

# AMS Homework Software Survey

*Elaine Kehoe*

Can using homework software help improve passing rates in freshman mathematics classes? High failure rates in first-year mathematics courses are perceived by administrators as a failure of mathematics instruction, and so reducing failure rates is essential. An AMS Task Force believes that the use of software to help grade homework and tests has the potential to improve student learning in freshman mathematics courses with a comparatively modest investment and to lead to higher passing rates in these courses.

As a result of the work of the AMS Task Force on the First-Year Mathematics Experience, the AMS conducted an online survey of 1,230 U.S. mathematics and statistics departments asking for their experiences using homework software and for the concerns of departments that were considering such software. (The full report of the Task Force appeared in the *AMS Notices* 56, pp. 754-60.)

Of the 1,230 departments, 467 responded to the survey. The survey responses were broken down by type of degree granted at the institutions (Ph.D., M.S., B.S.) and by private-versus-public institution, as well as by users versus prospective users.

Almost half of the 162 doctoral mathematics departments surveyed reported using homework software. Only 30% of the 190 master's-degree-granting departments and 13% of the 848 bachelor's-degree-granting departments reported using this software.

Overall, users were happy with homework software. Current users were more positive about the benefits of homework software and much less concerned about drawbacks than were prospective users. They considered the primary benefit to be better student learning and the primary drawback to be students' not showing their work.

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## Response Rates

Response rates, using college and university rankings taken from the 1995 NRC study, were as follows:

1. The top eighty doctoral mathematics departments: 71% (57 responses)
2. The remaining eighty-two doctoral departments: 65% (53 responses)
3. 190 comprehensive university (master's-degree-granting) departments: 45% (81 responses)
4. 848 college (bachelor's-degree-granting) departments: 30% (257 responses)

## Types of Software

All the homework software programs discussed can accept both algebraic expressions and numerical answers. Students log in to a website to see their assignments and enter answers; each student gets an individualized assignment with different numbers. Students can try again after a wrong answer and may be given hints or directed to tutorials on the topic. Instructors can manage and download homework scores and can typically limit the number of tries, penalize too many tries, allow hints to be displayed, and so forth. Chat rooms and users' groups are often available. Commercial software has online prompts and phone-in help services. This software can also be used to produce quizzes that are usually given in supervised computer labs.

*Publisher-supplied* software is tailored to the course textbook. Students pay a fee to get an account at the website. MyMathLab is from Pearson. WebAssign was developed independently but is now affiliated with Cengage Brooks/Cole and supports texts of other publishers; it can include tutorials and virtual labs.

Among *faculty-created* software, WeBWork, developed by University of Rochester mathematics faculty, has been the most successful. MapleTA is an outgrowth of eGrade, created by University of

Nebraska mathematics faculty, and can be hosted locally or on a Maplesoft server.

A *learning system* adapts instruction and questions as it learns about the strengths and weaknesses of a student. Forty-three mathematics departments use such systems. About six institutions mentioned using each of ALEKS and Hawkes Learning Systems, mainly for high school mathematics and remedial college mathematics. The best known locally developed mathematics learning system is Virginia Tech's Mathematics Emporium.

### Survey Questions

Following are the questions contained in the survey.

*Question 1. Benefits.* Respondents were asked whether the following benefits were a major issue, a minor issue, or not an issue in motivating the use or prospective use of homework software:

- A. Can grade homework that previously was ungraded
- B. Frees instructors/TAs from grading duties
- C. Promotes better learning (e.g., immediate feedback, ability to try again)
- D. Reduces student copying

The first three benefits were rated a major issue by a majority of respondents and a major or minor issue by almost all respondents, users or prospective users, and across all types of departments. However, "better learning" received a significantly higher overall rating than the first two; it was a major issue for 76% of respondents, averaged over current and prospective users. Benefits A and C were more likely to be rated as major issues by users than by prospective users, whereas benefit B received about the same ratings from both groups. Only 25% rated benefit D a major issue.

Some respondents noted that homework software led to greater effort and persistence by students; that it was attractive to students; and that it enforced some consistency in homework assignments in multisection courses. Others praised its supplementary tutorials and its appropriateness for drilling in basic skills.

