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The Development Instructional Model Based on Steam Education by TP-SMART MODEL to Enhance Technological Innovation and Creativity Skills of Secondary Student Mathayom 6

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Abstract

The Development Instructional Model Based on Steam Education by TP-SMART MODEL To Enhance Technological Innovation and Creativity Skills of Secondary student Mathayom 6, divided into 4 steps. Step 1: Study the current and expected conditions of student learning and innovation skills development. 2) Develop the model 3) Study the results of use 4) Evaluate the results. Sample group used in the study Mathayom 6/4 students at That Phanom School, Semester 1, academic year 2023, 1 classroom, 26 people. By means of Cluster Random Sampling, statistics used include mean ($\overline{X}$), standard deviation (S.D.), essential needs index (PNI Modified), and t-test (Match paired t-test) The results of the study found that 1) The results from the synthesis of learning skills and innovation components consisted of 3 components: Including (1) communication and cooperation (2) critical thinking and problem-solving and (3) Creative thinking and innovation Elements with the highest demand index values are creativity and innovation PNIModified=.294. 2) The model development is consistent with values between 0.80-1.00 and the overall average is 0.933. The confirmation results found that the overall components were appropriate at the highest level ($\overline{X}$=4.258, S.D.=0.668). 3) Results of the comparative analysis of scores before and after using the format. The difference is statistically significant at .05. 4) Overall evaluation of the use of the model The average is at a high level ($\overline{X}$=4.29, S.D.=0.65).

Keywords: actual situation, learning skills and innovation, STEAM education, TP-SMART model

1. Introduction

At present, problems that show the inferior quality of education and the learning system of students are: The quality of learners both nationally and internationally has deteriorated to an alarming level, including the ability to compete at a low level and not meeting international standards, this is clearly shown from important information: It was found that the O-NET test results of the students. It was found that the quality of students is lower than average in all learning subjects and tends to decrease every year. Including the results of the PISA test that assesses 15-year-olds. Around the world to see how ready they are to live together in society The aim is to test whether students can use what they can. Can lessons learned in the classroom be applied to solve problems in real life or situations? The results of the evaluation found that Thai children have lower quality than average in both mathematics Science and reading. It shows that the quality of Thai students is not yet International standards and scores are consistently below average. The level of proficiency and ability of Thai students compared to other nations is very low. It was found that 46.75 percent of students had low educational results and only 0.46 percent had high educational results (Office of the Secretariat of the Education Council, 2019).

Developing students' learning and innovation skills is considered important to help promote and support students' learning skills and innovation. Learning design must include learning in which children create knowledge together and learn as a team. Practicing asking the right questions is more important than finding the answers. These skills cannot be taught directly. However, the learning process can be organized. Guidelines for developing students' learning and innovation skills: 1) Creative thinking and innovation Learning should be organized with a student-centered focus. (Student-centered Approach) and learning management that provides opportunities for students to participate thoroughly (Inclusive Approaches). Teaching according to the STEAM Education approach is a learning management that is an extension of STEM Education. By adding the science of art It is the integration of all 5 fields of science together: Science (Science: S), Technology (Technology: T), and Engineering.

(Engineering: E), Arts (Arts: A) and Mathematics (Mathematics: M) by art helping to promote awareness. Increase interest in science subjects of more students (Buaphan et al., 2020). Art is a science that helps increase inspiration make students use their creativity to design solutions to problems. There are learning activities related to real-life problems Learners can apply knowledge to solve problems using the process of engineering design. The researcher is therefore interested in studying the learning management model according to STEAM Education guidelines to promote learning skills and innovation in the subject of Polymers for Mathayom 6 students.

2. Research Objective

The objectives of this Research and Development were to:

1) Study the current and expected conditions of student learning and innovation skills development.

2) Develop a learning management model according to STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on polymers for Mathayom 6 students.

3) Study the results of using a learning management model according to STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on polymers for Mathayom 6 students.

4) Evaluate the use of learning management formats according to the STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on polymers for Mathayom 6 students.

3. Research Method

There are four steps in Research and Development, as follows:

Step 1: Study the actual conditions and the conditions that should be the learning and innovation skills of students.

Step 2: Develop a learning management model according to STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on polymers for Mathayom 6 students.

Step 3: Study the results of using a learning management model according to STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on polymers for Mathayom 6 students.

Step 4: Evaluate the use of learning management formats according to STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on polymers for Mathayom 6.

