

Intelligent Class-based Math Theory Searching Software

-- Report of 8-hour Fujen PBL course

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Abstract

Artificial intelligence is gradually becoming the forefront of technological development under the advancement of the fourth industrial revolution. Its application in education has also been developed to a great extent. Artificial intelligence can help to improve the quality and efficiency of education teaching so that students can learn the correct and more suitable content more quickly and effectively. In this paper, an app for artificial intelligence in education will be proposed, explained, and analyzed. The discussion is divided into six parts: app design overview, automatic text recognition in intelligent teaching systems, modeling, educational data mining, evaluation, and embedded experiments.

Background

In the large data environment, AI technology will subvert the previous education knowledge system so that there is no boundary between disciplines, general education, and professional education interact, and education content is constantly diversified. In addition, using an AI learning platform, personal learning behavior data can be recorded entirely, including everyone's interests, preferences, learning levels, etc. The system will determine the content, method, and schedule suitable for each person to learn and truly realize personalized service. The student structure is relatively complex, There are individual differences, so it is necessary to teach students according to their aptitude. It cannot be ignored. The most modern digital learning management system allows teachers to create Conditional activities according to students' previous Achievements in the task, providing students with no Same selection. AI also needs to be applied in school management and teaching achievement improvement. To make teachers easier to accept AI technology, the threshold for using AI technology should also be lowered. Teachers are not experts in information technology. The ease of use of technology is the key to improving the teaching effect of teachers relying on good information technology. The use of AI educational applications to improve the teaching efficiency of educators and reduce the workload can enable educators to accept AI technology and increase interaction with AI applications to allow AI to technology to achieve large-scale applications and generate teaching big data.

Part1 App Design Overview

This section will introduce the app design process in this project, including inspiration sources, target audience, app usage pipeline (including a specific example), difficulties and solutions during the design process, and the improvement process.

“Education is the basis for the development of human talent, and its purpose is to improve human intelligence and an activity that is almost the same as artificial intelligence.” This is said by Jiang, M., Xu, Z., & Shen, Z. (2021). Artificial intelligence and education goals have a high degree of similarity, so applying this emerging technology to education is appropriate. Pedagogy has been well-improved and perfected since ancient times. The application of artificial intelligence will also allow it to be further developed.

Sources of Inspiration

In Zheng, H. U., & He, W. (2021), many typical AI+education application scenarios are categorized and listed. In the “Management Solution” module, “Intelligent Teaching System (Decision Support Service)” is mentioned, whose leading technology is to use deep learning and machine learning to analyze various data generated in knowledge teaching and student management and to extract useful information to obtain knowledge to assist in school management decisions. In the “Learning Episodes” module, “Intelligent Teaching System (Intelligent Recommendation Service)” and “Camera Search; Online Question Answering” are mentioned. They apply technologies such as image recognition, deep learning, and data mining to assist students in personalizing their learning and teachers in making teaching more accessible and more efficient.

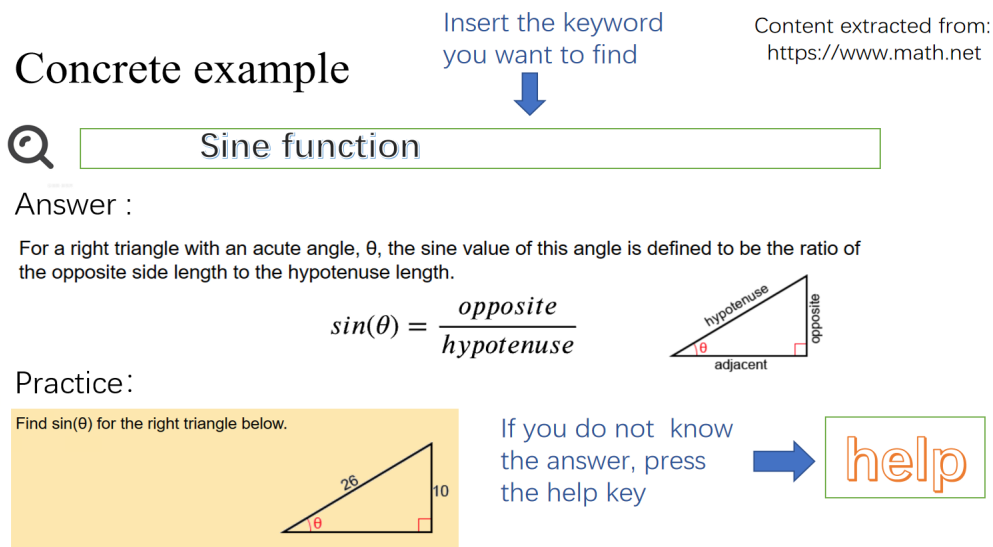
The app's primary function is to search online for mathematical theorems, theories, etc., to help students learn, consolidate and practice the content.