*Question 2. Drawbacks.* The following drawbacks were rated by respondents:

- A. Students do not show work
- B. Types of questions are restricted
- C. Students get frustrated with format
- D. Students get lazy on first try
- E. Funds for student graders are lost
- F. Students can easily get electronic help

The first three were typically a major or minor issue at more than 80% of departments in all categories and among users and prospective users. Only Drawback A was a major issue for a majority of all responders. Generally, prospective users rated these drawbacks major issues more frequently than did current users. Drawback D was a major issue more for prospective users than for

users at private Ph.D. and M.S. departments and all B.S. departments.

Some respondents explained how they worked around drawbacks; for example, in-class quizzes helped to mitigate the problem of students' getting homework help from the Internet. Other complaints were that available homework questions did not cover a topic in the textbook, that it was tedious to create needed additional questions, and that students "game" the system by entering nonsense answers so that some systems will give them enough hints to make the answer obvious.

*Question 3. Status.* This question asked whether the respondent was a current user, a prospective user, or not interested in becoming a user. The respective total percentages were 54, 25, and 22% aggregated across types of institutions.

At least 44% of all doctoral departments use homework software. Doctoral departments probably have greater incentives for use, such as very large introductory courses for which there are inadequate resources for hand grading. Another advantage for doctoral departments is the availability of departmental technical support in getting started with the software. With lighter teaching loads, some doctoral faculty members may choose to spend time learning how to use such software, constructing new homework sets for this software, and instructing other faculty members in its use.

*Question 4. Which Courses* (for prospective users only). Prospective users were asked which courses their departments might be interested in using homework software for and whether they anticipated using it for all or part of the grading.

Few prospective users planned to use homework software for all grading in any of the listed courses. Typically, at least 75% of Ph.D. and M.S. prospective users were considering such software for grading some of the homework in precalculus, business calculus, general calculus, and calculus for scientists. For multivariable calculus, differential equations, and statistics, the percentages dropped to 60–70%. In general, there was little difference between the plans of prospective users at private versus public institutions, although in general prospective users at public institutions were a little more likely than those at private institutions to plan to use such software for all grading.

*Question 5. Which Courses.* Users were asked in which courses software was used and whether it was used for all or part of the grading.

The highest percentage of homework software use was for college algebra and below (87%), calculus for scientists (81%), and precalculus (78%). The percentages were about a third higher at Ph.D. departments (which used it in an average of 3.8 courses) than in M.S. and B.S. departments (which used it in an average of 2.7 courses). At

doctoral departments, users were substantially more likely than prospective users to use software for grading all homework in all the listed courses except differential equations. An example of the doctoral pattern is calculus for scientists: 35% of users employed software to grade all homework in this course, whereas only 8% of prospective users contemplated all-software grading. These users may lack the resources for hand grading, or they may have developed a comfort level based on using software for part of the homework.

For college algebra and precalculus, MyMathLab was used 50% of the time, followed by WebAssign with 25%. General calculus, calculus for scientists, and multivariable calculus were split fairly evenly among MyMathLab, WebAssign, and WeBWork (which was originally designed for calculus courses). Statistics usage was dominated by MyMathLab and statistics-specific software.

