

Implementation of Fisher Yates Algorithm for Question Randomization in Human Digestive System Educational Application

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ABSTRACT

At SMPN 1 Lebakwangi, the teaching and learning process of science subjects in class VIII has utilized media such as books and videos, with identical exercises and quizzes given to all students. However, this approach faces challenges due to the limited variety of learning media and practice questions, which rely heavily on textbooks. As a result, students often struggle to absorb and understand the material effectively, finding the learning process less interesting and diverse. This research aims to develop alternative learning media in the form of an educational application that focuses on the human digestive system. The app incorporates the Fisher-Yates algorithm to randomize quiz questions, ensuring that students receive different sequences of questions. The system was developed using RUP (Rational Unified Process) methodology, and the design was made with UML (Unified Modeling Language). User Acceptance Test (UAT) results show the effectiveness of the application, with scores of 91.66% for appearance, 92.47% for material content, 89.74% for learning process, and 91.77% for improving understanding. This educational app serves as an interactive, engaging, and diverse learning medium, offering alternative practice questions that improve understanding of human digestive system material.

1. Introduction

Technological advances have paved the way for innovative approaches in education, where educational applications are becoming increasingly prevalent as a means of enhancing the learning experience. Education plays a role as a means to improve students' knowledge and skills, which requires more interactive learning media innovations to be able to support the success of the teaching and learning process [1]. Learning media plays an important role as an intermediary in the delivery of material, both through books, videos, and interactive educational applications [2]. Learning is an interactive activity that involves two main parties, namely teachers and students, with the aim of improving understanding and assignment of learning materials [3].

The teaching and learning process at SMP Negeri 1 Lebakwangi grade VIII who study Natural Sciences (IPA) in odd semesters must explain material about the human digestive system. During the teaching and learning process, the media used are books that have been determined by the school and video media, but what is often used by teachers is video media, where the teacher invites students to watch a video of the human digestive system material until it is finished, after which it is followed by a question and answer session. However, the learning method is by using

books. However, the learning method using books results in students being less able to absorb in understanding the material well and is less interesting and the learning method using videos can only be seen during lesson hours. Therefore, more interactive learning media is needed to increase students' understanding of the material and make the learning process more interesting.

There are two systems or methods used during quizzes, the first is that the teacher prepares questions in the form of paper that is given to each student, and second, the teacher prepares a quiz through a google form. However, by applying these two methods, each student will get the same order of questions when doing the quiz, so it is necessary to randomize the questions so that each student gets a different or varied order of questions. Therefore, a different media approach is needed besides quizzes using paper and google forms. So, another alternative that can be used is needed, namely utilizing educational application technology as a means of learning in Natural Sciences (IPA) subjects.

One of the solutions to overcome these problems is to develop an educational application that is equipped with a question shuffling system so that each student gets a different variety of questions. The Fisher-Yates algorithm can be implemented for the randomization of exam questions in android-based learning applications

[4]. Fisher-Yates is a method that can create random permutations, named after Ronald Fisher and Frank Yates. This algorithm has the ability to create unique randomization and can shuffle objects in a variety of ways [5].

Related research has been carried out by Sukmana who implemented the Fisher-Yates shuffle algorithm in a mathematical educational platformer game [6]. This algorithm is effective in generating random permutations of finite sets, ensuring that the sequence of questions presented to each student is unique [3]. Another study conducted by Andriyat, R. A. K. (2025) The Fisher-Yates Shuffle algorithm can be a fairly efficient alternative to shuffling arrays or lists of data [7].

Based on this background, this study aims to implement the Fisher-Yates algorithm in an Android-based educational application with human digestive system material. It is hoped that this application will be able to improve student understanding, create a more interactive learning experience, and provide alternative learning media for teachers and students.

2. Method

2.1 System Development Method

The system device development method that will be used in designing this application uses the RUP work methodology (Rational Unified Process).

RUP stands for Rational Unified Process, an iterative software development process framework created by Rational Software, a division of IBM since 2003. RUP is not a single process with concrete rules, but rather an adaptable process framework meant to be customized by development organizations and software project teams who will select process elements according to their needs [8].

