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Systematic Literature Review: Helping Students Learn Mathematics through the Integrated Flipped Learning Model of Ethnomathematics and STEM

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Abstract

Flipped learning is recognized for its flexibility and student-centered approach, integrating technology to enhance engagement and understanding. However, contradictions arise between the theoretical foundations of flipped learning and its practical implementation. Self-Determination Theory suggests that autonomy, competence, and relatedness should enhance motivation, yet many students experience anxiety and lack confidence when learning independently. Self-Regulated Learning Theory supports student autonomy, but real-world findings indicate that many learners struggle with self-discipline and require more structured guidance. Cognitive Load Theory emphasizes managing cognitive demands, yet the constructivist nature of flipped learning often increases cognitive overload rather than reducing it. Additionally, while Constructivism advocates deep, contextual learning, it sometimes conflicts with structured instructional approaches necessary for effective flipped learning.The integration of Ethnomathematics and STEM within the flipped classroom further exposes these contradictions. While ethnomathematics promotes cultural relevance in learning, it is often limited to artifact exploration rather than fostering deeper cognitive and moral engagement. Similarly, STEM integration aims to enhance interdisciplinary connections but faces challenges in meaningful application. To bridge these gaps, this study proposes the Social-Cognitive-Cultural Constructivist (CSCC) Learning Theory as a new framework for optimizing the flipped learning model. Further empirical studies are needed to refine this approach and ensure that flipped learning effectively aligns with its theoretical underpinnings while addressing practical challenges in student learning.

Keywords: *Flipped Learning, Self-Determination Theory, Ethnomathematics, STEM*

Introduction

Mathematics learning is increasingly developing along with the development of the times and the integration of technology. Technology in mathematics education plays a role as a tool and an integral element of understanding. Technology integration encourages teachers to be more flexible in providing different learning experiences to students (Kafyulilo et al., 2015; Liburd & Jen, 2021). Teachers are no longer limited by space constraints, and various types of technology also facilitate their creativity to carry out more optimal mathematics learning. The flexibility offered in technology integration also has a negative impact on learning. Unpreparedness in using technology is one of the variables that contributes to the suboptimality of mathematics learning for both students and teachers. Boca (2021), Bringula et al. (2021), and Keržiÿ et al. (2021) agree that personal factors and personal behavior of each person cause students and teachers to be unprepared in using technology. Technology integration can provide new mathematics learning experiences for students. Meanwhile, meaningful and student-centered learning is a new paradigm in mathematics learning (Polman et al., 2021).

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Field studies show that mathematics teachers have implemented student-centered learning. However, the learning model has not been properly validated regarding the suitability of syntax and its application. In addition, it has not been adapted to the environment around the students, including the cultural context and customs. The learning model is less practical and effective in helping students improve their abilities. Low learning abilities of students, especially in mathematics, are still found. One example can be seen from the ANBK results obtained by junior high school students in Surabaya, especially in Ngawi City, which still need to show more optimal results. The ANBK results in 2020-2024 showed a significant decline. One of the factors in the low ANBK results of students is the need for more implementations that bring students closer to meaningful learning experiences.

The study of ethnomathematics began to emerge around the 1970s. It was Ubiratan D'Ambrosio from Brazil who could be considered the father of ethnomathematics (Francois, 2009:1517). Ethnomathematics is here to research the socio-cultural aspects of mathematics. And it is possible to search for aspects of mathematics in certain ethnic cultures. Ethnomathematics uses etymology from Greek, namely ethno, mathema, and tics. Ethnomathematics is a program that combines mathematical ideas and procedures practiced by members of different cultural groups, identified not only as indigenous peoples but as groups of workers, professional classes, and groups of children of certain age groups as well (D 'Ambrosio 1985).

In 1999, D'Ambrosio enhanced the meaning of ethnomathematics in mathematics learning by saying that ethnomathematics can be used in the mathematics learning process to encourage students to learn mathematics by connecting the mathematics material taught with local culture, past experiences, or cultural practices (Latif, 2018). Learning with culture includes the use of various forms of cultural manifestations (ethnomathematics). In learning with culture, culture and its manifestations serve as media to help students learn. They also serve as contexts for examples of concepts or principles in a subject, as well as contexts for applying concepts or principles in a procedure.

Ethnomathematics is a system of knowledge that offers the possibility of a harmonious relationship between humans and between humans and nature. Ethnomathematics contributes to restoring cultural dignity and offers intellectual tools for exercising citizenship. It enhances creativity, strengthens a culture of self-esteem and mutual respect, and offers a broad view of humanity. Ethnomathematics uses cultural experiences as a means to make mathematics learning more interesting for students and gives them an understanding of the mathematical knowledge embedded in their sociocultural environment. (Rosa et al, 2017).