Details of the research method are shown in the Figure 1.

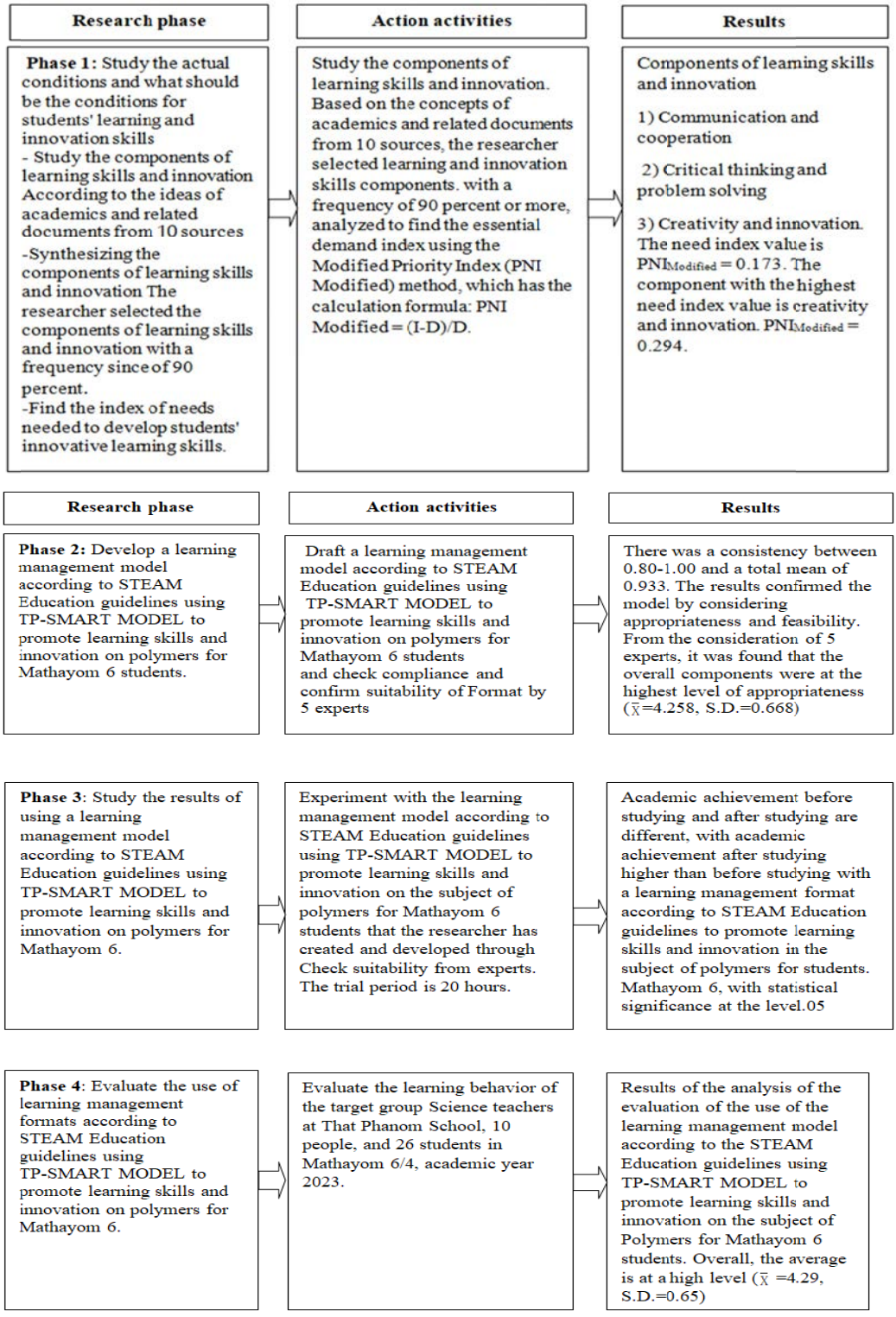

Figure 1. Research phase, action activities, and results

4. Results

Part 1 studies the actual and expected conditions of the development of students' learning and innovation skills.

Results from the synthesis of learning skills and innovation components. From documents and related research, totaling 10 sources, using frequency criteria starting from 9 which is equal to or more than 90 percent of the total frequency, consisting of 3 components: 1) Communication and cooperation 2) Critical thinking and problem

solving, and 3) Creativity and innovation. Studying the actual and expected conditions in developing students' learning and innovation skills. The results of the study are as follows. A total of 164 respondents were Mathayom 6 students, with the majority being 53.05% female, followed by 46.95% male. Overall analysis results have details as shown in Table 1.

