

# The Application of Multiple Regression Model in Blended Teaching of Higher Mathematics

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*Higher mathematics is a term used to describe complex mathematical ideas and subjects that go beyond the fundamentals of algebra, geometry, and number theory. Geometry, linear algebra, discrete mathematics, topology, and analysis are often covered. It entails creating fresh mathematical ideas and solving challenging issues by applying solid mathematical rationalization. Economics, statistics, mathematical modeling, and software for descriptive statistics are all areas covered by mathematics applications. Global concern is being raised by the falling number of students pursuing elevated amounts of mathematics. The underperformance and disinterest of students in mathematics may be attributed to a variety of issues. One cause of the drop is the knowledge gaps that arise when learners do not acquire or comprehend important mathematical ideas. It is essential to provide the best teaching strategy. Blended learning combines online and in-person instruction utilizing a range of tools and communication channels that are accessible to both students and instructors. In the setting of data processing and statistics, multiple regression analysis could serve as a helpful tool for teaching mathematics. Thus, we suggested using a multiple regression model (MRM) in blended higher mathematics instruction. Using performance measures and comparisons to existing methods, we assessed the efficacy of the suggested approach. The study results proved that MRM has provided an implementation cost of 45. According to the results, the proposed approach helps students learn mathematics in a more significant way.*

*Povzetek: Predstavljen je model za multiplo regresijo (MRM) v kombiniranem poučevanju višje matematike, ki združuje spletne in tradicionalne metode. Rezultati kažejo, da MRM izboljša učni proces, zapolni vrzeli v znanju in poveča motivacijo študentov.*

## 1 Introduction

The concept of higher mathematics is used to describe more complex areas of mathematics that usually need a solid grounding in calculus, linear algebra, and other basic mathematical principles. Blended teaching is an approach to education that combines online resources with more conventional methods of instruction. Both the learner and the instructor should be in the same room for there to be a truly blended teaching experience. Students may study at their speed using blended teaching. Learners may review previously covered ideas and materials at any time, and move on at their own pace. With a learning management system (LMS), learners may go at their speed while still having quick access to previously covered information. These fields of study are common in bachelor's degrees and higher graduate degrees in maths, physics, and engineering, and they find applications in disciplines including computing, encryption, finance, and data

science [1]. In this method mixes face-to-face classroom instruction with distance education. That someone might, for instance, study the internet to have a general understanding of a subject, before attending a lecture in person to ask questions of specialists and hone their knowledge in more depth. Dealing with abstractions and arguments, as is common in higher maths, necessitates an excellent grasp of mathematical reasoning and issue abilities. Higher-level mathematics may be taught in a mixed format, giving students the advantages of both traditional classroom instruction and an internet study. Implementing a blended teaching program successfully requires setting goals and objectives that are explicit, quantifiable, agreed upon, practical, and efficient [2]. The foundations of the blended teaching paradigm center on the formulation of instructional materials and settings. Content training, individualized training, student autonomy, connections, discipline, and relevancy are just a few of the pillars. As the average score of the class using

the blended teaching model is more than the minimal completeness requirement, it may be stated that blended teaching is more successful than traditional learning in increasing students' achievement of mathematical topics in tenth grade [3]. It is generally accepted that processors, graphical calculators, and the Web may be efficient mathematical tools, while the use of such technologies in mathematics teaching remains restricted in many settings. Although the term "blended teaching" is still not given a universally accepted meaning. Investigators of learning are becoming more interested in the potential of blended teaching environments for the instruction and study of mathematics [4]. Consider more about the "flipped classroom" technique: in this approach, students are given background information and readings from an outside category, and then return to use what they acquired in concern, group projects, and class discussions. The above strategy has the potential to shine in advanced mathematics, where drill and problem-solving are essential to mastery. Studies conducted at institutes have driven research into the implementation of flexible classrooms. The flipped classroom approach pushes students to use mathematical ideas to solve real-world issues, which helps them develop the critical reasoning and problem-solving abilities that are necessary for many different professions [5]. The analysis of simultaneous is used to analyze the connection among an independent measure and several dependent factors. Multiple regression models can be used to examine the correlation between various instructional methods, technological resources, or other elements and learner success in the setting of integrated learning. The efficacy of blended teaching models in contrast to conventional teaching can be assessed using multiple regression models. To determine that technology devices are most useful for improving student learning, multiple regression techniques could be utilized [6]. The application of technology as an educational tool aims to make learning more effective; among the pathways of learning effectiveness is the growth in students' reasoning ability; the anticipated potential is higher-order thinking skills, such as mathematical creativity.

