

MATHEMATICS PROBLEM SOLVING ASSESSMENT TEST

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ABSTRACT

Evaluation of students programming skills involves various measures including mathematical problem solving skill. The Mathematics Problem Solving Assessment Test (MPSAT) attempts to help students and lecturers of introductory programming courses to evaluate student's mathematics problem solving skills prior and after attending an introductory programming course. Offering a single-time registration and quick assessment, development of MPSAT has considered various aspects including the type of questions, timing of assessment, scoring guide and the development method. MPSAT is written for Windows platform using PHP and Javascript. The preliminary test and post test, each consists of 40 questions are intelligently selected from the database. Automatic result and performance analysis adapting the six strands of California High School Exit Examination (CAHSEE) Mathematic Release Test, offers prompt evaluation on the student's performance in mathematics problem solving.

Keywords:

Computer Science education, mathematics problem solving, introductory programming

1. INTRODUCTION

Mathematics problem solving is one of the basic skills needed by students in programming course, but there is no specific test conducted yet to evaluate the level of mathematics problem solving skills among introductory programming students. Objective of the project is to implement an automated Mathematics Problem Solving Assessment Test (MPSAT) to evaluate student's mathematics problem solving skills. MPSAT will be administered once in the beginning of the semester, and once at the end of semester. Results of both tests should be compared and analyzed by the system to see whether the introductory programming course assist student's performance in mathematics problem solving skills. Lecturers can also apply learning and teaching strategies based on the diagnostic information as well as improve awareness. Krulik and Rudnick, (1996,1995), Repenning and Sumner (1994), and Langley and Rogers, (1996) defined problem solving as process of understanding a problem and come out with a means-end analysis. Programming is about writing step by step instructions to solve a problem. Studies on Mathematics in computer course have been studied by many researches.

Stein (1998), Kelemen, etc (1999), Gudzial, (2003), Kaplen, (2004) and Assiter

(2005) studied the relationship between mathematics problem solving and computer science. Kelemen, etc. (1999) highlighted the adoption of mathematics in programming including use of De Morgan's propositional rules to solve the negation process in if and if-else statements. Assiter (2005) observed that students who use mathematics in the form of formal methods (symbols and notation, logical precise reasoning, using patterns, problem analysis, modeling, abstraction, generalization, understanding software) developed better software than those who do not. Web-based assessments allow students to have independent practice and self-evaluation. Brusilovsky and Pathak (2002), Dreher and Williams (2004) and Sosnovsky (2004) explored the development of automated web based test instruments. Nguyen and Kulm (2005) conducted a study on 95 students from two different middle schools in Southeast Texas. Prior to the study, all students took mathematics pre-test and at the end of the study, they took mathematics post-test. From the survey results, 94% preferred web-based over paper-and-pencil practice (Nguyen and Kulm, 2005).

2. CRITERIA OF MPSAT

Mathematics Problem Solving Assessment Test MPSAT utilized the same strands used

in California High School Exit Examination (CAHSEE). CAHSEE was administered to high school diploma students from California public schools. All questions on the CAHSEE was evaluated by committees of content experts, including California educators, teachers, and administrators, to ensure the questions' appropriateness for measuring the designated California academic content standards in mathematics. Following the actual implementation in CAHSEE environment, the Mathematics Released Test includes statistics, data analysis and probability, number sense, measurement and geometry, mathematical reasoning, and algebra. Table 1, lists each strand, the number of items that appear on the exam and the total number of released test questions.

Table 1: Questions Distribution

Strand	No. of Questions on CAHSEE	No. of Questions on MPSAT	No. of Questions on Database
Number Sense	14	7	29
Statistic, Data Analysis, and Probability	12	6	23
Algebra and Function	17	9	30
Measurement and Geometry	17	8	30
Mathematical Reasoning	8	4	35
Algebra I	12	6	17
Total	80	40	164

For convenient purposes, the MPSAT scoring guide was adopted from the Mathematics Problem Solving guide developed by Northwest Regional Educational Laboratory, Mathematics and Science Education Center. The categories include: conceptual understanding, strategies and reasoning, Computation and Execution, Communication and Insights. The MPSAT is specially designed to evaluate mathematics problem solving skills for introductory programming students in computer science program. To evaluate how this introductory programming course has assist students in their mathematics problem solving skills, the students have to take two tests; pre test at the early of semester and post test at the end of semester. In this way, students result of both test can be compared and

analyzed to see if their mathematics problem solving abilities have improved after completing the introductory computer programming course MPSAT consists of 40 objective questions for each test These 40 questions are selected randomly according to their strand from the total of 164 questions available in the database (refer Table 1). All 164 questions are from available online databases and adopted into MPSAT, each question is given a unique code so that it is easier to manage. The code begins with two alphabets or numbers, which represents the question's strand, followed by two numbers to differentiate questions from the same strand. MPSAT scoring guide is divided into 4 levels, which are Emerging, Developing, Proficient and Exemplary. The levels were specified based on Scoring guide by Northwest Regional Educational Laboratory, Mathematics and Science Education Center. There are 4 levels of score, which are:

