Characteristics of Effective Mathematics Homework

Benjamin Roper

Dr. Wilson

EMAT 7050

October 15th, 2014

Introduction

The idea of mathematics homework produces various connotations for teachers, students, and parents, but its completion can have many benefits both inside and outside of the classroom. Cooper, Robinson, and Patall (2006) generally define homework as "any task assigned by schoolteachers intended for students to carry out during non-school hours." Although the term includes the word "home", students have the freedom to complete the assignment in other locations, such as a library or another class. A teacher can vary the length, skill area, and many other factors to customize homework for a class or student. It is also his or her job to determine the purpose of an assignment; the most common instructional goal is for students to practice material learned in class, but it can also be given to preview upcoming material or extend thinking that was established in the classroom. Students may have homework for noninstructional reasons, which can include meeting district requirements and punishment (Cooper et al., 2006). Ten purposes for giving homework are provided by Epstein & Van Voorhis (2001); some of the unique objectives include personal development and peer interactions. Many teachers have a unique strategy for distributing and grading homework, several of which will be discussed later in the paper. They are designed primarily for middle and high school students, yet other references may involve studies with elementary students.

I chose this topic because I wanted to know about the effectiveness and strategies involved with giving homework. I agree with Jackson (2014) that, "most

teacher credential programs offer little or no guidance to prospective mathematics teachers about how to deal with seemingly nuts-and-bolts matters as homework" (p. 351). Although the preparation program at the University of Georgia was extensive, I wish I had been given more advice on these daily activities. I have worked with multiple teachers since graduation, and none of them had the same process for assigning and grading homework. In my short amount of teaching experience, I have also noticed frequent negative attitudes toward homework by from students, as well as a low completion rate in many classes. I would like to investigate if there are ways to improve students' perception toward homework and in turn, increase its effectiveness.

Homework has been present in American schools for many generations, but the public opinion of the concept changes frequently. In the early 1900's, "educational theories suggested that homework could be an important means for disciplining children's minds" (Cooper & Valentine, 2001). The assignments given in this time period primarily consisted of drill practices for students to repeat; however, in the 1940's, an emphasis was placed on developing a problem-solving process rather than the repetition of procedures. The public also expressed displeasure in this decade at the amount of assignments since they detracted from other home activities. During the Space Race period of the 1950's, educators called for increased rigor in homework due to the fear that students would be unprepared for technological careers or to compete with global adversaries. After public opinion of homework declined again in the 1960's due to increased pressure on students, the country saw a decrease in achievement test scores in comparison to other

countries two decades later. This change prompted more positive views on homework (Cooper et al., 2006). While I have had limited classroom experience, most of the teachers I have observed in more recent years assign homework at least three times a week. The assignments primarily consist of exercises similar to examples discussed in class and are typically not cognitively demanding. The results of this history show a constantly changing trend that is often affected by American culture and policy.

Student Views

As students grow older and advance to higher grades, they tend to have more negative attitudes toward homework; thus, they are less motivated to complete the assignments (Hong, 2011). When rating teacher effectiveness, Hong reports that students give higher marks to those who assign homework daily. This observation indicates while students may not be interested in the work, they may still see its importance in their education. For teachers to create the most effective assignment, they should fully understand its purpose to make it more meaningful for students. Hong (2011) claims that, "teachers with a good understanding of students' homework experiences can improve the quality and relevance of homework and lessen the homework problems that student experience" (p. 283). He also explains that research in homework achievement seems to favor girls more than boys; the former produce more organized work and better attitudes, while the latter group spends less time on the assignments.

Regardless of the teacher's purpose, the amount of homework given to a student may prove to be a traumatic, emotional experience for the child. Lange &

Meaney (2011) explain that, "this trauma…occurs when children find their experiences to be deeply distressing or disturbing emotionally or mathematically with possible long-term impact…on their lives as mathematical learners" (p. 36). This unfortunate effect can also translate into the home when a parental relationship may suffer if the child becomes a passive learner. Some parents may unintentionally exert too much pressure on their child so that the stress of homework becomes too much to bear. Several students I have taught in high schools have explained that they could not complete their homework due to various after-school commitments. It is another reason, as I will discuss later, why teachers must make assignments relevant to provide an ideal homework experience.