The ethnomathematics perspective in the mathematics curriculum helps all participants to understand and appreciate alternative perspectives, cultural diversity, natural language, mathematics, and visual representations that form a unique system for meaning-making. In this context, reorienting teaching and learning to include ethnomathematics can engage and excite students in learning and encourage them to see themselves as capable of doing mathematics by validating their own cultural experiences, which serve as important components in understanding and celebrating learning. In mathematics learning, ethnomathematics elements can be used to help students construct concepts as part of mathematical literacy. In addition, ethnomathematics can make the learning environment more exciting and interesting so that students become very interested in mathematics lessons, which is expected to have an impact on their mathematical abilities, especially mathematical literacy (Saironi, 2022).

The importance of ethnomathematics approach in designing learning models not only stimulates research progress, but also supports efforts to create meaningful and contextual learning experiences for students. By utilizing local wisdom and culture in mathematics learning, this method can create a closer bond between learning materials and students' daily realities.

By emphasizing holistic and contextual mathematics learning, the Learning Model with an ethnomathematics approach brings positive contributions to the development of mathematics education. The results of this bibliometric analysis serve as a basis for supporting further development in designing curricula and teaching practices that strengthen the connection between mathematical concepts, everyday life, and students' cultural identities.

The sustainability of research and implementation of learning model design with ethnomathematics approach needs to be encouraged to ensure its positive impact can be felt by more students and teachers. Integration of ethnomathematics approach in mathematics curriculum can be a concrete step to support contextual learning, trigger students' interest, and develop their understanding of mathematical concepts.

Through the ethnomathematics approach in mathematics learning, it is expected that students will not only become mathematical concept understanders, but also creative and contextual users of mathematics in everyday life. With an awareness of the richness of local knowledge and culture, mathematics education can be more inclusive, accommodate diversity, and produce meaningful learning for all students.

The 2019 TIMSS survey showed that environmental factors, quality of learning practices, and socio-economic background are closely related to learning achievement (Mullis & Martin, 2017). Based on these results, personal and behavioral factors are obstacles in optimizing student-centered learning. Another aspect that is not included in environmental, social, customary, and cultural factors is the implementation of learning that is not optimal. The absence of technology and multidisciplinary fields of science as supporting factors for the implementation of learning is also an indication that the implementation of learning is not optimal.

STEMis part of learning that connects the abilities of science, technology, engineering, and mathematics to obtain real solutions to problems in everyday life (John et al., 2016). STEM is prepared so that students have multidisciplinary abilities in preparing their competencies in the future.Through STEM, students' conceptual understanding of science and mathematics can be improved, which can develop their knowledge of engineering and technology (Mcdonald, 2016). In STEM learning, it will be more interesting and enjoyable because it is related to contextual problems and provides direct knowledge so that it can provide students with stimulus in thinking about problem solutions. Kennedy (2014) said that in STEM there are four definitions, including: (1) science is knowledge about nature and the environment; (2) technology is the skill of utilizing artificial tools that make human work easier; (3) engineering is the skill of running/creating a procedure to find a solution to a problem; and (4) mathematics is a science that discusses the relationship between quantities, numbers and space with logical arguments without or accompanied by empirical evidence.

Based on this, further research is needed related to the proposed solution. Investigation and analytical studies are needed to develop a new learning model. Furthermore, analytical studies are also needed to determine the contradictions in learning theories as the basis for meaningful and student-centered learning. Therefore, this analytical study focuses more on the role of the social environment, traditions, and STEM-integrated culture in optimizing the process of meaningful and student-centered mathematics learning. This study was conducted to analyze and examine the importance of meaningful learning that allows students to follow the learning process. This study is also important to obtain recommendations whether the existence of technology, which in previous studies has various negative impacts, can be maximized by integrating the concept of meaningfulness in learning. Based on this, the novelty in this study is the results of in-depth analysis and study related to the integration of meaningful learning through the context of ethnomathematics, STEM and learning flexibility through the flipped classroom model which can be developed as a recommendation for a new learning model. Analytical studies related to the integration of learning approaches and methods still need to be carried out, and this is what makes this study novel.

Method

Systematic Literature Review (SLR) is a method used to determine, assess, and interpret all existing research related to the problem formulation or subject being studied (Calderon and Ruiz, 2015). SLR is defined as a comprehensive analysis and assessment of previous research, conducted methodically using relevant guidelines and procedures.

High quality academic publications can be found, selected, evaluated and synthesized through the use of Systematic Literature Review. Furthermore, to present different theories that address the research topic and are relevant to the case study..

Discussion

Flexibilityin the Flipped Learning Model

Blended learning, such as the modelFlipped learning, has the advantage of learning flexibility by integrating technology as a connecting space during the process. The model is implemented in two stages, namely learning outside the classroom and learning in the classroom.(Ramadhani, 2020; Ramadhani & Fitri, 2020; Ramadhani et al., 2022). Furthermore, the application of the flipped learning model provides space for interaction (Attard & Holmes, 2020; Fernández-Martín et al., 2020).