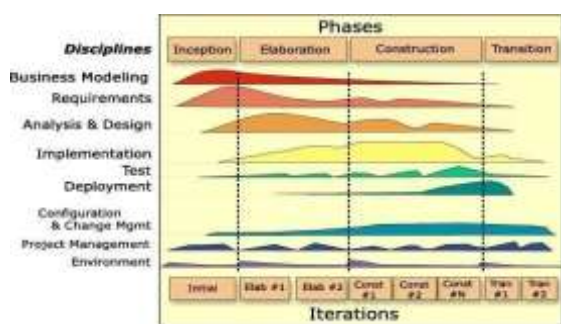


Figure 1 Rational Unified Process [9]

2.2 Data Collection Method

Observation: Observation is a data collection technique by conducting direct observation with the intention of understanding and obtaining information with a phenomenon or event that has or is happening in the environment [10]. At this stage, the author obtained permission from the school of SMP Negeri 1 Lebakwangi to conduct research on the learning

process, especially the subject of Natural Sciences (IPA) class VIII odd semester on the material of the human digestive system.

Interview: Interview is a data collection technique that is carried out through face-to-face meetings. and question and answer directly between the researcher and the interviewee [11]. In this study, the authors conducted interviews with teachers teaching Natural Science (IPA) class VIII SMP Negeri 1 Lebakwangi, the teacher interviewed regarding the author's research was Mrs. Nenden Ratna Suminar, M.Pd.

Literature Study: This literature study was conducted by the author to obtain relevant information related to the research [12]. In this study, the authors collected literature studies by searching for data on written sources such as books, journals, articles, and sites on the internet related to android applications, fisher yates algorithms, Natural Science material about the human digestive system and others.

Questionnaire: Questionnaire is a technique of collecting data or information through forms that contain questions that can be addressed to a person or group of people in the organization to get responses or answers that will be analyzed by those who have a specific purpose [13]. At this stage, the author sent questionnaires to respondents, namely students of class VIII A, this was useful for knowing the understanding of the material, the learning process, and the media used at SMP Negeri 1 Lebakwangi.

2.3 Analysis and Design Methods

In designing the human digestive system educational application, the method used is RUP (Rational Unified Process). RUP has four phases in software development, namely:

Inception: At this stage it is more modeling the necessary business processes (business modeling) and defining the needs for the system to be created (requirements) [9]. At this stage the author conducted observations, interviews with Mrs. Nenden Ratna Suminar M.Pd., as a Science Teacher (IPA) SMP Negeri 1 Lebakwangi, literature studies and questionnaires.

Elaboration: This stage is more focused on system architecture planning. This stage can also detect whether the desired system architecture can be created or not, eliminate the worst risks that the project will experience, and analyze problems [9]. At this stage the author makes use case design, scenarios, activity diagrams, class diagrams, and sequence diagrams as well as user interface design.

Construction: This stage focuses on developing system components and features [9]. This stage is more about system implementation and testing which focuses on software implementation in program code.

Transition: This stage is more about deployment or installation of the system so that it can be understood by users [9]. At this stage the author conducts user training, black box testing, white box, and UAT (User Acceptance Test) to find out whether the application has met user expectations or not.

2.4 Research Object

The author conducted research at SMP Negeri 1 Lebakwangi which is located at JL. Raya Cineumbeuy No.78, Cineumbeuy, Kec, Lebakwangi, Kuningan Regency, West Java.

The method used during the learning of Natural Science subject material on the human digestive system is by using books and videos and the quiz method used is paper and google form.

2.5 Analysis of Current Learning System

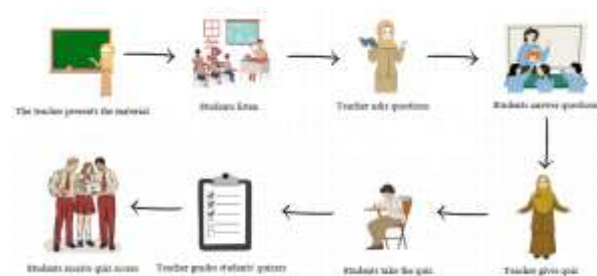


Figure 2 Current System

The following is an explanation of figure 2:

1. The teacher presents the material using the book provided by the school.
2. Students listen to the teacher's explanation until it is finished.
3. The teacher asks questions to the students.
4. Students answer the questions asked by the teacher.
5. The teacher gives quiz questions using paper.
6. Students take the quiz and give it to the teacher when they have answered all the quiz questions.
7. The teacher checks the quizzes, grades them and distributes the quiz sheets to the students.
8. Students receive the quiz scores.