The discrepancy between American and global achievement in mathematics has led to research on the difference between homework in different countries. Chen and Stevenson (1989) completed four cross-cultural studies examining the homework practices and achievement of students in America, China, and Japan. Children in the 1st grade in Minneapolis spent much less time on homework than those in Sendai, Japan, and even less time than students in Taipei, China. For students in the 5th grade in Chicago, their time spent on homework was comparable to those in Beijing, China. Of course, the amount of time that a child works on homework is related to the amount of problems given. When asked to estimate how much homework they assigned weekly, Chinese teachers said they assigned more than the Japanese, who then said they gave students more than Americans. This study also examined each culture's attitudes toward homework. American instructors considered homework much less important than the Japanese and

Chinese ones. Also, when asked about the purpose of homework, a majority of all the teachers said it was for reinforcement of concepts, but American teachers primarily used it to help develop a child's personality. Surprisingly, Chinese students had more positive attitudes toward it than the American students did. This result contradicts the researchers' hypothesis that more homework would lead to negative feelings about it.

Importance of Homework

Overall, there is a positive correlation between students who efficiently complete their homework and academic performance. Longitudinal data has shown "that extra time spent on mathematics homework increases students' mathematics test scores" (Hyde, Else-Quest, Alibali, Knuth, & Romberg, 2006, p. 137). Other research has shown that frequent homework assignments are beneficial to student achievement, but the length of them can have a negative effect on performance (Hyde et al., 2006). An extensive experiment by Harris Cooper and his colleagues compared the test scores of students in two classes: one with homework and another without. They found "that the average student in a class in which appropriate homework was assigned would score 23 percentile points higher on tests…" (Marzano & Pickering, 2007, p. 78). One trend that is consistently seen in research on homework is that it has a greater effect on secondary students (Cooper et al., 2001). This relationship could have many possible explanations, such as immature study habits or cognitive development. Based on this evidence, secondary schools that condemn homework would be depriving students of an important tool for increased performance.

Besides academic achievement, there are many other benefits to assigning homework. It can assist students with their study habits by giving them an outlet to practice concepts covered in class. Homework also demonstrates that learning does not have to only occur in a school during the day; teachers will need to design tasks, however, that provide an opportunity to further students' knowledge. Finally, the assignment can also help develop better character traits in students (Cooper et al., 2001). For example, the requirement of having to complete a reasonable amount of problems by a due date can help to increase responsibility in students.

Epstein et al. (2001) describes stark differences between the homework habits and achievement of low and high achieving students. The former group spent much more time on homework than the latter, likely due to decreased motivation or irrelevance to their lives. Those students may also not experience as much parental pressure to perform well in school. Surprising "low-ability students who did 10 [hours] of homework or more per week had as good report card grades as high-ability students who did no homework" (p. 184). Also, parents of low-ability students spend more time helping their children on homework than the other group. However, Epstein et al. reports on several studies concluding that students who regularly complete their homework typically receive better grades on their report cards, regardless of ability level.

Parental Involvement

Teachers constantly face the dilemma of recognizing when students are receiving too much help on homework from a parent or guardian. Schools certainly encourage family involvement in a child's education, but with too much guidance,

the assignment may not be accomplishing its purpose. There are many ways, however, for parents to effectively help their children learn outside of their classroom without dominating the experience. Bratina (1996) describes a program with worksheets specifically designed for students to complete with their parents. These assignments would not require a parent to reteach a skill learned in school; rather, students would discuss the learning activity from class with a family member. The tasks often would include practical examples of mathematics that can easily be facilitated, such as analyzing a grocery store receipt or keeping statistics during a sporting event. There are also numerous, inexpensive take-home kits that can be used to reinforce ideas with younger students. Bratina describes positive feedback from parents who used these resources, providing claims that they now felt more involved in their children's lives through these discussions. Additionally, parents will be able to learn more about students' mathematical knowledge, creating a valuable resource for teachers.

