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In-Service Elementary School Teachers' Perceptions About Metaverse-Assisted STEM Projects

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Abstract. The challenge for teachers to implementing STEM in elementary schools is to unite the four fields of Science, Technology, Engineering and Mathematics into a learning method and the development of interesting projects for students. The real strength in STEM teaching is the connections between fields that support and reinforce one another. It is a creative process for teachers to design truly transdisciplinary projects. Ideally, projects are based on authentic problems for students at school. This study aimed to determine how the perception of in-service elementary school teachers in positions about metaverse-assisted STEM projects. This study used a qualitative and observative approach. The data analysis technique used in this research was descriptive analysis. The results showed that schools need to really understand the main things related to STEM project-based learning with the help of metaverse, namely: First, metaverse-assisted STEM projects should focus on real issues or problems and every lesson should be contextual. Second, the metaverse-assisted STEM projects was an inquiry, hands-on, and open-ended activity.

Keywords: in-service teacher, elementary school, learning media, metaverse

1   Introduction

Science, Technology, Engineering, and Mathematics (STEM) have recently been an important education issue. Learning using STEM projects is an integration of learning science, technology, engineering, and mathematics that is recommended to help the success of 21st-century abilities [23, 24]. Learning based on the STEM approach focuses students on authentic and real-world problems, and students learn to reflect on themselves to solve a problem. Therefore we need problem-based learning to train students to solve problems [4, 12, 26]. In solving a problem, students are ex-

pected to think critically to get the best solution to solve the problem. In today's 21st century, humans must have abilities in various fields, including the ability to think critically, think creatively, communicate and collaborate, and master information and communication technology. Likewise, the world of education itself is faced with the challenge of being able to print the Indonesian generation to be able to face the global competition that will come. Based on this explanation, a pattern in learning is needed that can develop three aspects, including aspects of knowledge, aspects of attitudes, and aspects of abilities [2, 15, 28].

Based on data from the World Population Review in 2021, Indonesia is still ranked 54th out of a total of 78 countries in the world education level field ranking [36]. Furthermore, the PISA report found that Indonesia's literacy ability was ranked 72 out of 77 countries, mathematics scores were ranked 72 out of 78 countries, and science scores were ranked 70 out of 78 countries [22]. To overcome this, innovative learning is needed that can train critical thinking and problem-solving skills. One of the actions that can be overcome in implementing a STEM project is learning with the help of metaverse. With the project as a learning medium, it will certainly help students hone and grow their creativity. Not only that, students will be required to be able to work together in a group so that the problems set can be solved [32, 38]. In addition to co-operation, students' communication skills will also be developed because this learning model requires students to communicate with each other in their study groups or with other groups.

STEM project learning with the help of metaverse is a new learning product. It is still rarely studied even though this research is very important because the progress of ICT has also made it possible to use various types of media simultaneously in virtual form [3, 13, 34]. Mastery of STEM project concepts with the help of metaverse, namely integrating the principles of science, technology, engineering, and mathematics. The unity of STEM learning with the help of this metaverse aims to develop products, processes, and a unified system that will benefit themselves and the lives of the wider community [31, 35]. STEM projects with the help of metaverse are very suitable to be set at the elementary school level because they can help students to understand in-depth learning that emphasizes the four interdisciplinary needs that students need to face the challenges of global currents. In addition to using the STEM project with the help of metaverse to improve student learning outcomes, innovative learning media are also needed, and the STEM project approach with the help of metaverse so that students understand more about the material taught by the teacher during the learning process. In carrying out their role in the learning process, teachers need tools to convey information to students.

Integrating STEM projects with the help of metaverses is a combination of learning approaches with components of Science, Technology, Engineering, and Mathematics with metaverses as learning media and metaverse as a virtual world that users can enter. In it, users can work, socialize, shop, and play using special technology [17, 30]. Metaverse is a technology that can create simulations. The simulation is like the real world, where you can see the atmosphere and walk around a city that has never been visited. Metaverse not only provides a screen viewing experience, but users can sink and interact with the 3D world. Metaverse technology simulates many senses,

such as sight, hearing, touch, to smell. Although virtual reality is widely used for video game games, virtual reality is also widely used for other fields [13, 16].

