Algebra without Homework? Reaching Every Student

Greg Kelly, Hanford High School
Greg.Kelly@rsd.edu or gkellymath.hhs@gmail.com

The Traditional Math Class

Most of us who make education our life's work started teaching with the expectation that our classes would be inspirational and effective. As math teachers were going to guide students to discover mathematical truths, or at the very least give clear explanations for each new concept. Students would quickly grasp what we were explaining, and they would practice and work hard to be ready to move on to the next skill. Most of us like it or not, tend to model our teaching on the way we were taught.

Here is the dream:

1 Every student is in his or her seat when the bell rings, and of course almost every student is there every day.

2. Students have their homework out, and a brief time is allowed for students to ask questions about the previous day's material. (There might be an entry task first.)

3. The teacher reads the correct answers, and students score their papers. Some teachers choose to have their students exchange papers before scoring. (Although this is apparently a violation of FERPA.) The papers are then collected so that the grades can be recorded.

4. The teacher explains the new material, and works two or three example problems.

5. The teacher assigns homework based on the new material.

6. Students usually have time to start the assignment in class. They may ask questions by raising their hands or sometimes by coming up to the teacher's desk.

7. The assignment is completed at home. This may take from a few minutes to an hour.

8. Occasional quizzes are given part way through the chapter.

9. At the end of the chapter, the students take a chapter test that covers everything in the chapter.

10. Every student passes the class and is ready for the next class in the sequence.

What Goes Wrong

The reality:

1 Hopefully the teacher can start the class right away, but there are almost always missing students. Sometimes they are ill, or on a school activity, or just missing.

2. The "good" students will have their homework done, but many students will only have what they finished in class the day before. Of course the students who were gone the previous day

have nothing done. The students who ask questions are those who mostly "get it". Students who are totally lost will usually not speak up.

3. Students with right answers are happy, but students with wrong answers (or no answers) do not learn how to do the math. When the teacher records homework scores, it is not clear whether the scores reflect student work, parent work, or copied answers.

4. Most people who are math teachers became math teachers partly because they are logical thinkers who are quick to grasp mathematical concepts. Back when the teacher was in school, all that was needed was a clear explanation, and then he or she "got it." Many students are not quick at understanding new, abstract ideas, no matter how well presented.

5. Homework on the new material is fine, but if students don't understand the explanation they are stuck. They also need practice on previous material.

6. Some students lack the confidence or ability to work independently with new ideas, even in high school. They may be easily distracted or otherwise not disposed to work in class.

7. Many students cannot complete the assignment at home. They may not understand it, or they may be overwhelmed by the amount of homework given by all of their teachers. Students may simply choose not to do the homework; because they would rather do something fun. Unless their parents are teachers, they probably do not see their parents doing homework. For some students, home life is so chaotic and unpredictable that having quiet time to do mathematics is not realistic.

8. Quizzes do serve a purpose, but there is a danger that the student who is just "one step behind" will fail every quiz and be quickly demoralized.

9. A well written test will measure student achievement, but the typical class has only five or six tests per semester. A student who isn't quite ready for a test or has other issues that day risks destroying his or her grade in one fifty-five minute class period. After that, motivation quickly drops.

10. There are frequently student who are not successful, possibly due to motivation, attendance or lack of prior preparation. There are other students who are just unable to keep up with the pace of the class.

Why We Need to Change

Many aspects of teaching mathematics have changed since I was a student in Algebra 2 class in 1969. Even for teachers who are at the very beginning of their careers, there are changes that have occurred in the last five years.

The most significant change is that every student is expected to pass at least Algebra 2, if not Precalculus. (The "Smarter Balanced" test, which may soon be required for graduation, contains trigonometry questions.) When I started teaching high school only two years of math were required for graduation, and there were a significant number of students who only completed courses such as Algebra Prep, General Math, or Senior Practical Math. Consequently we find ourselves teaching Algebra

to students who do not possess the abstract thinking skills necessary for algebra. Many of these students, who were pushed through the prerequisite pre-algebra courses, are also deficient in computational skills.

Many of our students do not seem to possess the dedication, work ethic or attention span of previous generations. I believe that this is in large part because we have students in algebra who wouldn't have been in algebra under the old more selective model. There are also social reasons for this change. One of our goals should be to teach the value of patience and hard work, but students and their parents are used to instant results and fast-paced input. With the invention of the internet and smart phones, everything changed. If you look at a movie from thirty years ago, there were many longer scenes. Today's popular movies are much faster paced, often with constant action and scenes flashing by in a fraction of a second.

