

Assistant for math reviewing

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Abstract

If students want to practice or review any knowledge, they may look for related exercises to improve their proficiency in the knowledge. But choosing exercises that fit students' present proficiency by students themselves is difficult and wastes much time. The educational app: Assistant for math reviewing can find appropriate exercises automatically and dynamically for students to help them improve quickly and efficiently. This app gets students' proficiency based on their performance in answering exercises and gives advice for students to review based on their proficiency. The author addresses the following questions: what kind of exercises or knowledge should students review? How often should students review? How Assistant for math reviewing helps students improve efficiently. This paper outlines how Assistant for math reviewing works, what benefits students can get from this app, why this app can offer benefits, and why this app is better than other tools for reviewing math.

Keywords: math reviewing, computer-assisted learning, intelligent tutoring systems

1. Introduction

Nowadays, students make wide use of many exercises and analyze of knowledge to review some math knowledge from various kinds of sources, such as the internet and bookstore. But there are too many exercises for students to finish them all. Therefore, no doubt every student chooses some of the exercises. However, students may need more from the exercises they choose. How to choose proper exercises which can truly help students improve efficiently is another problem. Assistant for math reviewing is designed to help students find proper exercises and offer many other kinds of assistance to help students better master the knowledge, such as analyzing the ideas of solving problems, explaining how to use the knowledge in the exercises, and explaining the principles of the knowledge.

Reviewing is more than answering some random questions again and again. Its goal is to make students understand and master the knowledge. Students are supposed to choose questions and review content wisely. In other words, students should take a practice that fits their present proficiency in the knowledge they want to review. Thus, reviewing requires proper practice to get a deep and full understanding of the knowledge, and then reviewing can help students use the knowledge they review to solve related problems, proving that students master the knowledge (Mostow, 2012).

Assistant For Math Reviewing focuses on improving students' proficiency in knowledge efficiently by offering exercises with proper difficulty and reminding students to review related knowledge with the right frequency, as does this paper (Mostow, 2012).

Students enter some keywords and choose the difficulty

of these exercises for this app as input. Then, this app generates related exercises according to the keywords and difficulty. After that, students are expected to answer the questions (exercises). The app allows students to ask for hints and concrete answers during the answering. After answering, the app can calculate students' proficiency based on their answering performance. Finally, the app offers exercises that fit students' proficiency to help them review related knowledge.

Assistant For Math Reviewing gives exercises with different difficulties to students with different proficiency. For example, if a student is very proficient in the knowledge, the Assistant For Math Reviewing will offer exercises with great difficulty. If another student behaves badly in the knowledge, the Assistant For Math Reviewing will offer exercises with low difficulty. The flowchart of the application is shown in Figure 1.

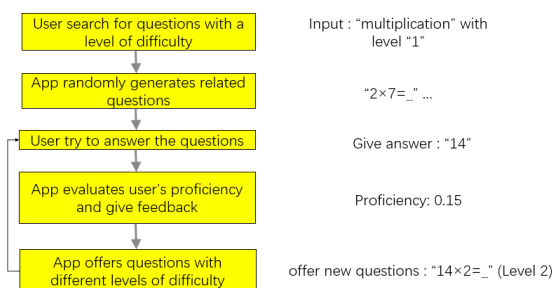


Figure 1: The workflow of the app

2. The interaction between students and this app

Assistant for math reviewing records information for several purposes. By detecting students' performance when answering questions, it decides what and how to

respond. By comparing each text word with the accurate answer, it detects miscues students make. Recording what questions students do wrong creates notes for students.

Question bank

Sometimes students want to record some special questions which do not exist in the system's question bank. Assistant For Math Reviewing allows students to add questions to the question bank in the system directly. Besides, students can add some labels to the questions. By searching for the labels students add, students can get the questions they add to the question bank.

Additionally, any question in which students make mistakes is recorded in the system. Students are allowed to manage the recorded questions. They can make a system record any question if they want. They can also delete any question in the record and highlight it to show its importance.

Offering help

In many cases, students find reviewing ineffective because they use the wrong methods. The Assistant for math reviewing offers help when students get into trouble and leads them to answer the question step by step. Moreover, after answering, the Assistant for math reviewing advise about what to learn next to better understand the question and knowledge for students based on their performance and the questions they try to answer. In this way, students can get comprehensive and useful help from this app to make themselves improve quickly.

For example, when a student pauses at a question, an assistant for math reviewing will pop up a tip to ask the student if he needs any help. Then, if the student clicks "YES" according to the question, the system will properly help the student move on and think by himself to answer the question. After answering, the Assistant for math reviewing offered advice for further reviewing. If the student answers the question correctly, the system may recommend that him to try to answer more challenging questions. On the contrary, if the student makes it wrong, the system will show the concrete answer and explain it step by step. Besides, the system is supposed to recommend that the student try to answer related questions with the same difficulty again to ensure that the student controls the knowledge he wants to review.

Interface

The activities in Assistant for Math reviewing are built out of several types of steps, each with its screen interface(Mostow, 2012): searching for questions(exercises) by keywords (knowledge); answering questions; checking the question bank; question(exercise) recommendation; review reminder; the analysis of questions.