Learning by using STEM project integration with the help of metaverse can answer the challenges of the 21st century, which requires humans to have information, learn and innovate, have a career and have global awareness, and have the character to meet the high market demand for products based on science and technology skills [5, 10]. In the era of millennial technology, educating the nation's next generation is not an obstacle. Furthermore, technological advances, especially in the era of digitalization of the world of education, have become a medium for educators and educational institutions to prepare future generations. For this reason, for school teachers in positions or teachers who are participating in the teaching profession program, it is time to implement a STEM project with the help of metaverse because today's teachers must be closer to increasingly advanced technology, education answers the challenges of the times so that they can give birth to children who can adapt to the development of the age of knowledge and technology but still maintaining noble moral values in society and accordance with the goals of national education [8, 19]. Furthermore, it is said that the STEM project with the help of metaverse has specific objectives, including: (1) science which means directing students to be able to use scientific approaches in everyday life, and (2) technology which means students must be able to take advantage of the use of technology properly, (3) Engineering (engineering) which means that students can design and apply and collaborate on the results of their knowledge and findings, (4) mathematics which means that students must be able to read symbols in mathematics and be able to solve mathematical problems in everyday life.

This research is important to do considering that technology in the field of education is currently growing. Metaverses as a means Virtual learning media is an intermediary that is used or used in learning as a tool for educators or teachers in the teaching and learning process as a means of carrying messages from learning resources to students or recipients of learning messages [14, 30]. Urgency The use of metaverses in learning activities based on study results empirical evidence that it can generate new desires and interests, arouse motivation and stimulation of learning activities, and even bring psychological effects on student [27, 33]. The use of metaverses at the teaching orientation stage will greatly help the effectiveness of the learning process and delivery of messages and lesson content at this time. Besides generating student motivation and interest, teaching media can also help students improve understanding, present data in an interesting and reliable way, facilitate data interpretation, and condense information.

Metaverse-Assisted STEM Projects studies are still rarely developed and researched. Research conducted by Mystakidis metaverse can enable mixed active pedagogy to cultivate deeper and sustainable knowledge. a metaverse that is borderless or provides unlimited space, creates greater engagement that [19] must face. With technological developments in the world of education entering the metaverse, teachers must be ready for wider international engagement, which is really wild. Anyone who enters, can. Although we can lock some space (digital). The benefits of metaverse based on empirical results are that with the existence of metaverse technology, it

makes it easier for us to access existing information via virtual, such as meeting virtu-ally and doing assignments and also discussing student/student material often through search engines, this can make it easier to access things that are difficult in learning. learning [21]. However, metaverse research assisted by project stems is still rarely carried out and developed even though this is important because the main goal of STEM is to make everyone mathematically and technologically literate. Teachers should not only focus on those who have prospects for "success" in STEM fields and who are gifted. Because basically, everything requires STEM. Studying STEM related subjects can broaden the horizons of the mind. If we learn to think scientifically, we will definitely learn the technique of trial and error. The key to this lesson is creative problem solving, questioning things, seeking the truth, and always being eager to explore more about how things work. Children have to learn these things. That's why children have to learn science and its way of thinking.

2   Method

2.1   Research Design

This study used a type of qualitative research. This research intends to understand the phenomenon of what is experienced by the research subjects, namely to find out how the perception of elementary school teachers in positions about the STEM Project with the help of metaverse. This study used a qualitative method to understand the actions of the subject and object under study through qualitative research techniques such as observation, in-depth interviews, and documentation. Then, the data were analyzed using the descriptive method [11, 25]

2.2   Participants

Participation in this study were primary school teachers in positions or teachers who were following the in-service teacher professional education program in the city of Surabaya as many as ten people consisting of three male teachers with coding (M) and seven female teachers with coding (F). The participants of this study are sources of data that can provide information related to the research problem being studied. The technique of taking research subjects using a purposive sampling technique that is selected with certain considerations and objectives.

2.3   Data collection

The data collection technique aims to obtain data in ways that are in accordance with the research so that researchers will obtain complete data. This study uses types of data sources obtained orally and in writing [18]. The data collection techniques used in this study are as follows. (1) observation, the implementation of observation, re-searchers need to involve themselves as subjects so that researchers can capture the interpretive process of what is observed. Researchers observing not only determine

who will be interviewed but also determine the context, events, and processes. Observation is done openly, ie the research is known by the subject and otherwise the subject voluntarily provides the opportunity for the researcher to observe anything that attracts attention. (2) Interview (Interview) This study uses interview techniques, because through interviews, data is obtained directly through a series of questions and answers with parties related to the problem. According to Moleong, an interview is a conversation with a specific purpose. The conversation is carried out by two parties, namely the interviewer (interviewer) who asks questions and the interviewee (interviewer) who provides answers to questions (3). Documentation This method is carried out by reviewing written sources relating to the subject matter of the problem. Documentation is used to collect data that is already available in document records. Documentation functions as a supporter and complement of the main data obtained through observation and interviews.