One of the elevated thinking abilities that students need to cultivate is the capacity to analyze creatively in mathematics. The amount of mathematics innovative reasoning ability is classified into four categories depending on that aspect, extremely creative, creative, pretty creative, and not creative [7]. Researchers discovered negative attitudes in students including a complete absence of confidence in their ability to succeed across working hard, offense while beginning to experience rejection creates anxiety about giving incorrect responses is one indicator of resilience that was investigated but first showed up at the start of teaching, and when teachers asked students to answer questions and proceeded to the forefront of the class to explain to other companions, the majority of students, approximately 67 percent, felt embarrassed to come to the front of the class. More than 50 percent of students, or around 18 students, remark that the issue is tough after studying the content and before working on the assignments [8]. The analysis year each student from a variety of programs revealed that online courses had a favorable impact on participation in tasks requiring mathematical reasoning, encouraging the utilization of internet learning in the context of mathematics instruction. Catch attention to the growing use of mobile technology in mathematics education, stressing that doing so has the impending to enhance performance by bringing mathematics instruction beyond the classroom and using specific benefits [9]. Multiple regression models could even, in general, be a useful tool for evaluating the efficacy of blended teaching in higher mathematics. Teachers may increase the quality of learning and improve learning performance by producing valuable teaching approaches, technological tools, and predictions of educational success [10]. The proposed multiple regression model (MRM) techniques for classifies in blended teaching of higher mathematics.

## 2 Related works

This section discusses the findings of several researchers, technical reports and research papers. The relevant literature is displayed in the table 1.

Table 1: Summary of related work

Reference	Proposed	Result	Limitations
[11]	Science technology and engineering mathematics (STEM) was success of elementary school students from poor socioeconomic regions was affected by conventional scientific education and integrated learning.	The research is a quasi-experimental investigation. Data from the student’s mathematical resiliency survey along with the initial maths competency exam.	The impact of students' mathematical resilience after implementing blended teaching orientation learning models of behavioral conflict techniques.
[12]	The study described learning management system that is coupled with a powerful computational platform and automatic monitoring systems was used for the objective. It has been noted that students enrolled in biotechnology programs have developed more curiosity and enthusiasm in the field, which has led to improved competency.	The analyze results was regard to the problem-solving technique, the students were particularly able to identify its perks and how using the program had also been valuable to their success in their professional and academic lives.	Complexity, resource shortages, human mistake risk, and vulnerability to cyberattacks are some of the limitations. Monitoring systems must be balanced with processing power.
[13]	The article provided the summary of a quantitative comparative investigation on the benefit of blended teaching, especially the station rotation approach, on the arithmetic performance of 413 sixth-graders. Scores from the Measure of Academic Progress (MAP) and the State of Texas Assessments of Academic Readiness (STAAR) were utilized.	The results suggest that blended learning might be positively implemented in schools, especially for children that require greater educational support in a single academic year and are intellectually backward.	MAP examinations may not completely capture each student's progress and might not evaluate certain abilities or ideas in enough detail, thereby disregarding essential qualitative components of learning.
[14]	The research on the use of blended learning in the context of English as a second or foreign language. In the relatively young discipline of blended learning, traditional instructional methods are combined with online and remote learning.	Outcomes determined that blended learning is an excellent way to improve students' desire to learn the language, as well as their language proficiency.	The difficulties faced by language instructors while implementing blended learning are not well covered in the literature. Therefore, research is required to recognize and address such problems.
[15]	The article offered a specific example of blended education that combines conventional classes with internet community interactions and student-centered active learning environments. The objective is to improve a mathematics lesson's task design	Mathematical findings point to significant advantages in the coordination and utilization of various semiotic representation systems as they have evolved.	Mathematical coordination and application of many semiotic representation systems, which have developed throughout time, are limited by their intrinsic complexity, cognitive load, and interpretive difficulties, which hinder their

