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The efectiveness of module based on Missouri Mathematics Project model to improve students' mathematical literacy skills

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Abstract

The ability that students must have in the 21st-century learning era is mathematical literacy. Generally, the selection and use of inappropriate textbooks is a factor in low mathematical literacy. The research aims to determine the effectiveness of using modules based on the Missouri Mathematics Project model in improving students' mathematical literacy. The type of research used is quantitative, using a one-shot case study. The participants of this study were 27 lower secondary students. The results showed that the module based on the Missouri Mathematics Project model could improve mathematical literacy with a classical completeness of 96%. Additionally, it can be interpreted from a one-sided t-test that the module based on the Missouri Mathematics Project (MMP) model is effective in improving students' mathematical literacy. The findings can assist educators in effectively utilising the modules based on the Missouri Mathematics Project model and its integration into their teaching practices.

Keywords: *Module; Missouri Mathematics Project; Mathematics Literacy*

INTRODUCTION

Learning mathematics is about more than just calculating the formulas. To deal with these problems, students must possess the skills to learn mathematics. Students are required to be proficient in operating numbers and understand the concept of the problem presented. One of the competency standards for junior high school graduates explains that students must be able to reason using mathematical concepts, procedures, facts, and tools to solve problems related to themselves, the immediate environment, and the surrounding community (Permendikbud, 2022). Thus, in learning mathematics, students are not only required to be proficient in counting. Mathematical literacy needs to be possessed by students to understand the concepts and information contained in the material summary

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and problem sentences. This is in line with Habibi and Suparman's (2020) research, which explains that one of the 21st-century skills students must have is mathematical literacy.

Mathematical literacy and textbook

Mathematical literacy needs to be possessed by students to help them understand information and relate it to material concepts. Literacy is an essential ability that can equip students to critically analyse information to make crucial decisions in life (Kemdikbud, 2020). The ability to read is known as literacy. Kemdikbud (2020) defines literacy as a fundamental ability that can equip students to analyse information critically and use it to analyse information. Students with the ability to analyse information critically and use it to make essential decisions in life. The information received by students plays a role in the decisions they make. Not only is it received, but information needs to be understood and critically analysed. Problems in life need to be solved using skills called mathematical literacy. This is intended so that the decision taken or made is the right one. In mathematics, literacy can be interpreted as the ability to use the mind to solve problems and be ready to face challenges (Stacey & Turner, 2014). PISA (Programme for International Student Assessment) defines mathematical literacy as a person's ability to formulate, use, and interpret mathematics used to solve real-world problems (OECD, 2014). Students are encouraged to be able to analyse all mathematical problems. The results of this understanding are then formulated into mathematical form to obtain a solution.

Mathematics is not limited to memorising and remembering formulas. Learning activities in the classroom involve students to read. In learning mathematics, students read summaries of material and mathematical problems in practice problems. Students need to understand the meaning of the reading to be able to solve the issues. Literacy mathematics literacy is not limited to solving problems in the form of problems in general but is more oriented towards everyday problems (Utami et al., 2020). The mathematical literacy indicators used in the PISA assessment (OECD, 2019) are: 1) communication, (2) mathematisation, (3) representation, (4) reasoning and argument, (5) planning strategies for solving problems, (6) the use of symbols, operations and formal language, and (7) use of mathematical tools.

Students receive all information and play an essential role in making decisions. This information is not only accepted but needs to be critically analysed. The development of the times encourages the education sector to continue to adapt to prepare students to face global demands. The development of the 21st century encourages students to master the field of mathematical literacy (Janah et al., 2019). Mathematical literacy is part of the development of student learning activities, which, of course, need attention to learning styles (Syawahid & Putrawangsa, 2017). Students need to be allowed to learn so that their abilities can increase. Realising independence and emphasising students' abilities can be achieved by paying attention to the occurrence, exploration, discovery, argumentation, and application of mathematical problems (Zhang et al., 2019). In short, students need to be facilitated to improve their mathematical literacy.