A study by Hyde et al. (2006) investigated the quality of the content instruction and scaffolding provided during help sessions by mothers of mathematics students. A survey found parents spend an average of eight minutes daily help their children, and their primary reason for doing so is to help the students develop a better understanding of the content. The study also showed most of the mothers focused on a procedural explanation, rather than emphasizing a conceptual one. There was also a strong correlation between the mothers' educational background in the subject and the quality of their instruction. Research by Hyde et al. indicates that parents cannot effectively help their children with their

homework if they do not understand the content themselves. White (2007) suggests holding monthly, informal workshops for parents to reinforce mathematics concepts they already know or learn new strategies. Parents can be given packets with simple definitions, examples, or online resources that can better prepare them to assist their child with mathematics homework. These figures in a student's lives have the potential to be an important influence in their educational experience with the appropriate amount of preparation and design.

In other countries, Chen and Stevenson's cross-cultural study (1989) showed that only around half of Japanese parents were involved with their child's homework. The authors explained that this result is surprising because of the "education mom" figure in Japanese culture. This study also examined the amount of time fathers assisted with homework. Although all the times were low, it found that American fathers spent the least amount of time, and Chinese fathers invested the most time. Finally, correlations between amount of homework help and school achievement were calculated. There were ten negative and statistically significant correlations, indicating that children perform poorer when they receive more assistance from their parents with assignments.

Teacher Strategies

As mentioned previously, almost all teachers have their own system for creating, distributing, and grading homework assignments. I will discuss a few examples and characteristics of these in the following paragraphs. White (2007) believes that quality of a homework assignment is more important than quantity: "fewer problems allow students to practice, as well as apply what was learned in

class" (p. 5). She provides an example about giving students practice with decimal operations. They would estimate their answers for four problems, and students would check their accuracy by solving the same problems in class the next day. I strongly agree with this philosophy; assigning students 30 exercises for one night where they repeat the same procedure is extremely redundant. I would rather see a wider range of problems that extend students' thinking of the material discussed in class. She also brings up the issue of grading such a large amount of homework. Since many teachers now teach five or six classes daily, they do not realistically have time to provide feedback on student work of this type. White suggests that when using homework as a measure of student performance, assigning fewer problems can allow teachers to provide better feedback. I am currently only teaching four classes yet still struggling to keep up with grading due to all of my other responsibilities. I have only been grading a few homework problems twice a week, but even that amount can be demanding.

Although students must practice procedural knowledge, its application is more important in homework. Thus, teachers should also strive to make assignments relatable to students' own lives (White, 2007). This strategy may become more difficult with some concepts in upper grades, so students need to be given at least one problem of how a mathematical idea is used in a certain occupation. They will then become more motivated to finish the work after seeing the relevance of the topic.

For students to successfully improve their mathematical abilities, teachers should provide feedback on submitted assignments in a thorough and timely

manner. Most teachers have a unique strategy for grading and returning homework. Austin (1980) specifically looks at how achievement can be affected by when students can ask questions about their work. His results showed that students perform better when they have the chance to ask questions about an assignment prior to submitting it for a grade. This observation supports the conclusion that immediate feedback on homework is more beneficial for students.

Jackson (2014) describes the "sandwich" homework strategy that originated in Marlo Warburton's algebra class. From the beginning of the year, she emphasized the importance of showing work by willingly giving students the answers to all of their problems. The students then have the responsibility to explain the necessary steps to reach the correct answer from the question, i.e. inserting the sandwich ingredients. If they do not initially obtain the right solution, students are given a chance to improve their grade by correcting their mistakes for partial credit. To support this strategy, "a midyear homework reflection [showed that] 80 percent said that having answers helped them learn" (p. 530). Students explain that being able to check their work prevents them from having to redo an entire section of exercises if they are following one part of a procedure incorrectly. This process also has the benefit of enabling opportunities for multiple solution strategies to reach the final answer; these students may feel less willing to simply copy a number from a neighbor. Many of the Ms. Warburton's homework questions reappear on quizzes, so mistakes on the homework are encouraged. While this strategy may not be effective for all students, I think it does a nice job of emphasizing student work over

the end results. I have worked with many students who believe that the answer is the most important part of a problem, rather than their thought process.