	that affect learners' mathematics achievement.		smooth integration and understanding in mathematical discourse.
[16]	Griffith Sciences Blended Learning Model was discussed in the section, along with the way it is utilized to integrate and manuscript blended concepts and structure in STEM education, the methodical support and instruction process was created, and the techniques employed to support the academic profession in teaching and learning.	A result of blended learning approach was created as a consequence of using technological advances to foster grassroots movements about its academic and professional trainees and create acquire for a shift in the blended learning technique.	Limited access to technology, possibilities for uneven student involvement, issues in sustaining human relationships, and difficulties in transferring hands-on activities to electronic submissions.
[17]	The article described the implementation of a blended learning method and the lessons learned to improve the arithmetic abilities and character of young adults in Bali's 8th grade. That improving teachers' ability to administer blended learning programs is crucial for improving students' mathematical aptitude.	Outcomes are to enhance teachers' ability to administer blended learning programs is crucial to raising students' morale and mathematical competency.	One disadvantage is that professors who are not experienced with blended learning techniques may object, which might prevent adoption from going effortlessly and affect students' learning produces and experiences.
[18]	The research used a quasi-experiment to analyze the impact of a tailored intervention technique on learners' achievement in the program and studying habits in a blended learning environment. The goal is to determine whatever information fusion technique uses their information to deliver the best achievements.	The results demonstrated that the students' academic performance improved as a result of adopting learning findings emphasize how crucial blended learning is to raising students' learning outcomes.	The absence of random assignment in quasi-experiments might undermine their internal validity. Limitations in controlling extraneous elements and confounding variables may erode the validity of correlations and generalizability.

### 3 Method

Higher mathematics is employed for a variety of purposes, including forecasting the behavior of intricate systems like weather patterns or financial markets, creating algorithms, developing encryption techniques for encrypted transmission, and simulating biological systems like genetics or epidemics. Higher mathematics study is crucial for pupils. As a result, we provided the multiple regression model for higher mathematics blended teaching. The dataset for the research is comprised of Chinese students. The proposed flow is depicted in figure 1.

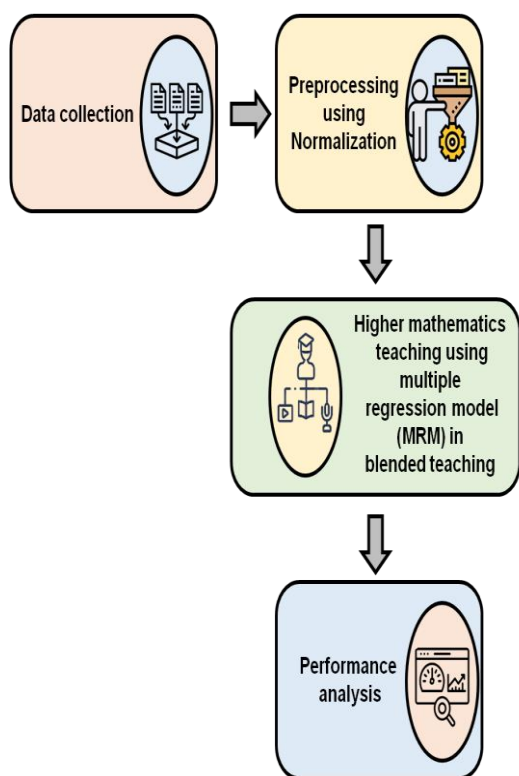


Figure 1: Proposed architecture

#### 3.1 Dataset

An amount of 408 students from the region of Guangxi are involved in this study. There are 317 female students and 91 male students, with a mean age of 14.3 years and 12.5 years, respectively. 22.3% of student is boys and 77.7% are girls, correspondingly. The 408 total students, 47.05% are junior high students and 52.94% are from primary schools. 11.4% of the 192 primary school pupils are male, and 88.6% are female. 14.81% of the 216 junior high school students are boys, and 85.19% are girls [19].

#### 3.2 Data preprocessing using normalization

Data preprocessing describes the procedures and methods utilized to clean and convert raw data before being utilized for analysis or artificial learning algorithms.