2.4   Data Analysis

Data analysis is the process of processing data with the aim of finding useful information that can be used as a basis for decision-making for the solution of a problem. This analysis process includes data grouping activities based on the characteristics of the data that has been obtained and reduced into a certain pattern. Then from there, it can be the categorization of themes which will then be interpreted or news based on the schemes obtained [7]. Data analysis was carried out with the aim that the information collected would be clear and explicit. In accordance with the research, the data analysis technique used to analyze the data in this study used Nvivo 12 software. The data obtained from observations, interviews, and documentation were recorded in field notes which consisted of two aspects, namely description, and reflection. Descriptive notes are natural data that contain what is seen, heard, felt, witnessed, and experienced by the researcher without any opinion and interpretation from the researcher about the phenomena encountered. While the reflection notes are notes that contain the impressions, comments, and interpretations of researchers about the findings found and are material for data collection plans for the next stage. The data that has been coded can be compared with other data that has been decoded with the help of nvivo 12 software. Perceptions of elementary school teachers in positions of STEM Project with the help of metaverse. Dimensions of perception of elementary school teachers in positions about the STEM Project with the help of metaverses measured in this study, namely (a) cognitive, (b) effective, for the purposes of collecting data in the field, the dimensions are translated into indicators can be seen in table 1.

Table 1. Dimensions and Perception Indicators of primary school teachers in positions regarding Metaverse-assisted STEM Projects

Dimension	Indicator
Cognitive	Knowledge of STEM Projects with the help of metaverse
	Understanding of STEM Projects with the help of metaverse
	Understanding of using STEM Projects with the help of metaverse
Affective	Paying attention to the purpose of using learning models and media
Dimension	Taking into account the various factors that influence media selection

3   Results and Discussion

The results of this study are data taken based on respondents' answers about the perception of elementary school teachers in positions about the STEM Project with the help of metaverse. Respondents' answers were analyzed to the Nodes created in Nvivo 12, the results obtained were (1) cognitive dimensions with indicators of Knowledge about STEM Projects with the help of metaverse, Understanding of STEM Projects with the help of metaverse, Understanding of using STEM Projects with the help of metaverses (2) Affective with indicators Paying attention to the purpose of using media, Considering various factors that influence the selection of learning models and media. The minmap visualization of this research can be seen in Figure 1.
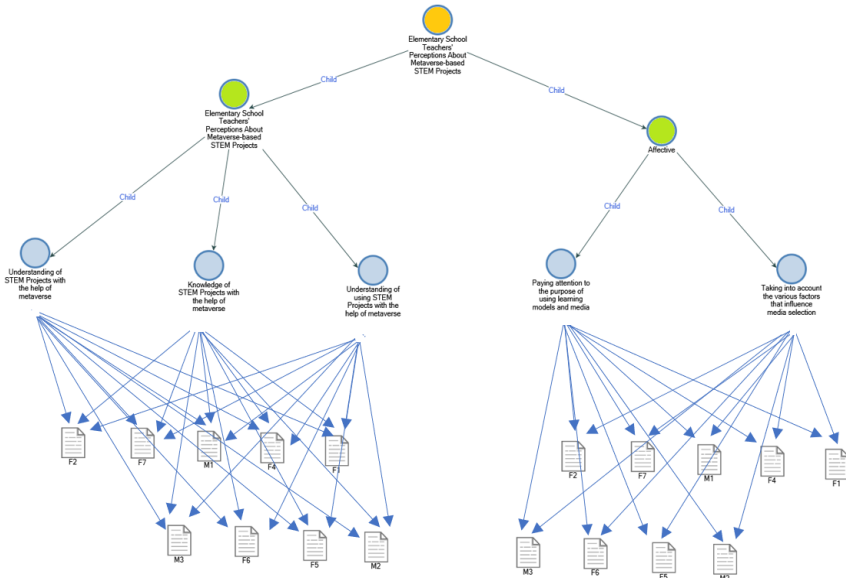
Fig. 1. The mindmap Teacher's Perception of Knowledge about STEM Project with the help of metaverse