The home lives of our students have changed as well. Some students are over committed, with multiple sports and activities, leaving little time for anything else. Other students are pretty much ignored by their over-worked and stressed out parents. When our current educational model was developed, once a student got home, he or she was pretty much cut off from friends. Not too long ago there was one family telephone, and one television with three networks. Now students have instant access to the world and to their friends twenty-four hours a day, and an almost limitless choice of electronic entertainment.

Most students notice early on that their parents do not do homework. Especially for students who do not see college as a realistic goal, homework just feels like punishment. Unfortunately we have all experienced teachers who use long homework assignments as a consequence of class behavior.

The consequences of failing a math class have become more severe. In the old days, it might have been tempting to "write off" students who were failing, especially if the failure appeared to be the result of lack of student effort. The thought was that the student would learn a valuable life lesson, and then repeat the class, presumably to go on to become a successful adult. Sadly, I cannot remember a single student who failed my math class and then became inspired to become a better student. Realistically, students who fail math become one of the huge army of adults who believe that they are "not good at math".

When a student fails math class, it is extremely difficult to find room in the schedule to make up the class. Since the graduation requirement will soon be twenty-four credits, any failed class must be made up somewhere else. Summer school is expensive for poor students, especially for those who need to work to support their families. It punishes the student and the student's family if they had other plans, and learning a year's worth of mathematics in a six week summer session is unrealistic. Students who have failed more than one class can easily (and correctly) come to the conclusion that graduation on time is not possible. Those students are the first to give up.

There is also a consequence to the teacher and the school for failing students. Our schools are graded on student performance on standardized tests. In all likelihood, teachers will soon be judged on student test performance as well. Students who are not successful in math class will not be successful on standardized tests.

Algebra without Homework

After several years of being away from teaching Algebra, I had the opportunity of teaching two sections of Algebra 2 last year. Knowing the discouraging failure rate that our school has experienced with algebra students recently, I decided to try to do something about it. I decided to challenge myself to teach algebra 2 without requiring homework. To make this work required several adjustments in my teaching style.

Assignments

The first adjustment was assignment length. In order for assignments to be completed during the class period, fewer problems were assigned. Because I was able to make class time more efficient, students did not actually do significantly fewer problems than in previous years. The assignments were structured differently, however. Each assignment consisted of three parts: new material, material from yesterday's lesson, and problems from the previous chapter. This resulted in some rather complicated looking assignments, but students adjusted quickly.

A typical assignment was:
3.5 p131 1-37 ei 1,5,7
3.4 p126 12-34 ei 2,4,8
2.6 p85 4-18 ei 4,8

The abbreviation "ei" in an assignment meant "ending in".
So 1-37 ei 1,5,7 means do problems 1,5,7,11,15,17,21,25,27,31,35,37. Using this abbreviation enabled me to assign fewer problems from each section than "odd" or "even" while still getting a representative sample. It also allowed me to assign odd problems (with answers in the back of the book) or even problems, or a mixture of the two.

Class Structure

The second adjustment was the way that the class was structured. The basic pattern was unchanged, in that we usually started out by completing the previous day's assignment, followed by new material. What was different is that in order to get everything done during the period, class time needed to be managed much more intently. Explanations of new material were frequently brief. Using the document camera and projector, I would often just start the new assignment, using the first problems to explain the concept. Students were expected to work the problems with me starting with the first problem.

Emphasis in this class was on guided practice. Usually I would work all of the new problems with the class, and frequently many of the others as well. By paying close attention to everyone in the class, and asking frequent questions, I was normally able to keep everyone on task and working with me. I made use of the classic technique of asking a question, and then allowing a three second pause before calling on someone. If the person I called on did not know the answer, I would simplify the question or ask a related question until I got a correct answer.

Most days I would give the class some time to work independently on part two or three of the assignment, but only for about ten minutes at a time. Students would be encouraged to work together, and after ten minutes we would once again work together to get everyone caught up to the same spot.

Before collecting the assignment, I would ask for any additional questions, and work through additional problems. When the assignment was complete I could have the class pass it forward. Since most of the problems were worked together, and in class, normally everyone had an assignment to turn in. Often the assignment was not completed the day it was assigned, so students would fold up the assignment in the book and put the book on a bookshelf on the way out. We would finish the assignment the next day. Since the students had used colored butcher paper to put covers on their books, and clearly labeled the spines of the covers, it was easy to find their books when they walked into class.

One of the keys to making this work was establishing a positive attitude in the class. The students knew that they were getting a "deal" by not having to do homework, and were convinced that I was on their side. I constantly emphasized that I believed that everyone could get an "A" or a "B", and we came close to achieving that goal.

Continuous Review

As mentioned previously, each assignment usually contained problems from the previous chapter. (Occasionally the review problems were from a review section of the current chapter instead.) We worked hard to fight the "learn it for the test and then forget it" syndrome.