Preprocessing the information guarantees that it is reliable, comprehensive, and properly structured for analysis, making it a crucial stage in the data science process. In this study, we utilized min-max normalization. When a variable's range of entries is wide and the relative variances between those values matter, min-max normalization could be beneficial. Making ensuring that all variables have the same size is a typical practice in machine learning algorithms to enhance model performance. As a data-normalizing approach, min-max normalization scales numerical characteristics or variables to a predetermined range of values.

The method involves rescaling a variable's values such that they fall between 0 and 1, with 0 denoting the variable's smallest value and 1 denoting its greatest value. Equation 1 gives the calculation for min-max normalization.

$$Y_{normalized} = (Y - Y_{min}) / (Y_{max} - Y_{min}) \quad (1)$$

where  $Y$  denotes the variable's initial value,  $Y_{min}$  denotes its lowest value, and  $Y_{max}$  denotes its maximum value.

#### 3.3 Higher mathematics teaching using multiple regression model (MRM) in blended teaching

Mathematics could be taught well through blended learning, which mixes in-person and online instruction. The main feature of blended learning, which combines interactive and cooperative learning, was developed in this paper using topic materials, flipped classrooms, and student-centered instruction. Many online and offline exercises were created to fully achieve the connection between online and offline education. Self-paced training sessions including viewing films and taking quizzes are included, as well as interactive training tasks like peer assessment and class discourse. The tasks marked with the special icon were educational tasks that were carried out online using a website. The remaining exercises were mostly conducted offline and using blended learning. Before the session, most students learned on an online system. By viewing the videos, responding to the Q and A, or participating in the topic discussions with their students, they may get a taste of the course in preparation. Students are free to select the time and location for their online class exploration. The flexible teaching dominated in-class interactions. The instructor utilized a built-in mobile software named rainfall education tools to conduct random committee meetings and case analysis while teaching important and challenging learning points based on the student's educational circumstances. The center was used for the students. Students may engage in peer-to-peer

discussions with instructors and their classmates, engage in activities, or communicate through on-screen remarks in a virtual classroom. Classroom instruction allowed for the smooth blending of online and offline education. Activities for learning after school were created to assist pupils in processing what they have learned. On the portal, multiple-choice questions (MCQs) and peer-review tasks were assigned to every unit of an instructional subject. The learning software arbitrarily produced the MCQ's choices and topics. In every lesson, there were two opportunities for students to finish their MCQ tasks. They have the option of responding twice or just once. Peer assessment aids students in comprehending and reconsolidating the information by assisting them in understanding the answers of their classmates. Students may examine the films, examine manuals, or refer to other pertinent resources as needed for these after-class projects. In this blended teaching MRM is incorporated to enhance the mathematics training.

In the environment of data research and statistics, a multiple regression model may be a helpful tool for math instruction. The efficacy of blended learning in advanced mathematics may be examined using MRM. The MRM attempts to evaluate how mixed learning affects mathematics produces by taking into account a number of variables, including instructional strategies, student involvement levels, and past educational achievement. The model may help teachers optimize their instructional strategies for enhanced academic performance in higher mathematics by revealing which components of blended learning contribute most substantially to student performance through statistical analysis. The following suggestions will help to teach mathematics using a multiple regression model. Before going on too many values, it starts with simple instances and introduces students to basic analytical concepts, including the connection between two variables. The fundamental ideas of the subject matter will be better understood by the students, as well as how they may be used to model connections between variables. It shows students practical applications of their studies, such as estimating the cost of a home based on location, size, and other criteria. Students will benefit from this as they learn about the real-world uses of arithmetic. It gives students the chance to use actual data and conduct numerous correlation assessments independently. Excel or other statistical tools may be used for this. It emphasizes how to analyze the findings. Instead of only computing the findings of the multivariate logistic analysis, it challenges students to concentrate on analyzing them. They will have a better understanding of how to forecast the future and reach conclusions using regression analysis as a result. It Determines the independent factors. The independent variables might include a variety of

elements that could affect how well students learn arithmetic, including the student's previous math knowledge, the degree of the instruction, the resources on hand in the curriculum, and the student's degree of desire and engagement. Therefore, teaching math may benefit greatly from using multiple regression analysis, especially when it comes to documentation interpretation and statistics. MRM can be utilized to model connections between variables and create predictions, and by giving students practical knowledge and real-world applications, they can better understand higher mathematics.

