

## Implementation of The STEM Learning Model Using Math City MAP (MCM) in Improving Creative and Critical Mathematical Thinking Ability

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### Abstract

*There is a need to summarize the result of STEM reachers findings, especially to improve mathematical creatives thinking and mathematical critical thinking skills. This research also synthetisizes relevant studies from various sources include: Google Scholar, Directory Open Access Journal (DOAJ), Semantik Scholar and Education Resources Information Center (ERIC) from 2015 to 2022. The result of the research show that the STEM learning models has a positive and significant influence on increasing critical thonking skills and students' mathematical creativity. Various descriptions of research characteristics such as sample sizw, level of education, and years of education can be examined further for further research. The intergration of STEM learning models can be used by educators to facilitate students with various project-based taks and problem solving. It is hoped that the use of the Math City map application will be able to motivate students to have joyfull and meaningfull mathematics learning. In this students are required to have critical and creatives mathematical thinkings skills. The results of this research contribute to knowledge for educators and research regardib=ng how STEM should be applied in mathematics lesson.*

**Keywords:** *STEM, Math City Map mathematical creative thiking, mathematical critical thinking*

### Abstrak

Perlu adanya rangkuman hasil temuan para pencapaian STEM, khususnya untuk meningkatkan kemampuan berpikir kreatif matematis dan berpikir kritis matematis. Penelitian ini juga mensintesis kajian-kajian relevan dari berbagai sumber antara lain: Google Scholar, Directory Open Access Journal (DOAJ), Semantik Scholar dan Education Resources Information Center (ERIC) pada tahun 2015 hingga 2022. Hasil penelitian menunjukkan bahwa model pembelajaran STEM mempunyai pengaruh positif dan signifikan terhadap peningkatan keterampilan berpikir kritis dan kreativitas matematis siswa . Berbagai uraian mengenai karakteristik penelitian seperti ukuran sampel, tingkat pendidikan, dan lama pendidikan dapat dikaji lebih lanjut untuk penelitian selanjutnya. Integrasi model pembelajaran STEM dapat digunakan oleh pendidik untuk memfasilitasi siswa dengan berbagai tugas dan pemecahan masalah berbasis proyek. Penggunaan aplikasi peta Kota Matematika diharapkan dapat memotivasi siswa dalam pembelajaran matematika yang menyenangkan dan bermakna. Dalam hal ini siswa dituntut untuk memiliki kemampuan berpikir matematis yang kritis dan kreatif. Hasil penelitian ini memberikan kontribusi pengetahuan bagi para pendidik dan penelitian tentang bagaimana seharusnya STEM diterapkan dalam pembelajaran matematika.

**Kata kunci:** *STEM, berpikir kreatif matematis Math City Map, berpikir kritis matematis*

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## INTRODUCTION

Mathematics lessons have long been feared by many students. Apart from involving many formulas, the domain of mathematics is very broad and always requires students to think at a high level of critical thinking. Conventional learning models make students feel bored and consider mathematics to be an unpleasant subject.

The development of science and technology is increasingly rapid, as a result of developments in the current modern era, giving rise to various innovations in the field of technology that were created to make human activities easier (Hulwani et al., 2021). Technology that makes human work easier is really needed, including in the world of education. Educators are required to be more creative in utilizing technological developments in the learning process (Rahmawati & Juandi, 2022).

Rapid and dynamic changes in the world of education require the ability to generate new ideas so that teachers and students are able to overcome the complexity of unexpected problems. The ability to provide new, unusual ideas and be able to examine problems from various points of view, as well as being able to produce many different ideas from other people is known as the ability to think creatively (Widana & Septiari, 2021). On the other hand, a variety of information is abundant and easily accessible from various sources, requiring critical thinking to filter which information can be accepted as true. So the ability to think creatively and the ability to think critically is very necessary in accordance with the skills demands of the 21st Century, namely so that students have a variety of abilities including critical thinking, creative thinking, communication and collaboration (Handayani, 2020; Nesri & Kristanto, 2020; Nurlenasari et al., 2019; Wulandari, 2019).

The STEM (Sains, Technology, Engineering, and Mathematics) approach can be used as an approach option when learning mathematics which can be implemented to facilitate students' creative thinking abilities and critical mathematical thinking abilities. This is based on several research findings related to the implementation of the STEM approach in improving students' abilities. students' mathematical critical thinking (Ahmad et al., 2020; Hadi, 2021) as well as increasing students' mathematical creative thinking abilities (Amiruddin & Juwairiyah, 2019; Suherman et al., 2021).