More recently, many teachers have been reversing the role of homework in the new flipped classroom. In a typical version of this style, students are assigned video lectures to serve as the primary instruction, and class time is committed to working on mathematically rich tasks. Unfortunately, due to the relatively new nature of this idea, there has been little formal research on the effectiveness of the flipped classroom. Moore, Gillett, and Steele (2014) describe the observations of two geometry teachers who implemented the flipped classroom for the first time. Mr. Gillett found that students seemed more willing to complete their homework assignments since they were not traditional exercises. There were also more student interactions in his course, including effective discourse and students frequently asking for help. He had one student claim, "that he did not like the flipped classroom because 'I have to think a lot harder. Before, I could just do problems.' This student had shown little engagement during class time in the traditional setting" (p. 423). In both classes, the homework completion rate increased due to the alignment with technology. The flipped classroom can be beneficial in increasing student motivation with homework, as well as making time spent in the classroom more valuable; however, more research is still needed to accurately judge its impact on student achievement. There are many variables dependent on the teacher in the design, such as the quality of videos and the tasks used during class.

Conclusion

Assignments students complete outside of a mathematics class can have many benefits for students, teachers, and even family members. Students can extend thinking established in the classroom or be given the opportunity to preview material for the next day. Teachers are able to informally assess their students or save time by giving them new content in a flipped classroom style. The students' parents can develop a better relationship with their child by spending time working on applicable assignments together. For homework to have these effects, however, it must be designed well. Jackson (2014) explains that a teacher's homework system:

> Must encourage mathematical thinking and skill development; provide useful, nonjudgmental feedback; enhance student responsibility for learning; help students self-assess without advertising weakness; and promote student self-confidence and motivation for learning. (p. 532)

All of these characteristics are vital for the parties to have the most rewarding experience from homework.

References

Austin, J.D. (1980). When to allow student questions on homework. *Journal for Research in Mathematics Education, 11*(1), 71-75.

Bratina, T. (1996). No kidding, my mom's got homework? *Mathematics Teaching in the Middle School, 1*(8), 610-614.

Chen, C. & Stevenson, H.W. (1989). Homework: A cross-cultural examination. *Child Development, 60*(3), 551-561.

Cooper, H., Robinson, J.C., & Patall, E.A. (2006). Does homework improve academic achievement? A synthesis of research, 1987-2003. *Review of Educational Research, 76*(1), 1-62.

Cooper, H. & Valentine, J.C. (2001). Using research to answer practical questions about homework. *Educational Psychologist, 36*(3), 143-153.

Epstein, J.L. & Van Voorhis, F.L. (2001). More than minutes: Teachers' roles in designing homework. *Educational Psychologist, 36*(3), 181-193.

Hyde, J.S., Else-Quest, N.M., Alibali, M.W., Knuth, E., & Romberg, T. (2006). Mathematics in the home: Homework practices and mother-child interactions doing mathematics. *Journal of Mathematical Behavior, 25*(2), 136-152.

Jackson, D.B. (2014). Homework: A sandwich! *The Mathematics Teacher, 107*(7), 528-533.

Lange, T. & Meaney, T. (2011). I actually started to scream: emotional and mathematical trauma from doing school mathematics homework. *Educational Studies in Mathematics, 77*(1), 35-51.

Marzano, R.J. & Pickering, D.J. (2007). The case for and against homework. *Educational Leadership, 64*(6), 74-79.

Moore, A.J., Gillett, M.R., & Steele, M.D. (2014). Fostering student engagement with the flip. *The Mathematics Teacher, 107*(6), 420-425.

White, Jeanne. (2007). Make math homework count! *New Teacher Advocate, 14*(4), 4-5.