The teacher's perception of Knowledge about the STEM Project with the help of the metaverse, in terms of the cognitive dimension in general, the teacher's perception is at a positive level. In the process of collecting data, the researcher also conducted interviews with several teachers regarding the teacher's perception of the online learning process from a cognitive perspective,

> *So far, what I understand is that the STEM project is a learning approach that is only used in learning mathematics and science, but after getting information through focus group discussions and training related to the STEM Project with the help of Metavese, I finally understand that the learning approach if integrated with Metavese-based learning media will create interesting learning atmosphere. Because students are happy with the visual world of digitalization (M1)*

> *The STEM Project with the help of the metaverse is new knowledge for us and we hope that there is a need to develop a STEM Project with the help of the metaverse that we can apply when learning in elementary school. During the focus group discussion, information related to the STEM Project with the help of the metaverse provided new knowledge for the respondents that the use of the STEM Project with the help of the metaverse in the teaching and learning process can generate new desires*

and interests, generate motivation and stimulation for learning activities, and even bring psychological effects to students (M3).

An understanding of the STEM Project with the help of a metaverse. A version of the use of a STEM Project with the help of a metaverse has many benefits that are provided by a STEM Project with the help of a metaverse in an educational context, including increasing student involvement in learning, helping students work through difficult concepts, helping promotes critical awareness, helps promote equality, and many more benefits are provided [1, 6, 29]. STEM projects with the help of metaverse have various kinds of diversity, so teachers need to identify and utilize existing learning resources, both those that have been designed (by design) and those who use them. The difference is that learning resources by design are learning resources that are intentionally designed and made for learning purposes [9, 20],

Based on the results of observations and observations made by researchers that in the field the use of learning media is one component of learning that has an important role in teaching and learning activities. Utilization of the media used by the teacher should be a part that must get the attention of the teacher / facilitator in every learning activity. Therefore, the teacher/facilitator needs to learn how to determine the learning media in order to effectively achieve the learning objectives in the teaching and learning process. In fact, in the field, the use of learning media is still often neglected for various reasons, including: limited time to make teaching preparations, difficult to find the right media, unavailability of funds, and others. This actually doesn't need to happen if every educator/facilitator already has the knowledge and skills about learning media. Difficulty implementing media in learning can be caused by there are some obstacles. The obstacle like a school that doesn't have Internet access. This of course makes the teacher and students become more difficult when need to access learning materials from Internet.

The teacher's perception of Knowledge about the STEM Project with the help of the metaverse, in terms of the affective dimension in general, the teacher's perception is positive. The teachers considered that the main thing that must be considered in implementing learning using STEM Projects with the help of metaverses was to first pay attention to the purpose of using learning models and learning media. Utilizing a STEM Project with the support of the metaverse has its challenges. For example, the limited budget and the environment and its aspects are a subsystem in learning that also affects the success of using technology in education. However, despite these challenges, integrating STEM Projects with the help of metaverses into learning is a necessity today. Because preparing students to be ready to face their future life must immediately start from the learning period at school. Designing learning activities that match the real world is sometimes difficult. For this reason, a learning approach that integrates digital technology media is needed to present the real world and all its problems in the classroom. So that students get used to problem-solving to face real problems.

The role of the STEM Project with the help of metaverse can be successful if it is able to change student behavior (behavior change) and improve student learning outcomes. The success of using STEM Projects with the help of the metaverse is very

dependent on how well the learning planning is planned [10, 30, 37]. STEM projects with the help of metaverse will be effective and successfully used in the learning process if a comprehensive analysis is carried out by taking into account various aspects. These aspects include objectives, student conditions, supporting facilities, available time, and teacher's ability to use them appropriately.

4   Conclusion

The development of technology gives birth to a variety of models, methods and learning media that are more effective and interesting for students. In-service elementary school teachers' perceptions of the STEM Project with the help of metaverse. the dimensions are (1) cognitive with indicators Knowledge of STEM Project with the help of metaverse, Understanding of STEM Project with the help of metaverse, Understanding of using STEM Project with help of metaverse (2) Affective with indicators Paying attention to the purpose of using media, Considering various factors that influence the selection learning models and media. The conclusion from the statement of elementary school teachers in positions about the STEM Project with the help of the metaverse is that they think that the STEM Project with the help of the metaverse is able to help all aspects of the learning process carried out by a teacher. A STEM project with the help of a metaverse is one aspect that must exist and be fulfilled by a teacher in a learning process. With the development of technology today, there are so many learning media that are increasingly diverse and sophisticated

Statements of Conflicting Interests

The authors declare there is no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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