According to TIMSS 2015 findings, Indonesia ranks 45th out of 50 countries with a mathematics score of 397, this means that children's mathematics abilities are in the poor category. The Organization for Economic Co-operation and Development/OECD (2018:5) report claims that the 2015 PISA results is 490, while Indonesia is only 386. The average achievement of students is far below the average value, for this reason there is a need for innovation to improve students' ability to think critically and creatively. The use of the Math City map/ MCM application is one innovation to motivate students in improving their creative and critical thinking skills through fun and meaningful learning.

GPS-based application with the location of math questions on Math Thrail can be found using the Math City Map which will be a guide for students in solving problems. (Ismaya, et al., 2018). The MATIS 1 working group of the Institute for Mathematics and Informatics Education at Goethe University Frankfurt am Main created the Math City Map.

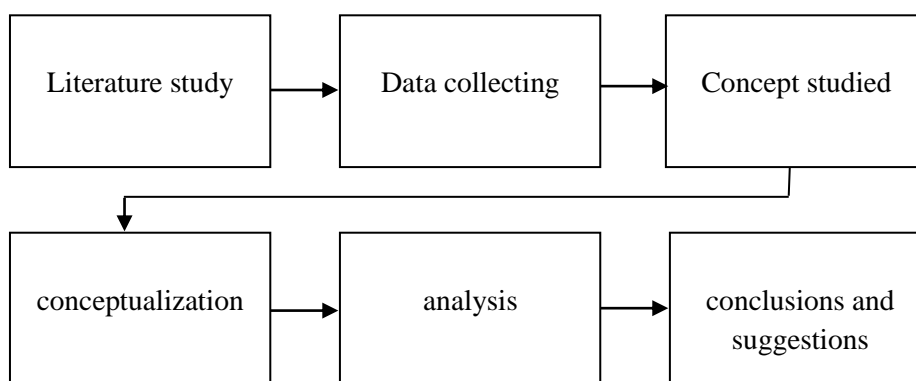
Students use this application to practice the mathematical knowledge they gain in real life to solve various problems. Apart from being able to solve practical mathematics problems, students can expand their knowledge of local wisdom, identify historical building structures, objects of historical and cultural value that can be integrated into mathematics lessons. Apart from solving mathematical problems, Math City Map can also be applied thematically in other subjects. Thus, this application can be used to solve mathematical problems realistically and can be applied to other subjects.

## METHOD

This research uses a literature study approach in writing and collecting data. The literature study approach displays a number of steps including collecting bibliographic information, reading and taking notes, and managing research materials (Zed, 2008:3). The literature review is connected with theoretical studies and other references related to the values, culture and norms formed in the social environment studied (Sugiyono, 2012).

The design used is Posttest-Only Control Design, which means random control through a final test in which there are two classes, each class is chosen randomly, meaning there are no superior classes and the same curriculum is used. The experimental class received STEM learning assisted by Math City map. Both of these learnings were visible in the students' final learning outcomes. Meanwhile, the control class only received conventional learning.

Kartiningrum (2015) said that several steps in writing a literary study are shown as follows:



**Diagram 1. Diagram of The Concept Studied**

## RESULTS AND DISCUSSION

Applying the STEM learning model with the help of the Math City Map application is one way to help students improve their mathematical creative and critical thinking skills. Students will learn in fun and meaningful mathematical situations. According to Ismaya (2018), the Math City Map provides the location/findings of mathematical problems in the Math Trial which will be used as a catalyst for a mathematical problem that will be answered by students. MATIS 1 Institute for Mathematics and Informatics Education working group at Goethe University Frankfurt am Main in Germany responsible for creating the Math City Map. The steps for learning STEM with the City Map math application are: (1). Download the Math City Map application on Playstore. (2). Launching the program. (3). Select the "add trace" menu option at the location of the problem to be solved. Students can enter relevant map codes for trial or group sessions.

Learners then enter a password or code for the track or group session card. Math City Map is played in groups or groups. This game requires cooperation between group members to solve problems optimally. The next step after entering the Path menu is to load the adventure area map and answer questions. Then students are tasked with choosing a location point on the map to solve questions in the educational game. When students choose a point and are taken to that point, questions will appear that will stimulate students to think creatively and critically. Then students are required to choose a location and solve questions through the game. At each location, various kinds of questions will be provided that can encourage students to think critically.

Students answer by writing short answers on the application. This guide helps students understand how to find solutions to problems. If a group/team of students responds correctly and quickly in the first opportunity, they will receive an additional 100 points. However, if a team is not quick to answer correctly on the first try, then answer correctly on the second try, then that team's score will not be the best. Apart from accuracy in answering questions, speed of time is also an added value for the group of students.