The facts in the field based on Indonesia's ranking on the 2022 Programme for International Student Assessment (PISA) have increased compared to 2018 (Kemdikbud, 2023). However, Indonesia is still in the lower middle category, ranking 68 out of 81 participating countries. PISA is a survey organised by the OECD to measure the achievements of 15-year-old students in reading, mathematics, science, and student well-being (OECD, 2019). One of the factors that can cause low mathematics literacy is inappropriate book selection (Fuadi et al., 2020). Textbooks are a medium used by

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students to explore information. The things listed in the textbook will be used as a guide for students to understand the material. Thus, the selection of textbooks is significant in supporting the quality of information students explore.

The quality of a textbook affects the quality of learning outcomes (Ulumudin et al., 2017). Thus, a learning resource that can fulfil these needs is needed to improve mathematical literacy. One of the student learning resources besides books is modules. Students can study the module independently to support learning activities. Quality teaching materials are one of the influences on the success of learning (Setyadi & Saefudin, 2019). To facilitate students and meet the needs of the 21st century, the modules presented need to contain mathematical literacy content. The module can add questions related to mathematical literacy and higher-order questions (Tarim & Tarku, 2022). In improving mathematical literacy, modules that can be used have at least three leading indicators: process, content, and context (Susanti et al., 2021). The process component includes the steps in solving specific problems. The content component relates to the study of materials taught at school. Meanwhile, the process component consists of situations related to everyday life.

The Missouri Mathematics Project

Not limited to the teaching resources and questions developed, strengthening the learning model and applying it to a book is important (Wijayanti & Winsløw, 2017). The learning model can be included in the module and used as a reference. The suitable learning model can help students understand the material (Abdullah, 2017). The chosen model must have the potential to improve mathematical literacy. Missouri Mathematics Project (MMP) is a learning model in the field of mathematics applied in Missouri, a state of the United States, under the Missouri Department of Elementary and Secondary Education (Herdawati, 2022).

A textbook that can fulfil these needs is needed to improve reading habits and mathematical literacy. Because the school uses modules, supporting these needs can be realised with modules oriented to mathematical literacy, especially circle material. The learning steps in the MMP model are packaged in a mathematics module that aims to improve mathematical literacy. The steps can be seen in Table 1 (Herdawati, 2022).

The MMP model is implemented with structured time management by students and teachers. The research conducted by Mellawaty et al. (2019) explained that learning by applying the MMPis carried out in three phases, namely the initial phase, the core phase, and the final phase, where each phase of students and teachers have their respective roles that must be carried out. The example of activities carried out by the teacher is to guide students to remember and refine the previous material into the new situation being taught by asking questions about the core of the previous learning and discussing the tasks given at the earlier meeting. Furthermore, students carry out development activities, namely by imagining and innovating by being given a brief explanation of the material taught by the teacher and given examples of problems. Another process to see the extent of student's understanding of concepts is done by providing controlled exercises or exercises with teacher guidance in a way that students are directed to try carefully, work, imagine, innovate, and work in teams to work on problems. For example, guided practice activities planned to last 25 minutes are implemented and adhered to by teachers and students. This can make students learn efficiently. Teachers plan activities according to the student's abilities and the time available. Meanwhile, students follow the learning seriously.

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Table 1. Missouri Mathematics Project model learning stages

Stages	Description
Introduction (*Review*)	Discussion by teachers and students on previous learning activities regarding material that students find difficult.
Development	Development of new ideas as a deepening of the concept of mathematical material.
	Active explanation and questioning between teachers and students is necessary.
	Development is more effective when combined with practice control to ensure students are following the learning.
Guided Practice	Exercises in the form of worksheets in groups were given to students to monitor for misconceptions.
Independent Work (Seatwork)	Independent work or seatwork in the form of individual worksheets is aimed at expanding students' understanding of concepts.
Assignment	Students can use closing activities to summarise important points, self-reflection on the learning that has been done, and giving assignments from the teacher.
	Assignments are meant for students to spend at least fifteen minutes working at home or outside of class.

The learning stages of the MMP model direct students to analyse what they are facing when learning the material (Diaz & Ariawan, 2020). Guided and independent exercises are the core components of the MMP model. Student activity in doing exercises can help achieve improvement (Abidin, 2020). Thus, learning activities that apply the MMP model can help students improve mathematical literacy (Winardi & Dwijanto, 2017; Rahma, 2022).

