability. Many students mentioned that the instant feedback given by the homework system on the correctness of their solutions was quite beneficial. The step-by-step solutions provided for certain questions were also very helpful in highlighting their mistakes. This ultimately helped students who may get frustrated easily; especially when such students are unable to spot the errors they make while attempting homework questions. As one student noted, "this online homework system gave me a great study guide for questions and a way to work on them to perfection." A few students also praised the outline of the homework system as useful tools to help them practice and master concepts; for example, the "Practice It" and "Master It" tabs allow students to let the system generate problems for them to complete and structures new problems based on the correctness of the prior answer. Furthermore, what students identified the most in their responses were the many program features including video lectures and additional learning features (e.g., downloadable text book).

However, students provided some alternative and less desirable responses regarding the web-based homework platform. Some of the disadvantages mentioned included the system's emphasis on the final solution and not on the actual process of solving the given problem—this was connected to specific examples when students wanted to know how to get a correct solution after trying a few times and inserting incorrect answers. The homework system only gives feedback to correct or incorrect responses for most of the questions attempted by student users. One common feature of this program that frustrated many students, especially when an error exists in their solution or when inputting mathematical symbols in the answer column, was the fact that the web-based homework system only provided a green check, to indicate a correct response, or a red letter 'X', to indicate an incorrect response. These types of responses do not hold up to traditional, and "good," feedback usually provided by instructors in remedial or developmental courses. One student even mentioned the difficulty of inserting answers in fraction form on the web-based platform; issues such as this one indicate that sometimes frustrations regarding technology use in the classroom have much to do with the technology itself. Furthermore, the program does not provide sufficient feedback on the specific portions of an answer that are incorrect in a specific problem. Citing one very specific example in the graphing of

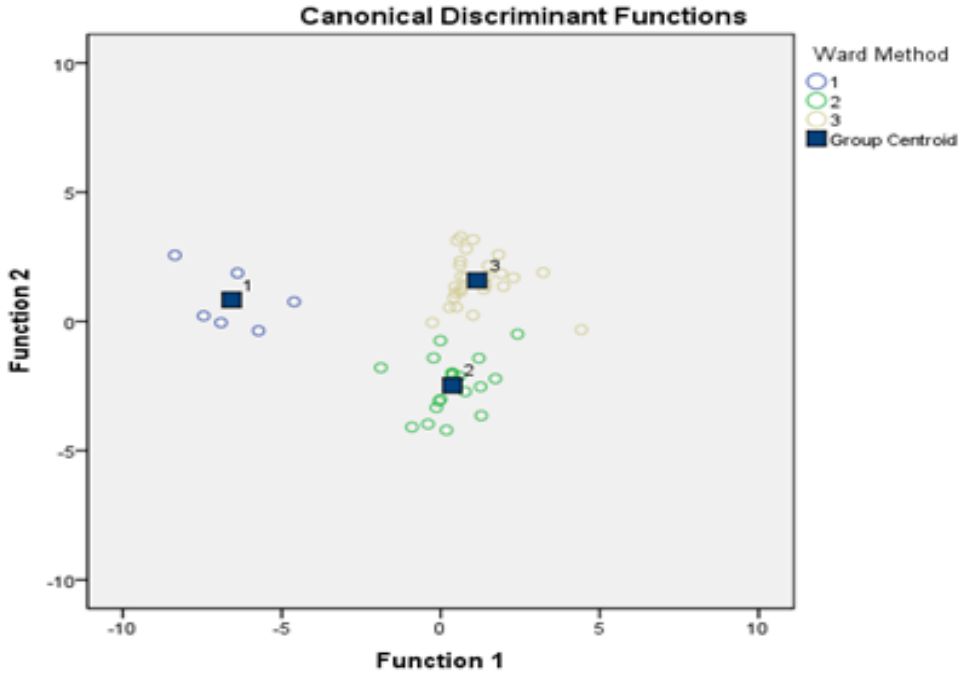


**Figure 1**. The diagram of the canonical discriminant functions on the students' achievement results

points, one student mentioned that the program is very rigid and does not allow users to plot the point easily.