Target Audience

The target audience for this software is mainly middle school or high school students. As you can see in the previous article, this software is expected to be used on a classroom basis. When analyzing the data, useful information about the students in a class can be extracted, and appropriate analysis can be made and provided to

the teacher, who can then make the next decision. For example, changing the teaching plan to help students learn better. That's why we set the target population as mainly middle school or high school students. Because younger students may not use the software or be exposed to much mathematical theory, they cannot function with it. And most of the older college or graduate students do not study as a class. They have different learning content, which will make data analysis difficult and inefficient.

The pipeline of using the App



First, enter the name of the mathematical theory you need to search for. (Note: the input may not be completely accurate).

The second step is to connect to our database. In this step, the content entered in the first step will be “normalized.” It matches the similarity with the standard terms and identifies what the user is searching for.

The mathematical theory is explained in the third step, and some examples are given to facilitate understanding. A practice problem is also presented to confirm that the student has learned it. The effect of consolidation is achieved.

The fourth step is data processing, analysis, and feedback. The data extracted from the first three processes are integrated, compared, etc., under the same chart. The final information or conclusion is presented to the teacher and students.

Difficulties when designing processes and the solutions

1. Consider that the user’s input is not necessarily the exact content. It is possible that it even be directly understood by the computer. So the second step is added, and a database is designed. Contains all the mathematical

theories that this software can search for.

2. When presenting the interpretation of mathematical theories. After analyzing the data, our results need frequent improvement to make students easier to understand and have a better teaching effect. This is to manipulate our database. For example, in the explanation of trigonometric functions when the interpretation of the image is much better than the text.

3. Considering that students may not be able to answer the sample questions given by the software correctly. The “help” button is added, which, when clicked, will present other explanations of the mathematical theory, and will also give the steps for solving the practice problems. After this, other practice problems will be matched. This process generates a lot of valuable data, such as the number of clicks on the “help” button, the percentage of people who can successfully solve the exercises after the click (whether the help is effective), etc.

Part 2 ASR in ITs

The full name of this section is Automatic Speech Recognition in Intelligent Tutoring Systems. However, as you can see in the introduction of the software features in the first part, this project was designed without

the inclusion of speech recognition. Instead, speech recognition is a redundant process for the functionality of this software. The user only needs to enter text or click the mouse option to complete the application function during use. So an adjustment was made in the design: brilliant speech recognition was changed to intelligent text recognition.

Smart text recognition was applied in two main steps in the design of this project app. The first is in the front end, during the user input. The second is after the software gives practice questions, students need to recognize the feedback they give when answering them. In this part of the article, we will discuss the two directions. After reading several reports by the professor and other papers in the online library, Mostow, J. (2012) was chosen as the primary source of citation for this part of the study, as its presentation fits better with the direction of this project.

Front-end input

As you can see in the second step of the software usage pipeline, it converts the potentially inaccurate input of the user in the first step into an accurate mathematical theoretical expression. That is, it is transformed into language that can be recognized by the computer and then matched with the content of the words in our database to find the corresponding content. In Mostow, J. (2012), it is recognized that several language situations can occur when children are learning to read.

Among those that are more closely related to this item are expectations and truncations. For example, if the correct input is a sine function, but the student only enters sine, we can associate the whole word with it, which is the expectation. In another case, the student enters the sin function, which is a typical case, this is an example of truncation, and we can also associate the correct entry.

We will get an accurate representation after normalizing the “fallacies” in the above text input. We would like to see this because it is easier to match with our database. It will also help students correct mistakes (e.g., misspelling sine as sin). This is not a huge problem, but it is necessary.