Previous research explains that learning mathematics by applying the MMP model effectively improves student learning outcomes. There was a significant increase after being given learning through the MMP model (Machfud, 2020). This research is in line with research conducted by Amri and Qowiyuddin (2023), which explains that the MMP model effectively increases student motivation to learn mathematics. This can be proven by the study results, which show a significant difference between the average mathematics ability of students before and after being given treatment. The difference can be seen in the increase in students' mathematics ability, so it can be concluded that the effectiveness indicator on students' mathematics ability has been met. The same thing is explained in the research of Septian et al. (2024) that after using the MMP model, students' problem-solving skills are in a suitable category, so it can be interpreted that the MMP model effectively improves students' mathematical problem-solving skills.

Learning modules based on the MMP model can help students become more active and independent in solving problems (Komalia et al., 2019). The research aligns with the results described by Mapilindo et al. (2021), which state that module-assisted mathematics learning will help students become more active. In addition, research by Ramadhani and Amudi (2020) explained that several factors influence the effectiveness of using modules in the learning process, the first of which is that the module has been validated so that it can help improve the effectiveness of learning. This study will integrate the learning module with the MMP learning model on the circumference and area of a circle. It will measure the effectiveness of combining the learning module with the MMP model on students' mathematical literacy skills.

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METHOD

This research employed a quantitative methodology, as Creswell (2018) defined. The research design is a one-group posttest-only design or a one-shot case study, a quasi-experimental research design in which a dependent variable is measured for one group of participants following a treatment (Campbell et al., 2015).

Respondents

The participants in this investigation were 27 lower secondary students in grade VIII. The participants in this study have attested to their willingness to engage in the research activities. This research was conducted in a lower secondary school in Jepara District, Central Java province, Indonesia. A previous study by Rodliyah et al. (2023) investigated the potential benefits of implementing a module based on the MMP in the same school. Their findings indicated that students in that school encountered difficulties in solving tasks based on stories in the textbook, which was attributed to their limited mathematical literacy skills.

Instruments

Circle is one of the materials taught in the even semester of junior high school or equivalent. In this grade, students are expected to explain and solve problems related to the central angle, circumference angle, arc length, and the area of the circumference of a circle and its relationship. Therefore, the module used in the current research also discusses the circumference and area of a circle.

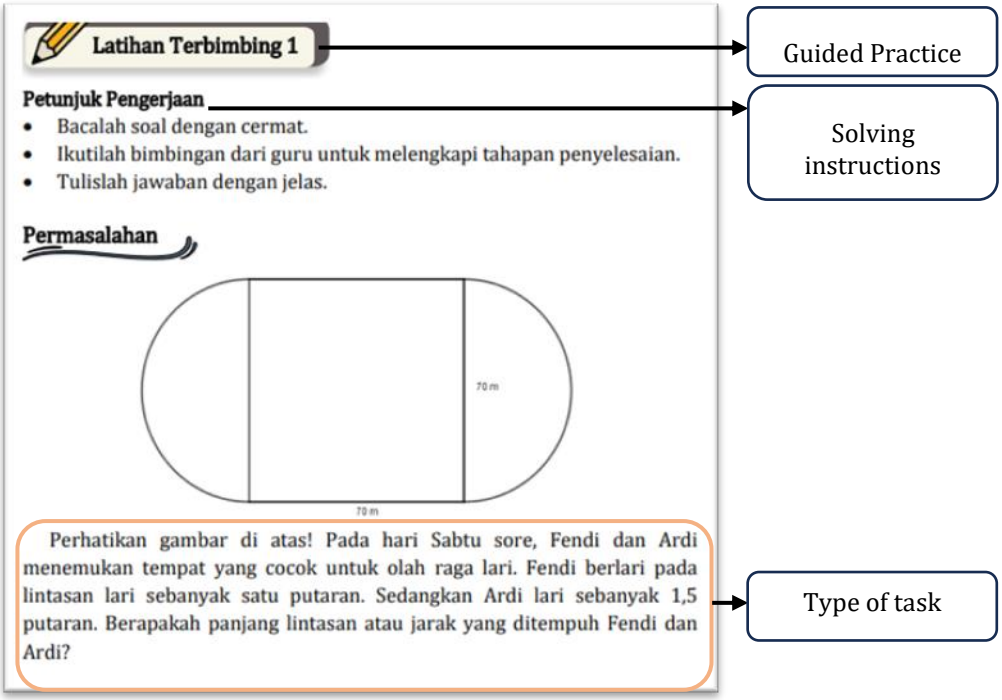

Figure 1. Guided practice in the module (in Indonesian language)