The second research question, "what associations exist between students' attitudes and beliefs about web-based homework and their achievement in developmental algebra?," included an investigation via cluster analysis and ANOVA. Cluster analysis results showed the relationships between different groups of students and their mathematics achievement based on a standardized department exam taken by all students in a given remedial or developmental course. From these analyses, a total of three groups of students were identified. Students in Cluster one rated survey items on attitudes and beliefs on the web based homework highly. Students in Clusters two and three rated more items on attitudes and the usefulness of web based homework system highly. Cluster one consisted of 12 total students, cluster 2 had 29 students and Cluster 3 had 37 students (Figure 1).

The third research question of this study was "What differences exist between high achieving, "middle" achieving, and low achieving students with regard to their attitudes and outcomes?" From the discriminant analysis, Cluster 1 students rate item Q2, Q17, Q21, Q29 and Q31 highly while Cluster 2 and 3 students rate Q6, Q16, Q22, Q24, Q26, Q36, Q38, Q39, Q40 highly. Results from the post-hoc test indicated that Item 16 discriminates "middle" achieving students (Cluster 2) and low achieving students (Cluster 3) while Item 28 discriminates "middle" achieving students (Cluster 2) and low achieving students (Cluster 3); it also discriminates between high achieving students (Cluster 1) and low achieving students (Cluster 3).

## DISCUSSION AND CONCLUSION

This study investigated how students' attitudes are connected to mathematics learning. Specifically, it examined learners' attitudes about web-based homework platforms in a developmental algebra course in a community college setting. It probed certain student demographics and whether mathematics achievement had any relationship with the attitude toward a web-based homework tool. This study also explored the benefits and disadvantages of using the web based homework platform from the students' perspective in learning algebra.

The first research question explored the usefulness of the web based homework system. The results from the survey questionnaire resulted in mixed responses from students on the benefits and disadvantages of the web-based homework platform. Students who liked the web-based homework generally mentioned the convenience, the many program features that include some video lectures and how the program helped them in learning. Some of the disadvantages mentioned included the emphasis on the final answer versus the actual work and steps involved in solving a problem to get the final answer, especially when students needed to know how to get the right solution after trying a few times and just getting a feedback of right or wrong.

The results of this study suggest that students with lower and average mathematics achievement have more positive attitude toward using a web-based homework system compared to higher achieving students. These findings are parallel with the notion that low-skilled students obtain more benefits than high-performing students from the usage of web based homework (Wooten & Eggers, 2013). Based on the results, it can be noted that web-based homework plays an important role in students' attitudes possibly because of the immediate feedback that improves understanding. This finding is especially important for students who are struggling with course content and mathematical literacy.

Further, this study provides evidence that a web-based homework platform used in developmental mathematics class may be more beneficial to students given that they receive immediate feedback through the automatic grading system. In addition, this study indicated that using web-based homework provides more opportunities and motivates lower performing students in learning algebra, particularly when this aid is complemented by in-depth and consistent instructor feedback. This is also consistent with the findings of a study on usage of the web-based homework in a first semester calculus class, where students' content knowledge and content acquisition are at a higher-order than that of a developmental mathematics course (Zerr, 2007).

Future studies should explore whether web based homework enhances the understanding of the material and whether success in completing the homework influences the success in the examination. In addition, increasing the sample size using random sampling would assist in making generalisation on students' attitude and usage of web based homework. Another interesting study could be done on whether the instructors could motivate students' to use the web based homework consistently to improve their grades. A longitudinal study might reveal how students' usage of the web based homework platform changes over the duration of their study and how it affects their attitude and achievement.

## REFERENCES

Bailey, T. (2009). Challenge and opportunity: Rethinking the role and function of developmental education in community college. *New Directions for Community Colleges, 145,* 11–30.

Baxter Hastings, N., Gordon, F. S., Gordon, S. P., Narayan, J., & Mathematical Association of America. (2006). *A*

*fresh start for collegiate mathematics: Rethinking the courses below calculus*. Washington, DC: Mathematical Association of America.