3. Models

There are five levels of difficulty in Assistant For Math

Reviewing in total. The higher the level, the more proficient. Assistant For Math Reviewing gets any question's difficulty level based on the knowledge used in the questions, the number of steps that must be taken to solve the question(exercise), and the number of knowledge used in the question. The following is an example. If there is a question whose topic is "Simple addition" and just using oral arithmetic can finish the question, the difficulty level of the question is 1, which means that the question is extremely easy and only be recommended to beginners in math.

Furthermore, Assistant For Math Reviewing measures students' proficiency by their performance when answering questions. Students' performance includes many aspects, such the accuracy, the frequency of seeking help, the frequency of asking for concrete answers, the number of finished questions and the time spent finishing answering, and the difficulty. Among these aspects, asking for a concrete answer can be seen as a wrong answer with the same meaning: the student does not know how to answer the question. Besides, there is a maximum of proficiency in each level of difficulty, which shows the influence of the difficulty level on proficiency. If a student wants to get the highest proficiency, the student must solve the questions with difficulty level 5 perfectly. The following is an example. Suppose a student finishes 20 questions with difficulty two, his accuracy is 0.81, the frequency of seeking help is 0.05, and the frequency of asking for concrete answers is 0. In that case, the app will conclude that the student's proficiency is 0.37. So it is obvious that the student has high proficiency.

Moreover, this app calculates the best difficulty level (output) of questions that students are supposed to review based on their present proficiency and present difficulty (input). For instance, if a student's proficiency is 0.68 in the questions with difficulty level 3, the app will offer questions with level 4, which means difficulty level 4 suits the student's present proficiency better. On the contrary, if a student's proficiency is 0.13 in the questions with difficulty level 3, the app will offer questions with level 2, which means questions with level 3 is too hard for the student to do with.

Equally important, the best difficulty level of questions that Assistant For Math Reviewing offer means that the student's proficiency will grow the most if the student chooses to review or finish questions with the best difficulty level. After continuous training and evaluation, the model can be continuously optimized(Mostow, 2004). For example, there is a student whose proficiency is 0.34 in questions with difficulty level 2. Then Assistant For Math Reviewing will offer questions with difficulty level 4.

After answering questions with difficulty level 4, the student's proficiency is supposed to increase to 0.57 based on this model. The highest proficiency means that the student masters the knowledge.

4. Educational Data Mining

Manual labeling

Although the Assistant gets too much data to inspect by hand, manual analysis of a strategic sample can be very helpful. Analyzing 20 random examples by hand often reveals bugs or insights (Mostow, 2004).

Mine data when students are answering questions

Assistant For Math Reviewing my data from students' profiles and the process of answering questions. Specifically, according to students' age and educational background, the Assistant For Math Reviewing give recommendation that fits students' present study career. For example, if a junior school student uses Assistant For Math Reviewing, the app will offer questions like "15×16=_" instead of "The area of the graph enclosed by the curve $r = 2\cos$ is _", which is too difficult to solve for the student. Additionally, just as mentioned before, the Assistant For Math reviewed my data like accuracy, the time spent finishing answering questions, and so on when students are answering questions. All these data app mines can contribute to offering appropriate questions to students and help them improve quickly.

5. Embedded experiments and evaluation

But there is another problem: how to ensure our models truly work? It is necessary to design experiments to evaluate the models and prevent their over-fitting because of the lack of data. The author uses a ten-fold cross-validation, dividing the students randomly into ten disjoint sets, as illustrated in Figure 2. App trains on nine sets, tests on the held-out set, repeats this procedure for each set, and averages the results (Heiner, 2004). We evaluate the model by comparing the average results with those obtained from the models. For instance, If the model calculates the best level of difficulty of questions that fits students. Each test set gets the best level of difficulty L in training sets and the average growth rate gr of the proficiency in the test set by using L. Then we evaluate the model by comparing gr with the growth rate we get in the model. If these two results are similar, the model will behave well in calculating the best level of difficulty of questions to offer next. But if they are different, the model may appear over-fitting, and we can choose a better parameter in the model by ten--cross-validation.

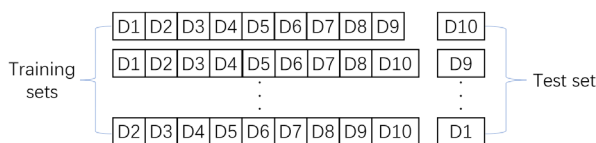


Figure 2: Ten-fold cross-validation

6. Conclusion and Future Work

The author presents an educational app that assists students in reviewing math knowledge. This app, Assistant

For Math Reviewing, offers related and appropriate questions to students based on their present proficiency to help them quickly master the knowledge. Assistant For Math Reviewing measures students' proficiency, their performance in answering questions, and the difficulty of the questions. Then, the Assistant For Math Reviewing calculates the best difficulty level of questions to offer based on students' proficiency. Students can constantly practice using Assistant For Math Reviewing until they master it. Meanwhile, the Assistant For Math Reviewing offers questions that suit students best to help them improve efficiency.

The author wants to build an educational learning tool for students and teachers to help them better communicate with each other. Students can raise any question, and the teacher can offer help to students. In this case, students can get insufficient help by using Assistant For Math Reviewing. Moreover, the Assistant For Math Reviewing is expected to help students effectively when they are answering questions and asking for help. Though giving help influences students' proficiency, effective help can help students better understand the questions and knowledge. It is necessary to offer help when students are answering.

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