## 4 Results and discussion

In this section, the proposed MRM effectiveness is evaluated. The assessment metrics used for evaluation such as understanding rate, pass rate, problem-solving, critical thinking, and implementation cost. The conventional techniques used for comparison are GeoGebra [20], Dynamic geometry software (DGS)[21], and Action learning and concept motivation (AL-CM) [22].

### 4.1 Understanding rate

An understanding rate is a unique ratio where the two terms are expressed in several units. Several techniques, including tests, quizzes, and other evaluations that gauge learners' comprehension of the subject matter, may be used to gauge the understanding rate in MRM learning. In order to ensure that students can understand higher mathematics and achieve in their learning, educators may also regularly communicate with and provide comments to the learners, assess their progress, and modify the teaching techniques as necessary. The recommended technique has a higher level of understanding rate in math when measured against the previously used methods. Figure 2 shows the understanding rate of the proposed and existing techniques. Table 2 shows the results of the understanding rate.

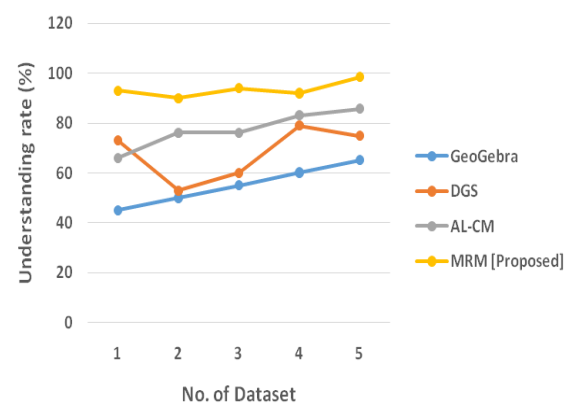


Figure 2: Understanding rate of the proposed and existing techniques

Table 2: Results of understanding rate

Understanding rate (%)				
	GeoGebra	DGS	AL-CM	MRM [Proposed]
1	45	73	66	93
2	50	53	76	90
3	55	60	76	94
4	60	79	83	92
5	65	75	85.6	98.5

Table 3: Results of pass rate

Methods	Pass rate (%)
GeoGebra	55
DGS	66
AL-CM	75
MRM [Proposed]	97.9

### 4.2 Pass rate

The proportion of standardized tests that succeed is known as the pass rate. The proportion of learners that successfully finish the course or program with a passing grade is referred to as the pass rate in MRM learning. Since pass rates differ between institutions and subjects, it is impossible to assign a certain pass rate to blended teaching. Figure 3 shows the pass rate of the proposed and existing techniques. Table 3 shows the results of the pass rate. In summary, effective implementation of MRM learning results in a high pass rate compared to the existing method.

### 4.3 Problem-solving

The expression problem-solving refers to skills that may be used to discover the root of an issue and give the best solutions. Problem-solving, being an integral aspect of the majority of actions, is the process of reaching a goal by overcoming barriers. Simple personal tasks and difficult challenges with blended learning are only a few of the problems solving. Information handling, reasoning, and imagination are the three skills that are the main elements of problem-solving. These three elements may be used to create problem-solving techniques that provide creative and successful responses to issues. Information handling, reasoning, and imagination are higher in the proposed method. Figure 4 shows the problem-solving of the proposed and existing techniques. Table 4 shows the results of problem-solving.