2.6 Problem Faced

The problems that the author identifies in this study, namely:

1. The lack of variety in learning media and the use of media that is limited to books that only contain text and images, resulting in students being less able to absorb in understanding the material well and less interesting.

2. The quiz method that still uses paper and google form causes each student to get the same sequence of questions.

2.7 Problem Solving

Based on this, the author tries to provide alternatives to the problems faced, namely:

1. Building an interactive human digestive system educational application to improve student understanding of the material and make learning more interesting.
2. Implementing the fisher yates algorithm for randomizing questions that are more varied in the android-based human digestive system educational application.

2.8 Algorithm Fisher Yates

The Fisher Yates algorithm also known as Knuth Shuffle is a method used to create random permutations of a finite set. The algorithm, named after Ronald Fisher, Frank Yates, and Donald Knuth, randomizes the set so that each permutation has an equal chance of occurring. Fisher Yates if implemented correctly, then the results of this algorithm will not be one-sided, so each permutation has the same probability [14].

According to Vinay Sign [15] the use of the modern Fisher Yates algorithm by Richard Durstenfeld adaptation reduces the complexity of the algorithm to $O(n)$, compared to randomizing using other methods such as using sorting which is very inefficient because of the nested loop. Fisher Yates algorithm is chosen because this algorithm is a better randomization method or can be said to be suitable for randomizing numbers, with fast execution time that does not require a long time to perform a randomization. The Fisher Yates algorithm consists of two methods, namely, the original method and the modern method. But in making this application, it is applied using the modern method. The modern method was chosen because this method is specifically used for randomization with a computerized system, because the randomization results can be more varied.

The next stage is to test the randomization process using the fisher yates algorithm, first determine 10 (ten) questions that will be used as material for random permutations. Then create a range for questions that have not been selected, then from the results of the permutation will be placed into the result column as a variable question that has been randomized. The process of randomizing the fisher yates algorithm in 10 (ten) questions is described in Figure 3 as follows:

Range	Roll	Stratch	Result
		1,2,3,4,5,6,7,8,9,10	
1-10	4	1,2,3,10,5,6,7,8,9	4
1-9	3	1,2,9,10,5,6,7,8	3,4
1-8	1	8,2,9,10,5,6,7	1,3,4
1-7	2	8,7,9,10,5,6	2,1,3,4
1-6	4	8,7,9,6,5	10,2,1,3,4
1-5	1	5,7,9,6	8,10,2,1,4
1-4	2	5,6,9	7,8,10,2,1,3,4
1-3	1	9,6	5,7,8,10,2,1, 3,4
1-2	1	6	9,5,7,8,10,2,1,3,4
Hasil Pengacakan			6,9,5,7,8,10,2,1,3,4

Figure 3 Working on Fisher Yates Algorithm

Here is the flowchart of the fisher yates algorithm:

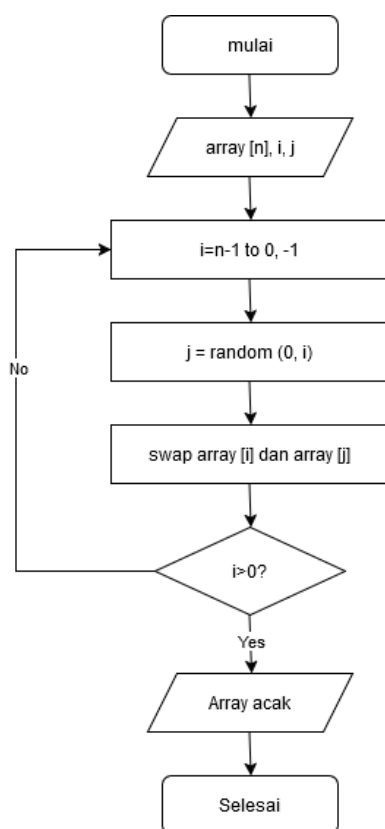


Figure 4 Flowchart of Fisher Yates Algorithm [16]

The flow of the fisher yates algorithm process steps based on Figure 4 is as follows:

1. Determine the number of arrays to be randomized (n).
2. After the number n is found, select a number (x) where x is more equal to 0 and x is less than n ($1 \leq X < N$).
3. After x is selected, swap x with the last number in the range of 1 to n.
4. Move the x numbers that have been swapped to the list array.
5. Reset the value of n where $n = n-1$.
6. If the value of $n > 0$ then proceed back to process number 2.
7. If n is not more than 0 then the randomization process is complete.
8. Randomization result.

