LOUSIANA STATE UNIVERSITY

Baton Rouge, LA

Product Name MasteringChemistry

Course Name Introductory Chemistry, Fall 2007

Key Results Students demonstrated learning and knowledge transfer, as illustrated by decreasing problem difficulty relative to a problem's position in the assignment.

Study Design

The students were assigned weekly MasteringChemistry homework. Twelve regular homework assignments were given (except the introductory assignment to MasteringChemistry) to the class, which consisted of about 260 students. The regular homework assignments had about 15 problems on average per assignment and the end-of-chapter (EOC) problems were always assigned after the tutorial problems within an assignment. A two-parameter item response model was fitted to the data scored dichotomously based on whether or not a student obtained the correct answer to a given part of a problem on the first attempt without requesting any help from MasteringChemistry, hence obtaining the difficulty and the discrimination parameters of the problem.

Results and Data

The difficulty of the problems against its position in the assignment correlates at -0.32 ± 0.09 on average for 10 homework assignments in which a linear association between problem difficulty and problem order in the assignment can be identified. Thus, the problem difficulty decreases over a given assignment. In other words, problems given later in an assignment are easier than the ones given earlier. See figures 1 and 2.

It is highly plausible that the decrease in problem difficulty is due to an overall effect of learning within a given assignment. The instructor followed the best practice recommendations given in MasteringChemistry and selected a roughly equal number of tutorials and EOCs as much as feasible within an assignment. The tutorial and EOC problems were selected so that they covered important parts of each chapter. Although the 1 (easy) through 5 (hard) difficulty scale was not used by the instructor in selecting the problems from the MasteringChemistry's item library, the problems selected mainly fell in the difficulty range 1–3. Even if the EOC problems (that were assigned at the end of an assignment) were inherently easy, the general negative correlation does not explain the decrease in difficulty we see among the tutorial problems along the order.

Since the instructor did not consciously select problems in decreasing order of difficulty within an assignment, it is reasonable to infer that on average we see a learning effect from one problem to the next within an assignment. The average decrease in difficulty per problem within an assignment is -0.26 ± 0.13. Thus, the difficulty of the next problem within an assignment effectively decreases by about 0.26 standard deviations. Since the student skill and the problem difficulty are placed on the same standard deviation scale in an item response model, this also suggests that the increase in skill from one problem to the next within an assignment is about 0.26 standard deviations.

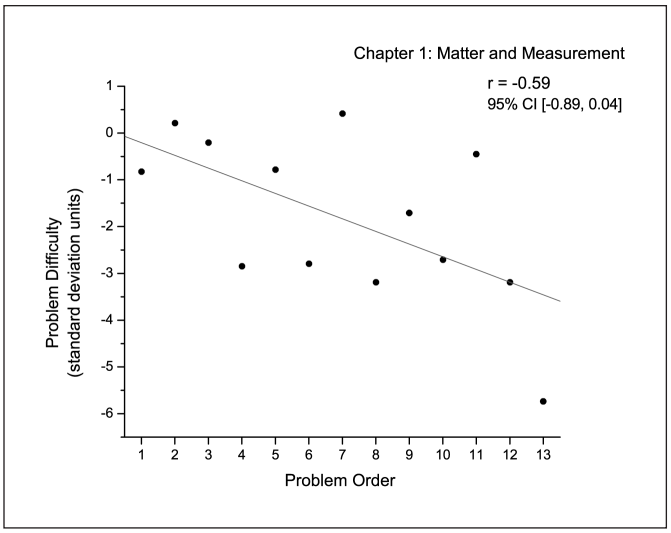

Figure 1. The difficulty of the problems decrease along the order in the assignment: Chapter 1 of Brown/LeMay/Bursten (Introduction: Matter and Measurement). The problem difficulty is reported on a standard deviation scale. A single-part problem with difficulty -1 means that a student who is one standard deviation below average in skill has a 50% chance in successfully answering the problem on first attempt.