1. 0 - 42 (Fail)
2. 43 - 58 (Pass)
3. 59 - 72 (Proficient)
4. 73 - 80 (Advance)

Two Computer Assisted Assessment (CAA) are included in MPSAT; the calculator and the scoring assistant. The on screen calculator feature enables the student to calculate faster in order to solve the mathematics problem of the questions. MPSAT also provide students with automated scoring with detail report on pre test and post test results as well as performance analysis instantly after each test. MPSAT architecture consists of three layers which is data layer, application layer and presentation layer. In data layer, 164 CAHSEE questions from six strands are inserted into MYSQL database. Then, in application layer, these questions are selected randomly according to their strand. 7 questions is selected from Number Sense (NS), 6 from Statistics, Data Analysis and Probability (PS), 9 from Algebra and Functioning (AF), 8 from Measurement and Geometry, 4 from Mathematical Reasoning (MR) and 6 from Algebra I (1A). In presentation layer, all these selected questions are displayed as a set of 40 questions in MPSAT.

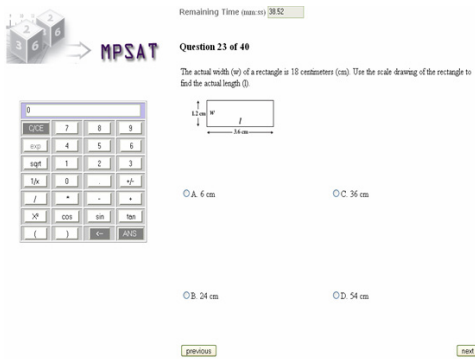


Figure 1: Test Interface

3. DEVELOPMENT OF MPSAT

The development technique is concerned with producing useful MPSAT development technique that are produced economically, implemented in the actual educational environment of Computer Science program and can be used by a large number of students to justify the continuing assessment and learning activities in this field. MPSAT offers several features for student and administrator as the user including registration, password authentication, test generator, result analysis, and question maintenance. Pre test and post test result analysis gives the details of student's pre test result consists of total score for pre test, level and description of mathematics problem solving skills, Percentage of correct answer for each strand. Performance analysis provides detail comparison on post test and pre test results as well as overall mathematics problem solving skills comparison, bar chart of pre test and post test total score, and comparison of correct answer for each strand.



Question Category: Number Sense Search

Edit Delete	Code	Question	Correct Answer
☐	NS01	The radius of the earth's orbit is 150,000,000,000 meters. What is this number in scientific notation?	b
☐	NS02	3.6×10^2	c
☐	NS03	John uses $\frac{2}{3}$ of a cup of oats per serving to make oatmeal. How many cups of oats does he need to make 6 servings?	c
☐	NS04	$11/12 - (1/3 + 1/4) =$	a
☐	NS05	One hundred is multiplied by a number between 0 and 1. The answer has to be	d

Figure 2: Question Maintenance Page

Administrator can view or search available questions in the database, add new questions and edit or delete existing questions from the database. The example of question maintenance page is shown in Figure 2. MPSAT runs on MYSQL 5.0.24a server. PHP and JavaScript played a major role as programming language used in MPSAT.

4. SUMMARY

MPSAT is a web based mathematics problem solving tool that consists of 40 questions from six strands, which are selected randomly from a set of 164 question from the database. Student is given 30 minutes to answer all questions. For the scoring guide, MPSAT use the combination of CAHSEE Raw Score and Scale Score Conversion and Mathematics Problem Solving Scoring Guide from Northwest Regional Education Laboratory. MPSAT runs on MYSQL 5.0.24a server while PHP and JavaScript played a major role as programming language. MPSAT can be administered to computer science student as a pre test at the early of semester. Then, at the end of semester, student needs to take the post test and MPSAT will compare the results of both tests

5. RECOMMENDATIONS

There are many opportunities for future research in this area. Functional testing should attempts to find errors such as incorrect or missing functions, interface errors or error in data structure. A future study should be conducted to test whether it really meets the actual requirement of introductory programming students in computer science program.

6. CONCLUSION

MPSAT allows lecturer and course coordinator of introductory programming course to rapidly and reliably measure the mathematics problem solving skills of their students as a formative and summative assessment tools. As a result, more effective teaching skills can be apply in order to helps students to develop their mathematics problem solving skills and at the same time gain deeper understanding on how to get excellent result in the programming course.

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