In the practice module

This refers to the process by which students give feedback on practice problems after being presented with an explanation of the theory of mathematics and a practice problem. They are expected to provide a correct answer at this point. However, this is an ideal situation, and they may not be able to solve the problem well after a long period of reflection.

In Mostow, J. (2012), it is mentioned that “From an ASR perspective, children’s oral reading is often characterized by hesitation, false starts, lapses, regressions, list-like rhymes, and off-character speech.” Students may also experience a hesitation when making an answer to a question, which is the time used to answer it. There may

be mistakes, i.e., mistakes in the initial answer. There may also be a “regression” process, where the question or a similar question is re-answered correctly. This can be seen as intelligent text recognition of student feedback. A lot of valuable data is generated in this process. For example, the time to answer, the probability of error, the probability of using help, and the probability of correct answer after using service.

Part 3 Models

In this part of the paper, the models and knowledge used in the app design of this project will be presented. This module is divided into three main parts, as follows: Student models, Pedagogical models, and Learning Decomposition Method.

The five models used in an intelligent teacher process, including Language models, Domain models, and so on, are introduced in the course taught. Among the most useful for this project’s app are Student models and Pedagogical models.

Student models

Student models estimate a student’s skills. Imitating the professor’s study, we also asked: when would a student request help on an exercise problem?

Data (hypothetical): 3 months of Tutor use by 100 students

Average ~20 hours per student

Transactions logged in detail

Help request rate when solving exercise problems: 0.5%–54%

Method: train tutor using the word student, history

Result: Summarize better ways to explain and reduce students’ HELP clicks to help them use the software and learn better.

Pedagogical models

Pedagogical models decide on the better tutoring mode

Problem: Which types of help work best?

Data: 270 students assisted in solving the exercise problem

Method: randomize the choice of help and analyze its effects. For example, the answer to the question is given directly, and other answers to the mathematical theory are provided to guide the students in making their answers.

Result: detected significant differences in effectiveness.

Learning Decomposition Method

The following content is studied by Beck, J. (2006). The standard learning curve approach assumes that all skill learning trials are equal. But some theories predict that certain types of practice may be more conducive to learning than others. So, trials can be broken down into various types of practice. The learning curve assumes that both types of exercise are equally valuable and that the

number of trials of both types should add up. But what about the fact that both types of practice are not equally valuable? The basic idea of learning decomposition is to find how to weigh the two types of trials to construct a best-fit learning curve.

The idea of learning decomposition allows the software to better serve the student. Break down a mathematical theory into reading the explanation of the theory, trying to solve the examples, using the “help” button, and learning in a different way than before. Finally, make sure the student learns the content. These steps have different values and help students in different ways. So by learning the theory of decomposition, they can be differentiated and analyzed to obtain further results. For example, which step the student gains the most, etc. Getting this data can also help us improve the software’s framework and content, etc.

Part 4 EDM

Two basic data

Regarding educational data mining, the app needs two basic and important data, and the first one is the frequency of every theory searched, from which the app can know how well the whole class and each student master the relevant theories. Because our explanations of relevant theories come from databases or websites, some explanations are unclear and easy to understand. In this case, the other data is about the number of times the help key is clicked, using which we can assess whether the interpretation of this theory is accurate and clear.

Thus, these two data will be collected and analyzed. Then the teacher can get the feedback from the app. For example, if the students often search for the theory about the sin function, which means that he or she cannot understand the sin function excellently or he can’t master it well. From another perspective, if the whole class searches for a mathematical theory frequently, it shows that this mathematical theory is difficult, and the teacher may need to explain it emphatically. As for the second data, if the times are high, it proves that this explanation is not easy to understand and needs improvement. It needs to modify the content to make it comprehend simply.

Grasp the relationship between the teaching environment and the app.