Brewer, D. S. (2009). The effects of online homework on achievement and self-efficacy of college algebra students. Retrieved from http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1414&context=etd

Brewer, D. S., & Becker, K. (2010). Online homework effectiveness for under prepared and repeating College Algebra students, *Journal of Computers in Mathematics and Science Teaching, 29*(4), 353-371 Conley, D. T. (2007). The challenge of college readiness. *Educational Leadership, 64*(7), 23–29.

Conley, D. T. (2010). *College and career ready: Helping all students succeed beyond high school*. San Francisco, CA: Jossey-Bass.

Cooper, H. (2007). *The battle over homework: Common ground for administrators, teachers,and parents*. Thousand Oaks, CA: Corwin Press.

Fennema, E., & Sherman, J. (1976). Fennema-Sherman mathematics attitudes scales: Instruments designed to measure attitudes toward the learning of mathematics by females and males. *Journal for Research in Mathematics Education*, *7*(5), 324–326. Retrieved from http://www.jstor.org/stable/10.2307/748467.

Herriott, S. R. (2006). Changes in college algebra. In N. Baxter Hastings, F. S. Gordon, S. P. Gordon, J. Narayan, & Mathematical Association of America (Eds.), *A fresh start for collegiate mathematics: Rethinking the courses below calculus* (pp. 90-100). Washington, DC: The Mathematical Association of America.

Hodges, D. Z., & Kennedy, N. H. (2004). Editor's choice: Post-testing in developmental education, a success story. *Community College Review, 32*(3), 35-42.

Hoyt, J. E., & Sorensen, C. T. (2001). High school preparation, placement testing, and College remediation. *Journal of Developmental Education, 25*(2), 26-34.

Jacobson, E. (2006). Computer homework effectiveness in developmental mathematics.*Journal of Developmental Education, 29*(3), 2-8.

Kinney, D. P. (2001). A comparison of computer-mediated and lecture classes in developmental mathematics. *Research and Teaching in Developmental Education, 18*(1), 32.

Ma, X, & Kishor, N. (1997). Assessing the relationship between attitude toward mathematics and achievement in mathematics: A meta-analysis. *Journal for research in mathematics education*, 28(1), 26–47.

Ma, Xin. (2001). Participation in Advanced Mathematics: Do Expectation and Influence of Students, Peers, Teachers, and Parents Matter? *Contemporary educational psychology*, 26(1), 132–146. doi:10.1006/ceps.2000.1050.

Martino, P. Di, & Zan, R. (2010). Where does fear of maths come from? cerme8.metu.edu.tr, (2002). Retrieved from http://cerme8.metu.edu.tr/wgpapers/WG8/WG8_Di Martino.pdf

Martino, P., & Zan, R. (2009). "Me and maths": towards a definition of attitude grounded on students' narratives. *Journal of Mathematics Teacher Education*, 13(1), 27–48. doi:10.1007/s10857-009-9134-z

McLeod, D. (1992). Research on affect in mathematics education: A reconceptualization of research on mathematics teaching and learning. Retrieved from http://www.peterliljedahl.com/wpcontent/uploads/Affect-McLeod.pdf

Roderick, M., Nagaoka, J., & Coca, V. (2009). College readiness for all: The challenge for urban high schools. *The Future of Children, 19*(1), 185–210.

Wooten, T., & Eggers, J. D. (2013). An investigation of online homework: Required or not? *Contemporary Issues in Education Research, 6*(2), 189-197.

Zerr, R. (2007). A quantitative and qualitative analysis of the effectiveness of online homework in first-semester calculus. *Journal of Computers in Mathematics and Science Teaching, 26*(1), 55.

Zimmerman, B. J. (1990). Self-regulated learning and academic achievement: An overview. *Educational Psychologist, 25*(1), 3.

Zimmerman, B. J., Moylan, A., Hudesman, J., White, N., & Flugman, B. (2011). Enhancing self-reflection and mathematics achievement of at-risk urban technical college students. *Psychological Test and Assessment Modeling, 53*(1), 141–160.

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