The module, based on the MMP learning model, was developed based on media learning validation, encompassing both graphical and illustrative elements. Furthermore, the material validation of the module was based on the following criteria: content eligibility, presentation eligibility, and language eligibility. A survey was also conducted to examine the responses of teachers and students. The survey results indicated the module's eligibility. The module example can be seen in Figure 1. Guided Practice is one of the

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characteristics of the Missouri Mathematics Project. It is an exercise in the form of worksheets in groups, which were given to students to monitor for misconceptions. This exercise was designed with scaffolding to facilitate task completion (Figure 2).

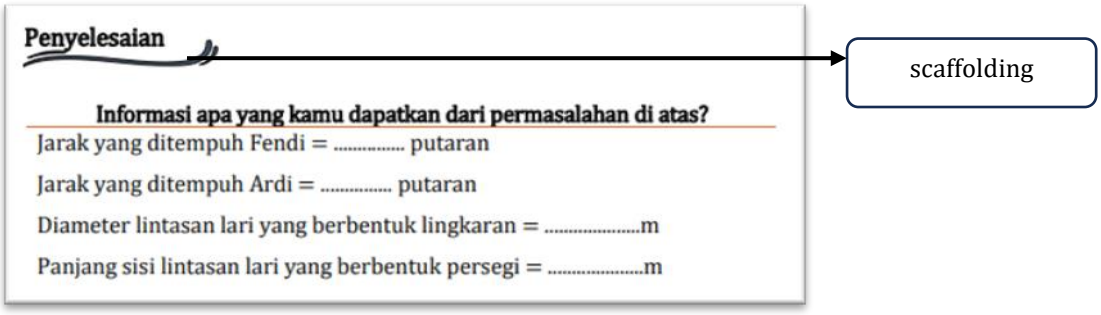

Figure 2. Scaffolding to solve the task (in Indonesian language)

Procedures

The learning model is packaged in modules as learning media used during learning. The implementation was conducted in March 2023 in three sessions, each consisting of 80 minutes. The research design is a one-shot case study conducted in a single class. The design is illustrated in Figure 3. The study commenced with the learning treatment, which employed the Missouri Mathematics Project model-based learning and module. After the treatment, a post-test based on literacy skills was administered.

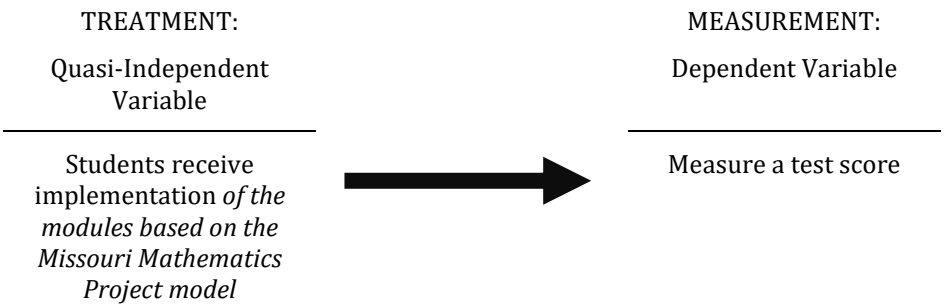

Figure 3. Research design

The validity and reliability of the questions used to measure students' mathematical literacy have been tested. The questions were as follows:

1. Mr Jamal will make a garden in front of his house. The garden is planned to be circular with a diameter of 63 metres. The edge of the garden will be planted with roses with a distance of 0.5 metres between each flower. How many roses does Mr Jamal need? ($\pi = \frac{22}{7}$).
2. Ajun observed a swimming pool that has a radius of 10 dm. The bottom of the pool is tiled with an equal number of black and white tiles. The area of each square of tile is 400 cm^2 . How many squares of black tiles does the teacher need to put on the bottom of the pool? (π = 3,14).

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Data analysis

The level of individual learning completeness is determined following the minimum completeness criteria (KKM) established by the educational institution, which is set at 75. The minimum completeness criteria are the learning completeness criteria determined by the education unit. These minimum completion criteria are aligned with the graduate competency standards. In establishing the KKM, the education unit must collaborate with the principal, educators, and education personnel. In contrast, classical learning completeness is defined as the percentage of students who achieve an individual completeness of at least 75%.