The Math City Map application has several advantages for STEM-based mathematics education. Math City Map allows students to learn mathematics in a fun and meaningful way, thereby reducing boredom. Playing educational games is believed to increase students' interest and learning abilities. This is in line with Hidayat's (2019) statement that learning will be more fun if subjects are packaged in games. In addition, the STEM learning model with Math City Map uses an Android application for smartphones which allows students to learn anytime and anywhere without location and time restrictions. Flexible learning means that students are not burdened with predetermined class durations. Students can adapt their curriculum to their personal learning style, maximizing their skills for learning (Waryanto, 2006). Apart from utilizing the Math City Map, students also comply with various syntaxes of the STEM learning model which is usually called the Engineering Design Process (EDP). EDP is also a form of activity in solving real-life problems (real-life problem solving), because the forms of questions in Math City Map are also real problems encountered in students' daily lives. EDP syntax includes: (1). Problem Identification is the process of identifying problems. (2). Related Information Search, at this stage students can collect and search for information related to problems. (3). Solution Design, namely how teams or groups look for solutions to problems. (4). Planning and Development, namely planning and developing solutions to problems obtained. (5). Testing: Evaluation and Design Improvement, or testing/evaluating a predetermined design. (6). Presentation, namely the group is given the task of presenting the results of their work.

In implementing Math City Map, a relatively stable internet connection is required to avoid learning disruptions. This is because it still has several learning limitations that are very dependent on connectivity and devices. Apart from that, Math City Map is an application that can be downloaded and installed on a smartphone, so it requires an iOS or Android based smartphone. For schools where it is not yet possible to use a device to implement the Math City Map application, this can be done by using a conventional Math City Map map, namely in the form of a map or plan made manually.

STEM-based Math City Map is an application that can be used to teach mathematics to children in an interesting way. The use of applications and social/existential problems in group settings, such as questions that connect one mathematical concept to other mathematical concepts, improves students' critical thinking. Therefore, coordination and teamwork must be prioritized when using the application. The use of Math City Map continues to improve students' critical thinking in mathematics lessons over time, which is reflected in the topics covered and methods used.

### **Problems example:**

An arena will be installed with synthetic grass. The cost of installing synthetic grass is IDR 2,000,000 per 1 cubic meter. How much does it cost to buy artificial grass if one step is 0.5 meters and the inner court running track is 200 steps deep and 152 steps wide?

Solution: Long	= 200 steps
	= 100 m
Wide	= 152 steps
	= 152 steps
	= 76 m
The field area is 2 x 12 circles	= $2 \times 12 \times 3,14 \times 38 \text{ m}$
	= $2 \times 12 \times 3,14 \times 38 \text{ m}$
	= 4534,16 m
The area of the field is rectangular	= $100\text{m} \times 76\text{m}$
	= $100\text{m} \times 76\text{m}$
	= $7600\text{m}^2$
The total area of the inner field of the running track	= $4534,16 \text{ m}^2 + 7600\text{m}^2$
	= $12134,16 \text{ m}^2$
Required costs	= Rp 2.000.000 $\times$ 12134,16
	= Rp 2.426.832.000.000

### CONCLUSION

An application that can be used to teach mathematics in a fun and meaningful way is called Math City Map. Math City Map with a STEM learning model can improve students' creative and critical mathematical thinking abilities. Students' abilities increase when they know how to relate a mathematical topic with the help of applications carried out in groups and in the form of questions that are triggered by difficulties. Thus, Math City Map has the potential to increase students' numeracy literacy, creative and critical mathematical thinking abilities. The application of the Math City Map in the STEM learning model makes students learn mathematics through real experience. With this experience, students' cognitive, affective and psychomotor development can increase. Students and teachers can use the Math City Map application to learn mathematics with a combination of STEM learning models in various ways.

The advantages of the Math city map are that learning mathematics is more fun, reduces boredom so that learning is more meaningful. Additionally, there are no time or location restrictions when using the Math City Map program to learn math. Implementing the Math City Map application improves coordination and teamwork skills and encourages more meaningful mathematics learning. However, the Math City Map application with a STEM learning model has limitations, namely that it depends on an internet connection and requires the installation of certain hardware, especially iOS or Android-based smartphones. Apart from that, the time required is quite long, and you have to prepare for learning from the start. However, for schools where it is not possible to use gadgets and the internet, they can use the Math City map in conventional form, namely in the form of a manual map and floor plan. Likewise, implementing the STEM learning model does not always use technology and expensive items. Teachers and students can use objects around them as learning resources. This of course requires teacher creativity. To be able to present Math City Map learning with a STEM learning model, teachers must really master STEM knowledge well.

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