Table 1. The condition should be and expected conditions of students' learning and innovation skills

Components	The condition should be (I)			The expected conditions (D)			PNI modified	Prioritize
	$\bar{X}$	S.D.	Interpret	$\bar{X}$	S.D.	Interpret		
Communication and cooperation	3.962	0.748	high	3.518	0.844	high	.122	2
Critical thinking and problem-solving	4.015	0.689	high	3.639	0.807	high	.103	3
Creativity and innovation	4.259	0.668	high	3.290	0.842	moderate	.294	1
Total average	4.078	0.578	high	3.428	0.735	moderate	.173	

From Table 1, the overall average of the needs index for the development of learning and innovation skills of students was found the need index value is PNIModified = .173. The elements with the highest need index values are: Creativity and innovation at $PNI_{Modified}$ = .294, followed by Communication and collaboration were valued at $PNI_{Modified}$ = .122, and critical thinking and problem-solving. $PNI_{Modified}$ = .103 respectively Therefore, the area in which the essential needs index value is greater than the total average essential needs index value is Creativity and innovation $PNI_{Modified}$ = .294

Part 2: Develop a learning management model according to STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on polymers for Mathayom 6

Results of checking the consistency of the learning management model according to STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on polymers for Mathayom 6 students by 5 experts. Results are listed in Table 2.

Table 2. Results of checking the consistency of the learning management model according to the STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on the subject of Polymers for Mathayom 6

Evaluation list	Consistency value	Interpret results
1. Recommendations for using the learning management model	1.000	agreeable
2. Highlights of the learning management model	1.000	agreeable
3. Learning management steps	0.800	agreeable
4. related theoretical concepts	0.800	agreeable
5. Results that occur to students	1.000	agreeable
6. Use in the learning management plan	1.000	agreeable
Total average	0.933	agreeable

Table 2, the results of checking the consistency of the learning management model according to the STEAM Education guidelines using the TP-SMART MODEL to promote learning skills and innovation on the topic of Polymers for Mathayom 6 by 5 experts found that the consistency assessment had a value between 0.800-1.000 and an overall average of 0.933, therefore The results of checking the consistency of the learning management model according to the STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on the subject of Polymers for Mathayom 6 students are consistent and appropriate.

The results of confirming the elements of the model consistency test found that 5 experts agreed and it was confirmed by considering the appropriateness and feasibility. The details are shown in Table 3.

Table 3. Results of confirmation of the learning management model according to STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on the subject of Polymers for Mathayom 6

Learning management format	Suitability			Possibility		
	$\bar{X}$	S.D.	Interpret	$\bar{X}$	S.D.	Interpret
1. Recommendations for using the learning management model	4.566	0.619	the most	4.533	0.646	the most
2. Highlights of the learning management model	4.600	0.527	the most	4.480	0.674	high
3. Learning management steps	4.600	0.569	the most	4.450	0.660	high
4. related theoretical concepts	4.550	0.547	the most	4.550	0.547	the most
5. Results that occur to students	4.266	0.794	high	4.600	0.603	the most
6. Use in the learning management plan	4.510	0.612	the most	4.530	0.623	the most
Total average	4.258	0.668	the most	4.515	0.611	the most

Table 3, results confirming the learning management model according to STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on the topic of Polymers for Mathayom 6

It has been confirmed by considering suitability and feasibility. From the consideration of 5 experts, it was found that the overall elements are at the highest level of appropriateness ($\bar{X}$= 4.258, S.D. = 0.668). The elements with the highest possible mean values are: The results for the students were at the highest level ($\bar{X}$=4.600, S.D. =0.603) and in the development of the model consisted of 1) Recommendations for using the learning management model 2) Highlights of the learning management model 3) Learning management steps. 4) Related theoretical concepts 5) Results that occur to students 6) Use in the learning management plan.

Part 3 studies the results of using the learning management model according to the STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on the subject of polymers for Mathayom 6.

Try out the format that the researcher has created and developed through examination of suitability by experts. The trial period is 20 hours. The sample group is Mathayom 6/4 students at That Phanom School, That Phanom District, Nakhon Phanom Province, Semester 1, the academic year 2023, 1 classroom, 26 people, obtained by cluster random sampling (Cluster Random Sampling). The results are shown in Table 4.