Students can explore the material presented by the teacher while still collaborating with others to increase their self-confidence, interest, motivation, and adaptation to the use of technology in learning.mlearning (Abeysekera & Dawson, 2015).Implementing the flipped classroom model provides flexibility in terms of time and place for students to collaborate and explore the material.

However, its implementation has not been actualized effectively and optimally in learning, this is supported by previous research,where Davies et al. (2013)comparing the effectiveness of regular classes, flipped classes, and simulations in lectures. The results showed that regular classes and flipped classes were more efficient than simulations, but there was no significant difference between the two.. Kim et al. (2014) alsoobtained findings that the implementation of the flipped classroom model provided significant results on the self-efficacy of Korean University students.

The Contradiction Between Supporting Learning Theory and the Application of the Flipped Learning Model

Contradictions occur in the advantages offered by the flipped classroom model. This is also seen in the less than optimal support of learning theories that underlie the model in the application of learning.

Self-determination theory also supports the flipped classroom model and presents three aspects, namely competence, autonomy, and relatedness. Competence is related to the need to feel capable and in control of the learning process. Autonomy is related to the need to participate in tasks. independently. Relatedness concerns the need to engage in tasks that allow students to interact and communicate with their peers (Khayat et al., 2021). This is also supported by Self-Regulated Theory which allows students to obtain concrete learning based on experience. Students can also monitor, regulate, and control their cognition, motivation, and behavior based on learning goals and contextual features (van Alten et al., 2020; Wolters et al., 2005). Students who follow the flipped classroom model can take advantage of the flexible environment through self-directed learning and collaboration. Personal and behavioral factors that support this theory are considered before implementing the model (Ng & Lo, 2022).

The application of self-determination and self-regulated theories does not occur in the flipped learning model. The results obtained by Kim et al. (2014) contradict the self-determination theory underlying the flipped classroom, where students will be motivated in the learning process when given the application of the model. Baloran (2020) also obtained results related to personal and behavioral factors, where around 59.25% of students in the Philippines experience anxiety during the learning process. This anxiety is influenced by a lack of self-confidence in participating in mathematics learning independently. Furthermore, students need full support from teachers in helping them understand the material given.

Cognitive Load Theory supports the flipped classroom model, which allows students to manage their cognitive load. This should align with self-determination theory and self-regulation theory (Akkaraju, 2016; Mattis, 2014). However, the three theories have not been able to provide full support for the implementation of the flipped classroom. Personal and behavioral factors are two main things that need to be ensured in maximizing the theoretical basis of the flipped classroom. The support of individual behavioral theory will optimize the implementation of the flipped classroom model in learning, especially mathematics learning. Furthermore, sociocultural and constructivist theories also provide space to complement the success of the implementation of the flipped classroom.

The Role of Personal and Behavioral Factors in the Implementation of the Flipped Learning Model

The flipped learning model offers flexibility with the support of technology integration that acts as a virtual classroom during out-of-class learning. Technology readiness and adaptation are important points to consider before implementing the flipped classroom model, especially in mathematics learning. Technology adaptation is one part of the competencies that teachers must have. In addition, this competency is called Technological Pedagogical and Content Knowledge (TPACK), which is the ability to master technology, content, or materials with the teaching process (Koehler & Mishra, 2009). TPACK is a theoretical framework that connects technology, content, pedagogy, and its use in the classroom (Schmidt et al., 2009).

The existing facts are contrary to the expectations offered in the flipped classroom model. Most students and teachers have not been able to adapt to the technology used in its implementation. Mailizar and Fan (2019), Mailizar et al. (2020), Cevikbas and Kaiser (2020), and Christopoulos and Sprangers (2021) have similar findings where teachers have difficulty using technology. There is no flexible time to develop ICT competencies in implementing the flipped classroom model. The ability to adapt technology also affects students' learning motivation and reduces self-confidence and self-efficacy (Al Salman et al., 2021). Technology adaptation of TPACK competencies is part of teacher behavior.

Personal factors also influence teacher and student behavior regarding technology adaptation. These factors include:self-efficacy (Bandura, 1986; Zimmerman & Schunk, 2008), emotional (Koob et al., 2021), componential, experimental, and contextual intelligence (Sternberg, 1986). Positive self-concept, realistic self-assessment, preference for long-term goals, leadership experience, community involvement, and knowledge are designed according to each student's preferred learning style (Dehghani et al., 2011; Sedlacek, 2004). Furthermore, these factors are important parts that need to be considered in implementing the flipped classroom model. The results of this study are in contrast to the important role in optimizing flexibility-based learning, namely the flipped classroom model.