3. Result and Discussion

In this research, an educational application of the human digestive system will be made for students of SMP Negeri 1 Lebakwangi which can be used as an alternative learning media. Because the learning process is still using books and videos, but the learning method using books that only contain text and images only results in students being less able to absorb in understanding the material well and less interesting and the learning method using videos can only be seen during class hours. Therefore, a more interactive learning media is needed to improve students' understanding of the material and make the learning process more interesting. This educational application is equipped with interactive buttons so that students can interact directly with the menus in the application. The material in the educational application in the form of animated videos is expected to be accepted by students at SMP Negeri 1 Lebakwangi. The main purpose of making this educational application is to help students understand the material of the human digestive system and make the learning process more interesting.

The design in a system aims to describe the entire process of activities that will be implemented in a system. In describing the process, the author uses UML (Unified Modeling Language).

3.1 Use Case Diagram

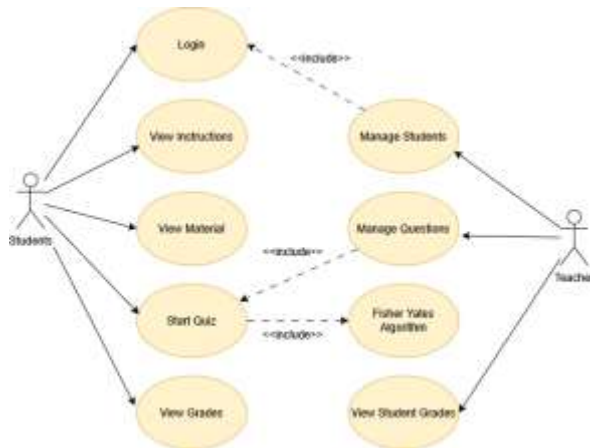


Figure 5 Use Case Diagram

In Figure 5. There are 2 actors, namely students and teachers, students access the system in the human digestive system educational application, namely login, see instructions, see material, start quizzes, and see grades while teachers access the system through the website, namely managing student data, managing question data, and seeing student grades.

3.2 Activity Diagram

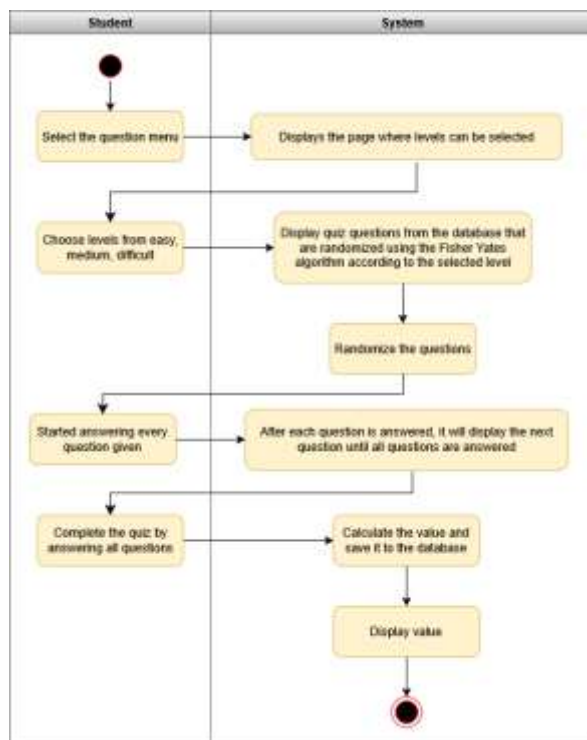


Figure 6 Activity Diagram

In Figure 6. Activity diagram of starting the quiz, students open the question menu page and then select levels ranging from easy, medium, and difficult. Then the student takes the quiz until it is finished and when the question has been answered, the system will display the quiz score obtained.