If the teacher fails to clear in time during the teaching process, Clearly recognize the relationship between students’ ability to accept knowledge and The ability to understand, it is likely to cause students to understand Confusion of knowledge.AI technology provides understanding Methods to solve the problem, such as students can Intelligent teaching system for open online courses Hand in the homework when the system finds the

home submitted by the student When there are a lot of wrong answers in the court work Later, the system will automatically send a warning to the teacher Generate an error report and send it to the school at the same time Teachers can reflect on the problems in the teaching process through systematic feedback. Students can also get the prompt of correct answers the first time. This app helps to fill in the explanation gaps that may appear in the courses and helps to ensure that all students have the same conceptual basis.

Algorithms and models

Due to the usage of the database, Sunayana Sitaram and Jack Mostow have argued that the app should use database keyword search and the SQL language, apply the search algorithms and different operators and use the narration model to analyze the number and frequency(Sunayana Sitaram and Jack Mostow 2012).

Part 5 Evaluation

Multi-dimensional analysis of course data

The app is a platform to provide more learning resources for students and help teachers analyze students’ learning situations [6]. Teachers can continuously optimize their teaching content and methods through the Education App’s data collection and analysis functions. With the help of data, teachers can evaluate the actual situation of students from multiple perspectives.

- (1) The time spent by students to complete each mathematical theory content;
- (2) The number of times the students have searched for each mathematical theory content;
- (3) The specific completion of the exercise (help click times, completion time);
- (4) Results of mid-term, final, and usual in-class tests

In this app, you can make detailed statistics and analyses, such as the specific data of students in completing various teaching activities, including the number of points obtained by completing tasks, etc. Through these data, teachers can fully understand the actual learning situation of students from a macro perspective and then urge students to actively research and learn.

Realize the organic combination of app and offline teaching.

For the teaching mode based on the learning education App, there is still a situation in which the app and offline teaching are separated from each other in the specific operation process. Although the app can meet the actual requirements of students’ autonomous learning, it lacks rationality in content release and time arrangement, especially in the specific content arrangement such as pre-class guidance, task arrangement, key and difficult knowledge analysis, etc., It makes it difficult for teachers

to understand the actual online learning situation of students from multiple channels, which affects teachers' classroom teaching design and also leads to the reduction of learning enthusiasm of many students. In the paper, Guo Ting said that If you want to fundamentally solve the existing problems in this regard, the key is to comprehensively plan and use the app and offline resources, take into account the specific learning progress of students, clarify the key and difficult problems in each stage of education, and provide a set of learning videos and learning courseware, and use the feedback results obtained as an essential basis for offline teaching adjustment(Guo Ting,2022)

Two criteria

For the part evaluation, there are two criteria to judge the app. The first one is to calculate the frequency change of each math theory search over time. And the other is to consider whether students can answer the following exercises after reading the explanation. Suppose the students in this class use this app to search specific mathematical theories less and less frequently. In that case, it means that the students have a higher degree of mastery of this mathematical theory, which shows that our app has an influence. Suppose the students can answer the practice correctly after reading the explanation. As a result, the time of clicks of the help key will be low, proving that our app plays a significant role in making students have a good command of these theories.

Part 6 Embedded experiment

Explanation form experiment

As for the part-embedded experiment, the first experiment is to explain in different ways to see which makes students understand better. In this case, it choose five forms to compare: 1. words 2. graphic 3. mixed with words and graphic 4. formula 5. form The experiment invited 500 students to participate in this experiment. Their learning level and IQ are at the same level. They are divided into five groups. Select a mathematical theory topic that they have not learned. Each group chooses a different form of explanation to read and then records the proportion of each group clicking the help key. It found that the percentage of click help in the first and fourth groups reached about 80%, the fifth group was about 50%, the second group arrived at about 40%, and the third group went a minimum of about 2%. From this experiment, it is concluded that the explanation should be more understandable by combining words and graphics so that students can understand.

The benefit of app experiment

In the second experiment, 200 students with similar intelligence levels and learning abilities were selected for a one-month test. One hundred used our app while learning, and the others tested pure learning. One month later, take a math test on the two groups of students and check the average scores of the two groups. The experimental results show that with the help of our app, students can still make specific progress in math scores. Compared with the traditional teaching mode, the new teaching mode that integrates app and offline teaching has a stronger subjectivity status of students, and the update speed of policies related to asset evaluation is also relatively fast, so teachers also need to effectively update the syllabus, teaching plan, teaching courseware, and exercise library.

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