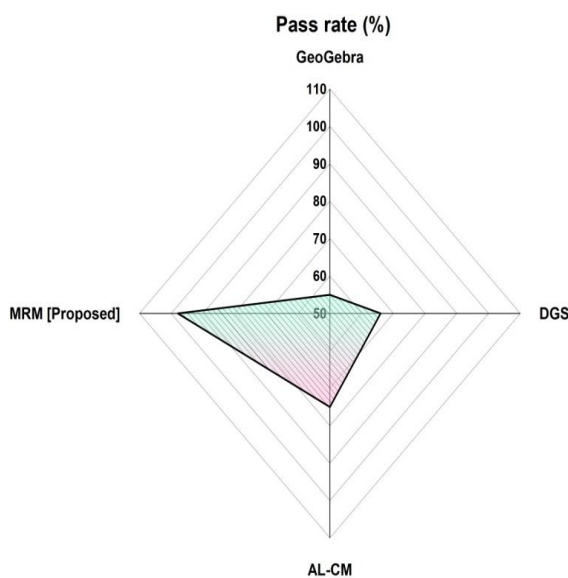


Figure 3: Pass rate of the proposed and existing techniques

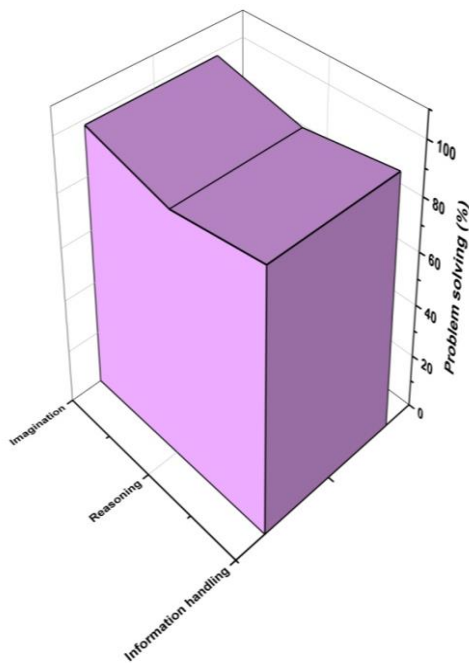


Figure 4: Problem-solving of the proposed and existing techniques

Table 4: Results of problem-solving

Problem-solving (%)	
<b>Information handling</b>	95
<b>Reasoning</b>	90
<b>Imagination</b>	98

#### 4.4 Critical thinking

Questioning, analyzing, interpreting, and making a judgment about what one reads, hears, says, or writes are all elements of critical thinking. To become effective learners and hard workers, students must acquire the talent of critical thinking. A good setting for the development of critical thinking abilities is found in higher mathematics based on MRM learning. Figure 5 shows the critical thinking of the proposed and existing techniques. Table 5 shows the results of critical thinking.

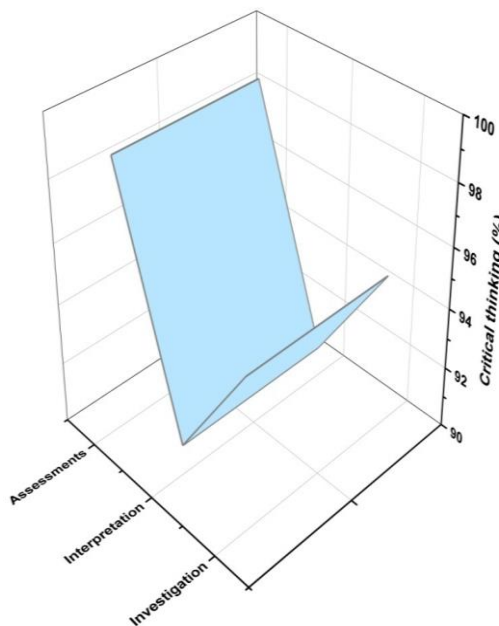


Figure 5: Critical thinking of the proposed and existing techniques

Table 5: Results of critical thinking

Critical thinking (%)	
<b>Investigation</b>	95
<b>Interpretation</b>	91
<b>Assessments</b>	98.8

#### 4.5 Implementation cost

The cost incurred in developing and implementing a plan to implement one or more particular concrete proof techniques is known as implementation cost. The cost of implementing MRM teaching will depend on the institution's particular requirements and objectives. These are some elements that may affect the price of implementing learning techniques for higher mathematics. Figure 6 shows the implementation cost of the proposed and existing techniques. Table 6 shows the results of implementation cost. It proves that the suggested method uses less implementation cost.



