

Superior Improvement for Under-performers: Worked Homework Solutions Are One Answer!

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Why are your under-performers underperforming, and what can be done? In our teaching experience, poor student performance can result from embarrassment or frustration at being unable to master the material, compounded by having no awareness of an easy remedy. The frustration snowballs and becomes reflected in poor attendance, tardiness, minimal homework completion, and diminished classroom participation or acting out in the classroom, resulting in poor learning, poor test results and poor grades.

A small study [1] was done in Texas in the mid 1990's where two groups of students, poor performers and good performers, were taught similarly, but with one difference: the poor performers were given their homework assignments with 50% of the problems accompanied by worked solutions. The good performers were given the same homework assignments without worked solutions. Surprisingly, the original group of poor performers achieved higher scores on the final exam than the original good performers!

Other studies and theories [2] confirm that viewing an appropriate balance of worked solutions mixed in with challenges is an excellent way for students to practice and learn mathematics. Some of the reasons include reduced stress and anxiety, reduced "wrong learning," and a higher likelihood of being able to complete the work in the time available.

Secondary math textbooks used in California typically have sections that describe a concept and then show about three worked-out sample problems, followed by a pool of 25 to 75 problems from

which homework problems can be selected. The limited number of worked examples per section is for an obvious reason: textbooks are long enough and heavy enough already without adding extra pages to every section!

As we all know, students learn using different methods and at different rates. Some students will be able to tackle the homework problems after viewing the textbook and classroom examples. Others may require numerous additional examples before they understand the concepts well enough to do the problems on their own. These latter students, unfortunately, are being left behind.

This strongly suggests that teachers send home explained solutions for half the homework problems. But, teachers may not have the time or resources to provide them. If students have access to the Internet, they can utilize the services of several websites that can help. Publishers are beginning to show extra worked examples correlated with sections of their textbooks on their websites. Holt, Rinehart, and Winston refers students to www.go.hrw.com for homework help correlated directly with their homework problems. John Wiley, Inc. offers general-purpose solver software with step by step explanations in conjunction with their calculus textbook, similar to the calculus solver available at www.calc101.com.

One website, www.hotmath.com, shows explained solutions to the odd-numbered homework problems from most of the popular secondary math textbooks used in California. Thus, teachers can now assign practice problems for homework where teacher-prepared, explained solutions are instantly available, and can mix in even-numbered problems for challenges. Students who do not need to see the worked solutions needn't bother, and students who might abuse the availability of worked solutions will be tested on the even problems.

The publisher of CPM (College Preparatory Mathematics) textbooks has subsidized the use of Hotmath.com for all users of its textbooks this school year. A recent survey [3] sent to over 2000 CPM teachers noted overwhelming support for the availability of worked solutions, and indicates noticeable improvement in student understanding as well as reduced time spent in class and office hours going over homework.

While underperforming students might not otherwise seek out extra help, they may be attracted to the above websites because of the direct relevance to their homework. Additional motivation comes from the freedom to use these websites without any fear of peer or supervisory embarrassment.

Another aspect of providing worked solutions is leveling the playing field: students with the motivation to come to office hours, the affluence to afford a tutor, or the luck to have a math-savvy

parent at home will get help on their homework problems. But for all the students who do not have these advantages, the availability of worked solutions can give them the instructional boost they may need.

We note that the availability of worked solutions has a benefit to advanced students as well: they can tackle the tougher problems on their own and needn't depend as much on teacher help. Advanced students can also work ahead in the textbook knowing that an instant "tutor" is available if their teacher is unable to spare them time.

The anecdotal student testimonials shown on the Hotmath website indicate a common theme: homework explanations were just what they needed to understand and become successful in their math classes. As electronic textbooks evolve over the next decades, we expect to see a dramatic increase in the number of explained, worked examples available to students. Our experience suggests that if viewing these solutions is directly correlated to assigned homework, then far more students will be attracted to and benefit from this proven approach.

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References

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- [2] Grillmeyer, Oliver; Chance, Sarah (2001), *Educational Foundation for Hotmath.com*, viewable at Pressroom at www.hotmath.com
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