Table 4. Results of comparative analysis of scores before and after using the learning management model according to the STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on the topic of Polymers for Mathayom 6

Test	Sample group (n)	$\bar{x}$	t	df	P
Pre-test	26	10.73	20.73	25	0.027
Post-test	26	23.50			

*Statistically significant .05.

Table 4, the results of the comparative analysis of scores before and after using the learning management model according to the STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on the subject of polymers for Mathayom 6A sample group of 26 people was analyzed using statistics. It was found that the pre-test score had a mean ($\bar{X}$) equal to 10.73. The post-test score had a mean ($\bar{X}$) equal to 23.50. It was found that the scores before and after using the learning management model according to the STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on the subject of Polymers for Mathayom 6 students were significantly different. Statistically at .05, the latter score was higher than the score before using the learning management model according to STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on polymers for Mathayom 6.

Part 4 evaluates the use of learning management models according to the STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation. Polymer for Mathayom 6 Results of the analysis of the evaluation of the use of the learning management model according to the STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation. Polymer matters For Mathayom 6 students as a whole, as shown in Table 5.

Table 5. Results of the analysis of the evaluation of the use of learning management models according to the STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation

Number	behavior	$\bar{x}$	S.D.	Interpret
1	Communication and cooperation	4.25	0.69	high
2	Critical thinking and problem-solving	4.30	0.62	high
3	Creativity and innovation	4.32	0.64	high
Total average		4.29	0.65	high

Table 5, the results of the analysis of the evaluation of the use of the learning management model according to the STEAM Education guidelines using the TP-SMART MODEL to promote learning skills and innovation on the subject of polymers for Mathayom 6 students as a whole. The average was at a high level ($\overline{X}$=4.29, S.D.=0.65). It was found that the aspect with the highest average was the creative and innovative aspect. The average is at a high level ($\overline{X}$=4.32, S.D.=0.64) Next is critical thinking and problem solving. The mean is at a high level ($\overline{X}$=4.30, S.D.=0.62) and the communication and cooperation are at a high level ($\overline{X}$=4.25, S.D.=0.69), respectively.

5. Discussion

Developing a learning management model according to STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on polymers for students. Mathayom 6 level. From the research results, there are issues brought up for discussion as follows:

Part 1 studies the actual and expected conditions of the development of students' learning and innovation skills.

Results from the synthesis of learning skills and innovation components. From documents and related research, 10 sources, use a frequency value of 9 or more, which is equal to or more than 90 percent of the total frequency, consisting of 3 components. These include 1) communication and collaboration, 2) critical thinking and problem solving, and 3) creativity and innovation. Learning skills and innovation, it is an important and necessary basic skills that students should have. To prepare students in every aspect because learning is necessary in today's era where information is transmitted quickly and is constantly changing consistent with the concept of Thanomchaithawat et al. (2016) stated that Learning and innovation skills include 1) critical thinking and problem solving, 2) creative thinking and innovation, and 3) communication and innovation work together with others (Communication and collaboration)

The overall average of the needs index for the development of students' learning and innovation skills was found to be $PNI_{Modified}$ = .173. The components with the highest need index value were creativity and innovation. $PNI_{Modified}$ = .294. Because at present creativity Expertise or the ability to use creative thinking processes, by using imagination and transferring, use your skills to create something unique. Until creating new things or newly created innovations, therefore, creativity and innovation Therefore it is necessary to develop as much as possible, which corresponds to Research that emphasizes the importance of developing the creativity of Conradty and Bogner (2020) conducted research to study the teaching of professional development with steam education that affects the creativity and motivation of students. Grade 6 students. The research results found that Organizing learning using steam education that integrates art subjects can encourage students to be more creative. Students are motivated to study.

Part 2: Develop a learning management model according to STEAM Education guidelines using TP-SMART.