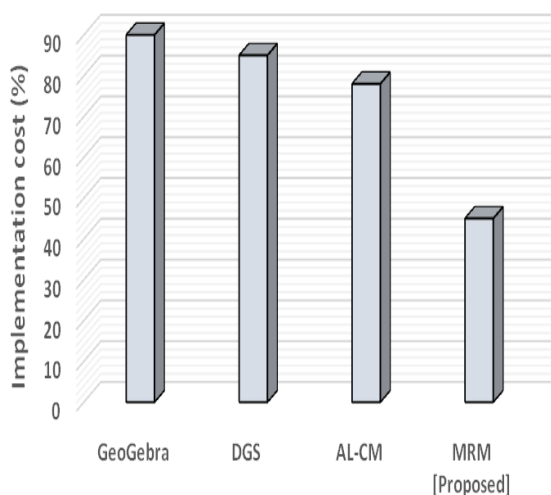


Figure 6: Implementation cost of the proposed and existing techniques

Table 6: Results of implementation cost

Methods	Implementation cost (%)
<b>GeoGebra</b>	90
<b>DGS</b>	85
<b>AL-CM</b>	78
<b>MRM [Proposed]</b>	45

### 5 Discussion

The drawback of using a GeoGebra is that it may be difficult for students to understand and manipulate multiple variables at once in the blended education. This could make it more difficult for students to understand fundamental mathematical concepts and increase cognitive load, which would hinder learning effectiveness. Several regression models into blended learning for higher-level mathematics are the possibility of increased interaction and visualization complexity. In a blended educational environment, students' comprehension and interaction with the regression recommendations may be hampered by DGS which is incomplete support for the complex data manipulation required. Higher education is that it might be too difficult for certain students, which will lower their interest in the subject matter. Since AL-CM emphasizes practical problem-solving and the application of mathematical ideas in practical situations, it might be better at producing desire. By analyzing these drawbacks, our suggested method MRM tends to overcome this issue and provide more efficient results

### 6 Conclusion

A multiple regression model (MRM) could be employed to examine the association between several independent factors and a dependent variable. MRM may be used to determine the variables that are most closely linked to student learning achievements when applied to the teaching of mathematics. MRM may be a very useful tool for engaging students and assisting them in understanding difficult mathematical ideas in higher mathematics. A method of education known as blended learning mixes online and in-person training in a manner that improves the learning process. Several disciplines, including physics, engineering, computer science, finance, and cryptography, utilize higher mathematics. It is crucial for simulating complicated processes and tackling issues that call for a better comprehension of mathematical ideas. Thus, we recommended the MRM in blended teaching of higher mathematics. The dataset used was composed of Chinese students. The data were normalized using Min-Max as part of the preprocessing. Evaluation and comparison with previously used methods are performed for the performance indicators understanding rate, pass rate, problem-solving, critical thinking, and implementation cost. The data showed that the suggested MRM provides students with an effective education in higher mathematics. A limitation of watching instructional videos during the coronavirus epidemic, according to parents, was that their children need their whole concentration. Higher education is provided more accessible and effectively when blended learning integrates conventional teaching strategies with internet resources. Technological obstacles, challenges in maintaining active engagement, and possible inequalities in resource accessibility are among the constraints. Specific educational processes, resource allocation, instructional approaches, and continuous improvement in course structure and execution are all made possible by the use of a multiple regression model in blended learning for higher mathematics. Such benefits subsequently translate into increased student engagement and achievement. The disadvantage of using the multiple regression model (MRM) in blended learning for higher education depends on assumptions regarding normality, linearity, and residual independence. Such presumptions could not always apply in complicated educational environments, which might jeopardize the model prediction of accuracy and generalizability. Regarding reliable results from studies, it is crucial to carefully evaluate the constraints and possible biases of MRM. In the future, innovative technology may be used with the suggested approach to maximize its efficacy.

MRM improvement: To increase the MRM's reliability and efficacy in estimating student outcomes, more optimization and refining of the model requires to be explored. Innovative technology integration wasthe prediction potential of the MRM will be enhanced by examining the integration of cutting-edge technology like natural language processing methods or ML algorithms. These tools may make it possible to analyze student data more thoroughly to gain a greater understanding of the trends and actions associated with learning.

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