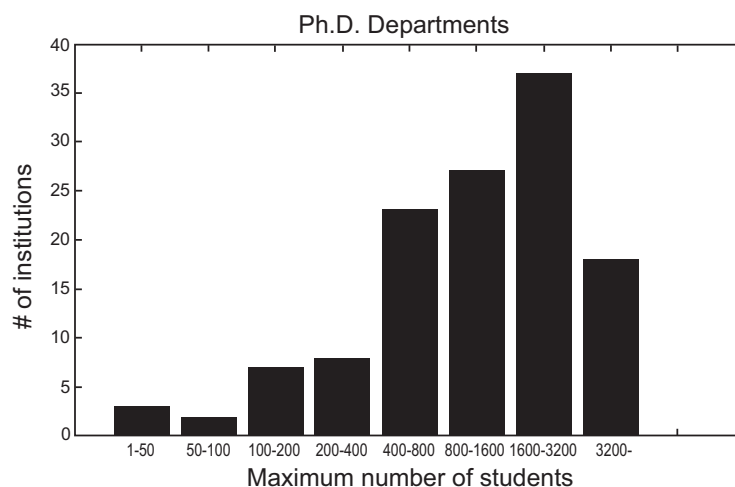
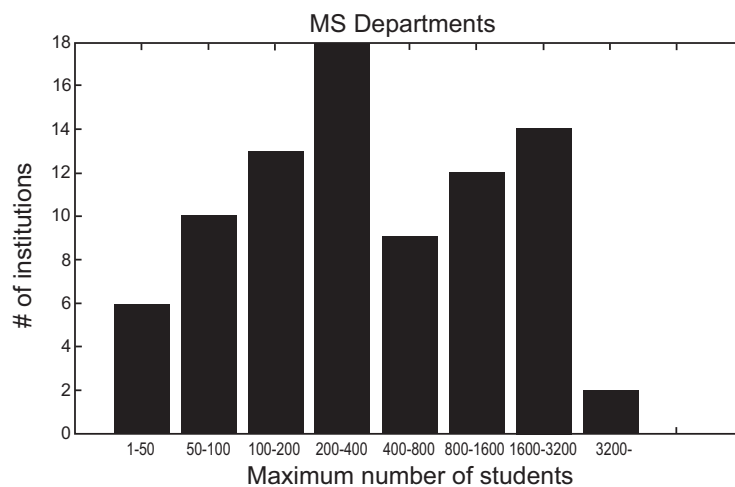
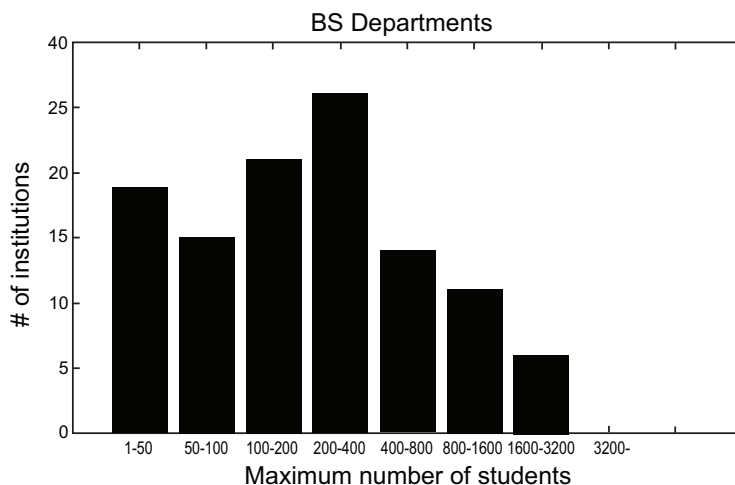
*Question 6. Enrollments of Courses Using Homework Software.* Responses reflected typical enrollments in introductory mathematics courses at the respondent's type of institution.

*Question 7. Changing Level of Usage.* There was negligible decline ( $\leq 5\%$ ) in the percentage of sections using homework software in any course. Furthermore, 35 to 50% of respondents reported increasing the number of sections using homework software, depending on the course. A few respondents were unhappy with a particular software system; they tended to switch to another system rather than discontinue the use of any homework software.

*Question 8. Which Software.* The most popular system was MyMathLab, cited 110 times, followed by WebAssign, cited 80 times (this number will grow with WebAssign's new association with Cengage Brooks/Cole), and WeBWork, cited 55 times. MapleTA was cited only 15 times. About seventy respondents listed other systems. Doctoral departments were more likely (almost 50%) than M.S. and B.S. departments to use multiple systems. Textbooks were the most common determinant in the choice of software; the textbook publisher's software was often used. Top-eighty doctoral departments were twice as likely to use WeBWork (almost 40%) as M.S. or B.S. institutions. WeBWork needs local technical support to be mounted and maintained (although small-size usage can be hosted by a WeBWork server at the Mathematical Association of America).

*Question 9: Software Enrollments.* MyMathLab was used by 230,000 students; WeBWork by a little over 100,000 students; and WebAssign by a little under 100,000 students. These numbers were affected by size of institution, enrollment in courses using software, and number of sections using software.

The following graphs show the distribution of the total number of students using homework software at different types (Ph.D., M.S., B.S.) of departments:



The histograms suggest that (1) Ph.D. departments generally used homework software course-wide; (2) M.S. departments had more partial-course adoptions; and (3) in many B.S. departments, just a few sections of a course used homework software (although another interpretation is that only one or two small-enrollment courses used homework software).