Individual learning completeness can be analysed through a one-sided t-test, while classical learning completeness is analysed through a one-sided proportion test. The Missouri Mathematics Project model is effective when the t and z count is greater than the t and z table, resulting in the rejection of H_0. A prerequisite test, comprising a normality test, is conducted before the effectiveness test. Furthermore, the limitations and implications of this study are discussed in the following section.

RESULTS AND DISCUSSION

In the Results section, we discussed the completeness of classical learning and the effectiveness of the module-based approach employed by the Missouri Mathematics Project model. This was followed by a discussion of related literature, a review of the implications of the findings, and an examination of the study's limitations.

Result

The implementation of the activities was successful. According to the Missouri mathematics module, learning activities were carried out in groups and individually. Students generally work on problems in a lesson through guided practice and independent work (seatwork). In addition, students and teachers carry out developmental activities in which both students and teachers actively explain and question. The implementation of the activities is shown in Figure 4.

Figure 4. Student Activities guided by teachers

The data obtained from the prerequisite test population exhibited a normal distribution. This is due to the fact that the normality test value (0.147) was more significant than 0.05. The data employed to ascertain the module's effectiveness was derived from the post-test results, which can be observed in Table 2. The mean post-test score was 90, with a standard deviation of 7.6. The lowest possible value was 71, while the highest possible score was 100.

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Table. 2. post-test results

Number of students	$\sum x_i =$	$\sum x_i^2$	Average	Standard Deviation	Minimum Value	Maximum Value
27	2417	217883	90	7,6	71	100

The hypotheses of the individual learning completeness of the experimental class were H0: μ = 75 (students' mathematical literacy has not reached the KKM), while H1: μ ≥ 75 (students' mathematical literacy has reached the KKM). The calculated t-value obtained (t=9) was then compared with the t-table value of 1.706. This means that the t-value ≥ t-table, thus H0 was rejected. It was therefore concluded that the mathematical literacy of the students using the Missouri Mathematics module has reached the KKM.

In testing the classical learning completeness of the experimental class, the null hypothesis (H0) was formulated as π = 0.75, indicating that 75% of the students were considered to be complete. The alternative hypothesis (H1) was formulated as π ≠ 0.75, indicating that the remaining students were considered to be more than 75% complete. The calculated z-value was then compared with the z-table value with α = 5%. If the Z-value is greater than that given in the Z-table, the null hypothesis (H0) was rejected. In this case, the Z-value was found to be 1.14, which is greater than the Z-table value of 0.87. This Z-test indicated that more than 75% of students reached the KKM, demonstrating the classical learning completeness of the Missouri Mathematics Project module in terms of developing mathematical literacy.

Discussion

The study indicates that implementing the Missouri Mathematics Project model effectively enabled students to achieve individual learning completeness. This can be defined as the point at which students have acquired the mathematical literacy skills required to meet the KKM standard. Furthermore, the study found that over 75% of students demonstrated classical learning completeness, indicating that most of their mathematical literacy skills had reached the KKM. The effectiveness of Missouri Mathematics Project model for improving students' mathematical literacy skills in line with the results of research from Susanto and Susanta (2022), which explains that the application of interactive e-modules based on project-based learning is practical in terms of mathematical literacy skills. These results can be seen from the t-count and significance level. In addition, using interactive e-modules based on project-based learning is more effective than the control class.

Using learning modules based on the Missouri Mathematics Project model has gone through a long stage, starting from the validation stage by several experts. This is undoubtedly one of the factors causing the learning module based on the Missouri Mathematics Project model to be effectively used in learning. This is supported by the statement of Ramadhani and Amudi (2020), which explains that several factors cause the effectiveness of using modules in the learning process; the first is that the module has been validated by material experts, media experts, linguists and practicing lecturers and declared quite valid and practical and can be used in learning so that it can improve learning outcomes. To conclude, textbooks (in this case, the Missouri Mathematics Project model) play a crucial role in education by providing a structured and comprehensive foundation of knowledge on a subject. They ensure consistency in what is taught, offering students a reliable source of information that aligns with educational standards. Textbooks are designed to break down complex concepts into manageable sections, making learning more accessible and organized. They often include a variety of

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supplementary materials, such as exercises and examples, which reinforce understanding and facilitate practical application. Additionally, textbooks serve as a reference for both students and educators, supporting long-term learning and aiding in assessing progress.