Not only did homework contain review, but every test after the first contained problems from two chapters. The first half of the test could be problems from the current chapter, and the second half of the test consisted of problems from the previous chapter. I do not use the standard "book tests". This motivates students to review the previous test, and helps to cement the mathematics into long term memory.

Second and Third Chances

Students learn at different speeds, so I gave them second and third chances to show me that they had mastered the mathematics in each chapter.

After each test was returned, we worked through every problem on the test. Students were expected to rework every missed problem on a separate piece of paper (or occasionally on a new blank test if I ran one off.) These reworked problems counted as an assignment. Students were allowed to keep their tests. One week after the test, I gave a makeup test in class. Before each makeup test I gave those students who I expected to take the makeup an extra blank copy of the first test (in blue – called the "Blue Review") which counted as an assignment. Students who scored 90% or above on the first try did not have to do the blue review. Students could score up to 90% on the makeup test, replacing (but not lowering) the first score. Since the makeup test was in class, we had a clear expectation that every student who scored more than a point or two below 90% would take the makeup test. Most students were happy to, since usually their confidence level was much higher the second time.

Since each test contained material from the previous chapter, I allowed students to use a successful test score to replace the previous chapter's test with a score up to 85%. That meant that if a student was struggling with a concept (such as factoring polynomials) he or she had a total of four chances on tests or retests to prove that he or she understood the material.

I gave quizzes only sparingly, and only for single topics such as graphing the standard parabola $y = x^2$. The quizzes were only worth a few points, often five points as compared to 100 point tests. Students were expected to get the quiz correct, and if they did not they tried again the next day until they got it right.

Returning Papers

I believe it is important that math assignments are returned to students. This helps to emphasize that their work is important. I use a unique technique for passing back papers called "split it and pass it". (Or more formally, I call it the "parallel processing model".) This technique lets me return even two weeks of daily work for a class of thirty-six quickly. Here is how it works.

I start by placing the entire stack of papers on a student's desk. The student is allowed to take his or her paper only off the top of the stack. Then the stack is split in two, and each section is passed one desk towards the student whose name is on the top. The process is repeated every time a stack is passed. Soon there are papers moving all around the room, like an atomic chain reaction. I have to tolerate some noise, since if a student doesn't recognize a name he or she is allowed to ask where the student is.

The key to making this work is to convince the students that it will work. Students are not allowed to dig through the stack, and not allowed to stand up or pass a stack across more than one desk. The entire stack is done in a couple of minutes.

Grading Plan

Assignments counted as 20% of the grade during the semester. Each assignment was expected to be complete, and since they were done in class they were not individually graded. In the gradebook, I just counted each assignment as one point, since a 1 is simple to type. Students and parents understand that the homework grade is actually a completion grade. If students are absent they are expected to take their books home to complete the missing assignments. The exception to this is if a student misses one class period for an excused absence. Each assignment is often completed over two days, and we cover each topic at least twice. I frequently allow students to turn in for full credit just the part of the assignment that was completed while the student was in class.

Tests count as 80% of the grade during the semester. With two tests and two makeup tests on each topic, students can usually get at least a 70% test score for each chapter. For those few students who still do not have at least 70% after four tries, I encourage them to come in after school and work individually with me. When I am convinced that they know the material, I change that test score to a 70%.

At the end of each semester I give a cumulative semester exam. The semester exam counts as 20% of the semester grade, which lowers the weight for homework and tests to 16% and 64% respectively.

Conclusion

At the end of my first year teaching "no homework" Algebra 2, all sixty-six students in two sections passed, mostly with "A" or "B" grades. Tests were written based on tests given previously in a more standard Algebra 2 class. Students were warned throughout the year that they could expect homework their next math class. Most students will continue to Pre-calculus, although a few of the weaker students will take Algebra/Trigonometry. Students showed increased mathematical confidence and ability. Both students and parents were happy with the success found in this class.

I use the same technique of continuous review assignments and overlapping two-chapter tests in Advanced Placement Calculus. In calculus class I still allow test scores to replace the previous test, but we do not have time for retests. My Multivariable Calculus class uses a more traditional style of assignments and tests.

Every teacher needs to find a personal style that works to maximize student success. Hopefully you will be able to use some of these ideas in your classroom.

Resources

The class web page with links to the syllabus:
https://sites.google.com/site/gkellymath/home/algebra-2

Seven algebra PowerPoint lectures, including one on factoring polynomials:
https://sites.google.com/site/gkellymath/home/algebra-lectures

Instructions in PowerPoint and Video for making reinforced butcher paper book covers:
https://sites.google.com/site/gkellymath