3.3 Sequence Diagram

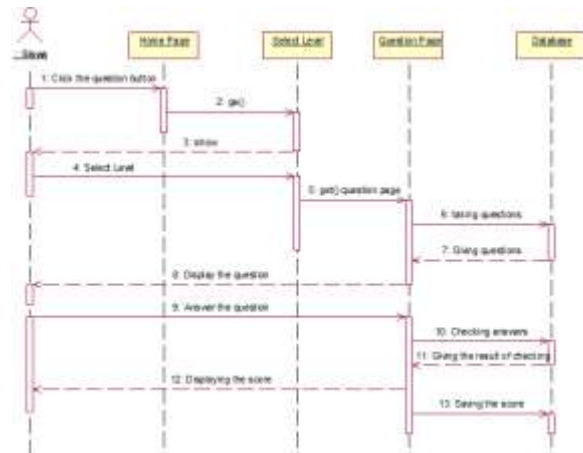


Figure 7 Sequence Diagram

In Figure 7. The Sequence Diagram of starting a quiz shows that students open the human digestive system educational application and are directed first to the main page. On the main page there is a question menu, students click on the question menu and are directed to the select level page after selecting the level students will be directed to the question processing page. Problem taken from the database that has been added by the teacher

3.4 Class Diagram

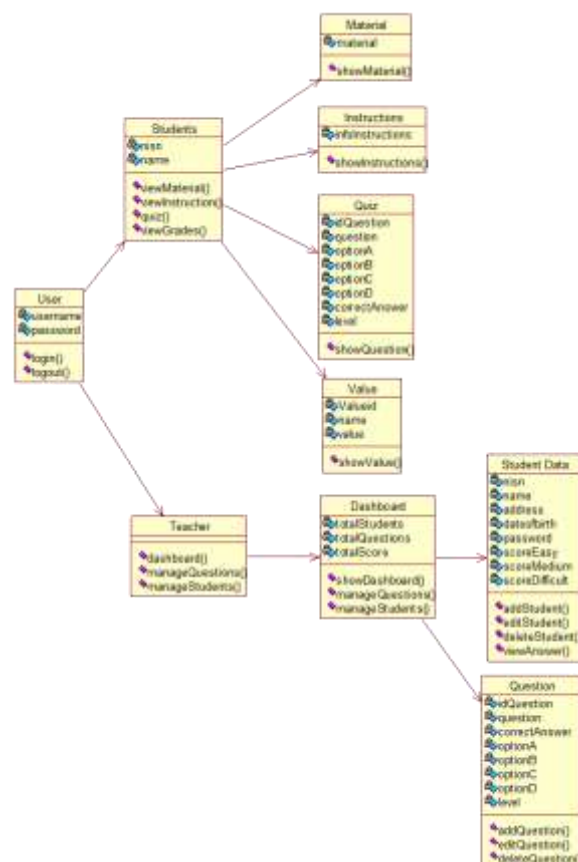


Figure 8 Class Diagram

In Figure 8. This Class Diagram shows the relationship between classes, where students and teachers have the main roles. Students focus on learning through the human digestive system educational application, while teachers manage data through the website.

3.5 Application Design

a. Login View



Figure 9 Login View

In Figure 9. This is a login view that is used to access the human digestive system education application.

b. Main Page Display



Figure 10 Main Page Display

In Figure 10. This is the main page seen by students after successfully logging in to the human digestive system educational application. This page serves as the main navigation center that provides quick access to various application features, such as materials, quizzes, instructions, and scores.

c. Instruction Display



Figure 11 Instruction Display

In Figure 11. This is an instructional display that contains instructions for using the human digestive system educational application to help students

understand the steps in accessing the human digestive system educational application.

d. Material Menu Display



Figure 12 Material Menu Display

In Figure 12. The material menu serves as a place for students to learn material about the human digestive system. The material is divided into 9 sections covering 6 main digestive systems and 3 additional digestive systems. The material is in the form of a video with a duration of 1-4 minutes.

e. Material Video Playing Display

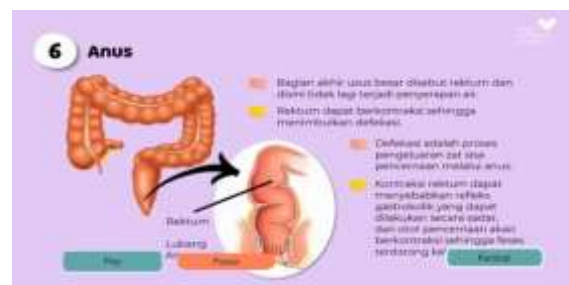


Figure 13 Material Video Playing Display

In Figure 13. This is a display of playing video material. When students watch the material video until it is finished, a notification will appear that the video has been completed and the heart increases, if the student does not finish the material video until it is finished, a notification will appear that the video has not been completed and the heart does not increase.