MODEL to promote learning skills and innovation on polymers for Mathayom 6. The consistency assessment has a value between 0.80-1.00 and the total average is 0.933, which is consistent and appropriate due to the learning management format according to STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on the subject of polymers. For Mathayom 6 and The results of confirming the learning management model according to STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on the subject of Polymers for Mathayom 6 students have been confirmed by considering the appropriateness and possibility From the consideration of 5 experts, it was found that Overall the components are appropriate at the highest level ($\overline{X}$=4.258, S.D.=0.668). Feasibility is at the highest level ($\overline{X}$=4.515, S.D.=0.611). The elements of the model that have the most appropriate mean values are Highlights of the learning management model is at the highest level ($\overline{X}$=4.600, S.D.=0.619). The component with the highest possible average is the result that occurs to students at the highest level ($\overline{X}$=4.600, S.D.=0.603) because the researcher has studied documents and academics. A synthesis occurred according to the STEAM Education guidelines using TP-SMART MODEL, which was learned from learning resources near the school and was the center of the minds of local people.

Civilization sites such as Phra That Phanom Woramahawihan or learning resources from the community local speaker Activity of dyeing fabric from natural dyes and learning management format according to STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on polymers for Mathayom 6. It has been considered by experts, which is consistent with Sribun and Pho-gen (2019) have done research to study the results of organizing biology learning according to the concept of steam education. Using the problem as a basis the research results found that Students' learning outcomes in mathematics were higher after studying than before. Statistically significant at level .05 Students have mathematical skills and processes is at a high level and students' satisfaction with biology learning management according to the concept Steam education is at a high level.

Part 3 studies the results of using the learning management model according to the STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on the subject of polymers for Mathayom 6 The results of the comparative analysis of scores before and after using the learning management model according to the STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on the subject of Polymers for Mathayom 6 students, a sample group of 26 people. It was found that the scores before and after using the learning management model according to the STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on the subject of polymers for Mathayom 6 The difference is statistically significant at .05, with the latter score being higher than the score before using the learning management model according to the STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on the subject of polymers for Mathayom 6 Because the learning management model follows the STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on the subject of Polymers for Mathayom 6 students, it is a learning management model that has been considered by expert Trying out the exam first to find quality and consistent with the research of Surayothin.C. (2018) has developed the curriculum. Integration to enhance the creative and innovative abilities of high school students. The target group is high school students, a total of 38 people. The research results found that the curriculum is appropriate at a high level. Students' creative and innovative abilities after studying are significantly higher than before studying at the .05 level, and students are satisfied with learning with the curriculum at a high level ($\overline{X}$= 4.16) Evaluation of the value and feasibility of the curriculum by those involved. Part 4 evaluates the use of learning management models according to the STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation. Polymer for Mathayom 6 Results of the analysis of the evaluation of the use of the learning management model according to the STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on the subject of Polymers for Mathayom 6 as a whole. The average was at a high level ($\overline{X}$=4.29, S.D.=0.65). It was found that the aspect with the highest average was the creative and innovative aspect. The average is at a high level ($\overline{X}$= 4.32, S.D.=0.64) Because students are interested and the activities stimulate students to develop learning skills and innovation. Can learn integrated in the local area from learning resources and from local lecturers which is consistent with the research of Pasani and Amelia (2021, pp. 1-9) conducted research on the introduction of guidelines in integrating steam education to create learning innovations in the COVID-19 outbreak situation For elementary school The results showed that 93.75% of the 96 participants were interested in the topic presented. This is because learning management stimulates curiosity and curiosity, resulting in increased knowledge and understanding about the methods for integrating steam education. From the study of related research it shows that Problem-solving ability is something that can be developed and practiced. By organizing learning using the Steam Education method, it is a problem-based learning management system. To allow students to face real problem situations, emphasis on action stimulate students' interest and aware of the problem, there is integration of knowledge in science, technology, engineering, arts, and mathematics.

6. Recommendations

From the research results on learning management model according to STEAM Education guidelines using TP-SMART MODEL to promote learning skills and innovation on polymers for Mathayom 6 students. The researcher has suggestions as follows.

6.1 Suggestions for Use

The learning management model according to STEAM Education guidelines using TP-SMART MODEL should be applied to promote learning skills and innovation on polymers for Mathayom 6 students to use in other educational levels or other levels, including early childhood education Vocational and higher education

Apply the model to other agencies or educational institutions in similar contexts. By being a leading lecturer in development exchanging learning from the use of the model and adapting it to the context of other agencies.

6.2 Suggestions for Further Research

The components of teacher leadership in competency-based learning management should be studied at other educational levels, e.g. early childhood education Vocational and higher education

The model obtained from this research should be tested with schools under the Nakhon Phanom Secondary Educational Service Area Office and expand the results to schools under the Office of the Basic Education Commission to consider the results that the developed model helps to develop the students.

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Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.