*Question 10. Obstacles to Adopting Software.* The following obstacles were rated by respondents:

- A. Difficulties in installing software on local server
- B. Inadequate technical support for start-up period
- C. Inadequate financial support for acquiring software/hardware
- D. Inadequate long-term technical support
- E. Inadequate long-term financial support for software/hardware
- F. Trouble for faculty members in learning to use the system and deal with its limitations
- G. Resistance by faculty members to using new software

Most were rated minor issues. Over 75% of top-eighty Ph.D. departments and of M.S. departments had technical start-up problems, major or minor, with all software systems. Also, 60% of these departments had problems with long-term technical support for WebAssign. However, the percentage of technical support problems for WebAssign at other Ph.D. departments and B.S. departments were comparable to those of other software, around 40%. Only a modest number of technical support problems were reported by departments using extensive learning systems such as ALEKS or Hawkes Learning System. All nine Ph.D. departments using MapleTA had start-up and long-term technical support problems (it is not known whether these departments were maintaining MapleTA locally or at a Maplesoft server).

As noted above, WeBWorK is locally maintained, and so local technical and financial support loom larger for WeBWorK. Around 70% of WeBWorK users at all types of departments reported major or minor installation problems. There were also significant start-up technical support problems, except at top-eighty Ph.D. departments.

Faculty had trouble learning to use homework software in 75 to 90% of departments. However, less than a quarter of responses rated this as a major factor for any of the systems. Faculty resistance was pervasive—80 to 100% of respondents—and was rated as a major factor by upward of 50% of respondents.

*Question 11. Attitudes.* The following groups rated their attitudes toward homework software as “very favorable, generally favorable, mixed, generally negative, very negative, don’t know”:

- A. Students
- B. Tenured/tenure-track faculty
- C. Lecturers and other nontenure-track faculty
- D. Graduate teaching assistants
- E. Faculty in client departments
- F. Campus administrators

There were very few negative responses. However, for most systems, at least 50% of the tenured/tenure-track faculty had mixed attitudes. Also, for all software, students and nontenure-track faculty had more favorable attitudes than did tenure-track faculty. At public doctoral departments MyMathLab was rated favorably by over 70% of students and nontenure-track faculty but by only 23% of tenured/tenure-track faculty. Also, WebAssign had particularly low favorable ratings, around 25%, among tenured/tenure-track faculty at M.S. departments.

### General Comments

All software systems received praise. Several department chairs wanted more of their faculty members to become interested in using homework software. Some respondents noted that their faculty believed that more students were doing the homework after the switch to homework software. Several respondents pointed to noticeable improvement in the passing rates in college algebra and lower courses, but one noticed no change. One complained that managing course homework spreadsheets was hard with commercial homework software. One doctoral respondent complained that funds for student graders were cut when homework software was adopted.

### Procedural Issues

Several survey questions required subjective judgments of the whole department’s experiences or of the general views of faculty. The views of the individual completing the survey may have biased some of these subjective responses.

Other subjective factors need to be considered. We suspect that, in departments not using homework software, a survey of individual faculty members would frequently find that some were receptive to considering its use and some were not. Because faculty typically have considerable autonomy in how they run their classes, most faculty members in a department might not be interested in homework software, even though it was being used by other faculty members. Note that question 9, asking for the number of students using homework software, provides good data about the extent of software use in a department.

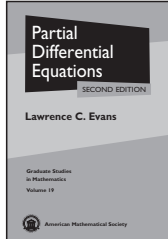
Clearly, departments using homework software or seriously interested in using it are more likely to respond to this survey. This is particularly evident with the thirty community colleges contacted, in which eight of the eleven responders were users. On the other hand, it is not reasonable to assume

that almost all homework software users responded to this survey. One of the methods used in surveys such as this to estimate the fraction of nonresponders interested in the topic of the survey is to look at the straggler responses—the very last responses that come in a month or more after most responses. Typically these late responses tend to be representative of the nonresponders. In this survey, the late responses displayed the same percentage of users as the early responses. So it is reasonable that there are a number of users who did not respond to this survey.

The Project Advisory Committee consisted of: Alan Tucker (State University of New York-Stony Brook), Project Director; Ellen Maycock, AMS Associate Executive Director and Project Liaison; Dale Alspach (Oklahoma State University); Jack Bookman (Duke University); Donna Krawczyk (University of Arizona); P. Gavin LaRose (University of Michigan); James Sellers (Pennsylvania State University); Brett Sims (Borough of Manhattan Community College); and Jean Taylor (Rutgers University, emerita).

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