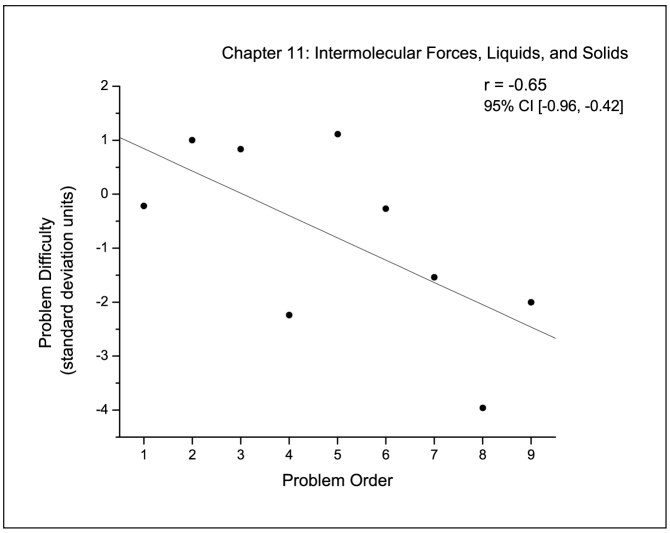

Figure 2. The difficulty of the problems decrease along the order in the assignment: Chapter 11 of Brown/LeMay/Bursten (Intermolecular Forces, Liquids, and Solids). The problem difficulty is reported on a standard deviation scale. A single-part problem with difficulty -1 means that a student who is one standard deviation below average in skill has a 50% chance in successfully answering the problem on first attempt.

Conclusion

In 10 of the 12 regular assignments given in MasteringChemistry, a linear decrease in problem difficulty occurs, with the earlier problems in an assignment being more difficult than the later problems. The average correlation between the problem difficulty and its order within an assignment is -0.32 ± 0.09 while the decrease in difficulty from one problem to the next is -0.26 ± 0.13 standard deviations. Hence, the learning effect attributable to a problem is about 0.26 standard deviations.

With acknowledgments to Prof. Randall W. Hall and Prof. Leslie G. Butler, Louisiana State University.

EXPERIMENTAL STUDY: PREDICTION OF FINAL EXAM SCORES

LOUISIANA STATE UNIVERSITY — Baton Rouge, LA

Product Name MasteringChemistry

Course Name Introductory Chemistry, Fall 2007

Key Results Research has shown that the Mastering system data can predict students' final exam scores with a correlation of over 0.6.[1] This predictive ability provides instructors with the opportunity to provide personalized instruction for students at risk of failing the course.

Study Design

The students were assigned weekly MasteringChemistry homework and were given a paper-based final examination at the end of the semester. MasteringChemistry data for 204 students was applied to develop a two-parameter item response model for answers scored dichotomously based on whether or not a student obtained the correct answer to a given part of an item on the first attempt without requesting help from the program.

Results and Data

The application of the item response model predicts the paper-based final exam score with a correlation of about 0.68. The correlation implies that about 46% of the variance in the final exam scores is explained by the regression line. The statistical uncertainty in the correlation is between 0.57 and 0.74 with high confidence.

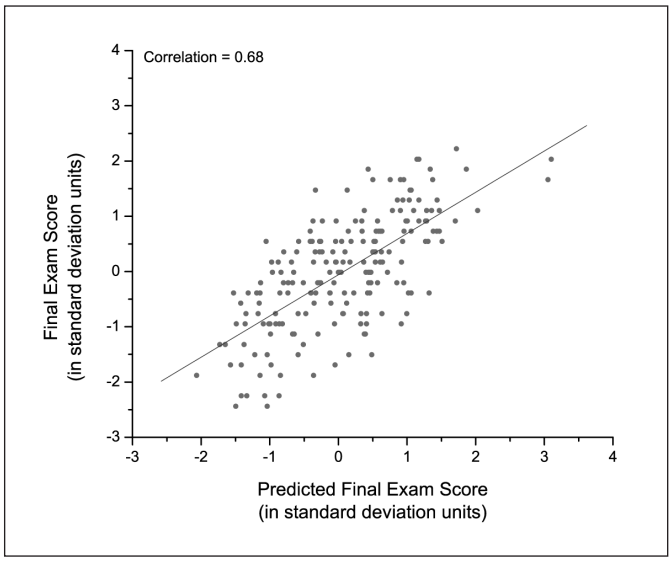

Figure 1. Correlation between the predicted versus the actual final exam score for 204 students at Louisiana State University in fall 2007 using MasteringChemistry.

Conclusion

The predictive ability of the Mastering platforms aids instructors in confidently assessing students at risk of failing the course and provides the necessary remediation. "[Given the fact that a student is being assessed] over the course of the semester over several hundreds of problems with many variables that directly correlate with [the student's] skill, it gives [a] better way to deal fairly with a student's actual skill. This eliminates the high-stakes nature of a final exam. Given such assessment capabilities, teachers could confidently determine a student's skill without worrying about the one who miraculously passed, deserved to pass, or failed, just because of some 'bad luck.'"[1]

[1] *D. E. Pritchard and R. Warnakulasooriya, Data from a Web-based homework tutor can predict student's final exam score, ED MEDIA 2005: World Conference on Educational Multimedia, Hypermedia & Telecommunications, pp. 2523–2529.*

With acknowledgments to Prof. Randall W. Hall and Prof. Leslie G. Butler, Louisiana State University.