The use of learning modules based on the Missouri Mathematics Project model by applying the circumference and area of the circle material in this study greatly helped student activeness in learning. This can be proven by students who are active in the group either discussing, asking friends, or asking the teacher if there is an explanation that has not been understood. Active participation in the classroom is crucial for students as it enhances their learning experience and academic success. When students engage actively, they not only absorb information more effectively but also develop critical thinking and problem-solving skills. This involvement encourages deeper understanding of the material and fosters a more dynamic and interactive learning environment. Additionally, active participation allows students to clarify doubts, receive immediate feedback, and contribute their perspectives, which can lead to a richer and more collaborative educational experience. Ultimately, a student's engagement in class plays a significant role in their overall educational growth and achievement. Research results by Mapilindo et al. (2021) explained that module-assisted mathematics learning would help students become more active. This is in line with the research of Komalia et al. (2019), which explains that the use of learning modules based on the MMP model can help students become more active and independent in solving problems. The existence of guidance in the MMP learning model can help students who have not been able to complete learning activities independently. Then, in the independent work and assignment stages, students solve problems without guidance from teachers or lecturers. Guidance at the beginning of learning and the absence of guidance at the end can provide opportunities for students to be responsible for completing independently (Basir & Wijayanti, 2020).

The use of learning modules based on the Missouri Mathematics Project model is effective in improving the mathematical literacy of grade VIII students on the circumference and area of the circle. However, some challanges were still made by students when solving the circumference and area of the circle. The difficulty is evidenced by some students incorrectly performing calculation operations and some students not understanding the concept of the circle. This is in line with the research of Manalu et al. (2020), who explained that the errors made by students were conceptual errors where students applied the circle area formula when finding the circumference of the circle. The formula was incorrectly applied, as evidenced by students not being able to distinguish the diameter and radius of the circle. The second difficulty is that students misunderstand the meaning of the question about the area of the circular roadside. Students had difficulty in writing the unit of the circle. In addition, students made procedural errors by dividing incorrectly. Surely, to reduce students' errors in solving the circumference and area of a circle, teachers should accustom students to solve story problems coherently so that they can have high literacy skills. Teachers can accustom students to write first what elements are contained in the known problem in order to facilitate student understanding when solving problems and get used to writing units in mathematics related to the circumference and area of a circle.

CONCLUSION

Reviewing the results of the research and discussion, it can be concluded that the module based on the Missouri Mathematics Project model is effective for improving the

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mathematical literacy skills of lower secondary students in grade VIII, which is indicated by the individual and classical completeness of on the circumference and area of the circle material. To support students' mathematical literacy skills, it is necessary to provide learning resources that support the improvement of mathematical literacy and other 21st-century learning needs. It can certainly be used as an alternative for teachers to be applied in the classroom. Through the Missouri mathematics project model, students are more enthusiastic and more active.

The findings of this study should be considered in light of the limitations of the research design, which provide insights for future studies in this field. The present study did not assess the initial abilities of the students. In other words, the principal limitation of this design is the absence of a comparison or control group. In addition, although the results of this study showed positive results, the study was conducted in a very short period of time when teachers and students fully understood the purpose of the study. Research activities with a longer duration are needed to determine the impact of the study more accurately. Finally, the use of the module will be meaningless when the teacher as the leader of the learning orchestra, does not implement with 'discipline' the activities of the MMP. Thus, it is necessary to study more deeply the other success factors of Missouri learning. However, the MMP model designed in line with the model is able to assist teachers and students in learning. Findings can indicate the need for professional development to help educators effectively utilize the model and integrate it into their teaching practices. Finally, Results can inform policymakers about best practices and evidence-based approaches to enhance educational systems and curricula.

AUTHOR CONTRIBUTION

Author 1: Conceptualization, Visualization, Investigation, Methodology, Software; Data curation, Writing—Original draft preparation; Author 2: Supervision, Validation, Conceptualization, Visualization, Investigation, Methodology, Software; Data curation, Reviewing, and Editing. Author 3: Supervision, Validation, Conceptualization, Visualization, Investigation, Methodology. Author 4: Software, Validation, Writing, Reviewing, and Editing

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