f. Display of Difficulty Level



In Figure 14 Display of Difficulty Level

In Figure 14. Is a display of difficulty levels which are divided into 3, namely easy, medium, and difficult. Each difficulty level has 10 questions with the provisions for the easy level, namely 6 easy questions, 3 medium questions, 1 difficult question, medium level, namely 3 easy questions, 5 medium questions, 2

difficult questions, and difficult level, namely 1 easy question, 2 medium questions, 7 difficult questions. The time rule for the easy level is 30 seconds, the medium level is 20 seconds, and the difficult level is 15 seconds, the score rule if answering correctly for the easy level is +10, medium +20, difficult +30 if answering incorrectly for the easy level is -5, medium -10, and difficult -10. Bonus score rules, when students answer 3 questions correctly in a row, they will get 20 scores, if students answer 5 questions correctly in a row, they will get 50 scores. And students will be given 5 hearts when working on questions obtained after viewing the video material.

g. Question Display



Figure 15 Question Display

In Figure 15. This is a display of questions when students take a quiz and questions in the form of multiple choices.

h. Game Over Display



Figure 16 Game Over

In Figure 16. Is a game over display, this game over page appears after the student completes the quiz when the student does not answer the correct questions at least 7 out of a total of 10 questions and cannot continue to the next level. Congrats Display.



Figure 17 Congrats Display

In Figure 17. It is a congrats display, this congrats page appears after the student completes the quiz when

the student answers the correct questions at least 7 out of a total of 10 questions and can proceed to the next level.

i. Score Display



Figure 18 Score Display

In Figure 18. It is a value display that displays the total score obtained by students after completing all levels, the value that appears based on the highest score or ranking.

3.6 User Acceptance Test (UAT)

To find out the user's response to the educational application of the human digestive system, testing will be carried out by giving a questionnaire containing 12 questions which are divided into 3 questions each covering 4 aspects, namely appearance, material content, learning process, and increasing achievement or understanding to 31 respondents, namely students of SMP Negeri 1 Lebakwangi. The following is the questionnaire data obtained:

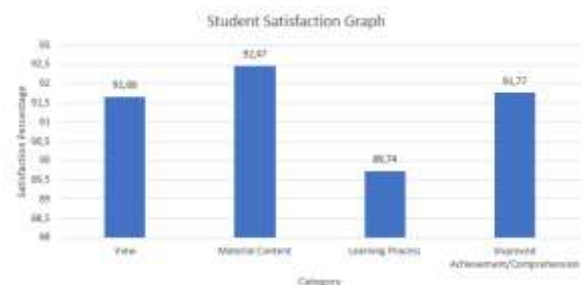


Figure 19 Student Satisfaction Graph

4. Conclusion

Based on the results of research and testing on the educational application of the human digestive system using the Fisher-Yates algorithm, it can be concluded that the application has shown promising results. The User Acceptance Test (UAT) conducted with students revealed positive feedback across four aspects: appearance with 91.66%, material content with 92.47%, the learning process with 89.74%, and improvement in achievement/understanding with 91.77%. These results indicate that the educational application can serve as an interactive and engaging medium for learning about the human digestive system, while effectively enhancing students' understanding of the material. Additionally, the Fisher-Yates algorithm has been successfully implemented in the application

to randomize quiz questions, ensuring that each student receives a unique and varied sequence of questions.

Based on the results of the research, several suggestions can be made for further development. First, to enhance the diversity of the learning material, it is recommended to add more interactive features in the application, such as more detailed simulations or animations related to the human digestive system. This could further engage students and strengthen their understanding of the topic. Second, while the Fisher-Yates algorithm has proven effective in randomizing quiz questions, further development could focus on optimizing the application's performance on devices with lower specifications, as the application is intended for use on mobile devices with limited RAM. Lastly, a broader trial involving more schools and classes should be conducted to gather more representative data and ensure that the application is well-received by various groups of students, thus having a greater impact on improving learning outcomes.

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