Ethnomathematics and STEM as Part of Culturally Contextual Learning Environment Design for Meaningful Mathematics Learning

Previous studies have shown a mismatch between factors that play an important role in optimizing flexible learning. Personal and behavioral factors play a role in the implementation of flipped classrooms and other learning models. However, both factors play an important role in the implementation of the flipped classroom model by intersecting with the technology used. The learning environment is one of the personal factors that is a special consideration for teachers before designing flexible learning (flipped classroom model). Previous studies in mathematics learning have used many contextual problems that are not based on students' cultural experiences (Reinke, 2019; Suarsana et al., 2019; Widjaja, 2013).

Design learning environments that are appropriate to students' cultural contextsand STEM integration is one solution to optimize the flipped classroom. By supporting a learning environment that is appropriate to the cultural context, it can provide a meaningful experience of the multidisciplinary sciences being studied.Through STEM, students' conceptual understanding of science and mathematics can be improved, which can develop their knowledge of engineering and technology (Mcdonald, 2016). STEM learning will be more interesting and enjoyable because it relates to contextual problems and provides direct knowledge so that it can provide stimulus for students to think about problem solutions.

Underlying the integration strategy, three outcomes are identified: (i) intra-disciplinary connections, which make it possible to present mathematics as an integrated whole, rather than as a set of isolated knowledge; (ii) interdisciplinary connections, between knowledge from different disciplines that complement each other; and (iii) connections between mathematics practiced by a cultural group and institutionalized mathematics, which are at the same time global in nature because they relate mathematics to the socio-cultural context.

Meanwhile, students will feel that contextual problems that are close to cultural experiences and other disciplines intersect with mathematical concepts. The learning environment in the application of the flipped classroom model requires several conditions and further development in order to be designed and implemented successfully. Program development is by integrating cultural and STEM contexts into the model's learning design. This can optimize the implementation of flexible but meaningful mathematics learning.

The implementation of a learning environment that is close to the cultural context can be done by integrating the dimensions contained in the ethnomathematics approach. This approach recognizes that different cultures develop different ways of doing mathematics.

Ethnomathematics represents the way various cultural groups create their mathematical reality through ideas, methods, techniques, and practices used in everyday life (Risdiyanti & Prahmana, 2020). These concepts are related to the motives behind a particular culture (ethno) in history developing steps to calculate, conclude, compare, and classify techniques and ideas (D'Ambrosio, 2018; Rosa & Orey, 2016). Madusise (2015) believes that mathematics is part of local wisdom. In line with that, Marsigit et al. (2018) stated that mathematics is a cultural product. Judging from the statement above, cultural and mathematical education can be connected based on an ethnomathematics approach. According to Rosa and Orey (2016), the concept has several similarities, namely: cognitive, conceptual, educational, epistemological, historical, and political dimensions, which are closely related to each other, and are used to analyze the socio-cultural roots of mathematical knowledge.

Several studies have successfully applied this approach.ethnomathematics and STEM in mathematics learning (Nurjanah et al., 2021; Risdiyanti & Prahmana, 2021; Rosa & Orey, 2017; Santos et al., 2020; Utami et al., 2019). However, the application of cultural context is still limited to cultural artifacts. The research conducted seems to be limited to the exploration of cultural artifacts outside the Ngawi area. The results of the study indicate that the design of learning environments with cultural contexts is still at the level of artifact exploration. In addition, the integration of meanings containing cultural character values and multidisciplinary sciences in meaningful mathematics learning has not been developed. This finding is a further analytical study to develop learning programs that provide flexibility and meaningfulness in learning design.

Cognitive Load Theory vs Constructivism Theory

The learning theories underlying the flipped classroom model do not fully support the success of its implementation. Various factors cause contradictions between learning theories that support the facts and findings of its implementation. Behavior and personal factors are two things that need to be considered by teachers who will implement flexible and meaningful mathematics learning. However, analytical studies that support the flipped classroom model and the ethnomathematics approach also need further attention. Based on this explanation, the learning theories underlying the flipped classroom include constructivist learning programs, Vygotsky, and ethnomathematics (Mercer et al., 1994). Some of these learning theories are Vygotsky (1978), Ausubel (Vallori, 2014), self-determination (Muir, 2021), self-regulated (Zimmerman & Schunk, 2008), cognitive load (Akkaraju, 2016; Mattis, 2014), and ecological theory (Bronfenbrenner, 1986). This is also the theoretical basis for the ethnomathematics approach.

The contradiction that supports the flipped classroom model and the ethnomathematics approach occurs in cognitive load theory and constructivism. According to cognitive load theory, providing instructional guidance has a significant impact on the implementation of efficient and effective learning (Sweller, 1988). On the other hand, constructivism theory emphasizes the importance of deep learning - contextual understanding of the material (Loyens & Gijbels, 2008). The core of the learning environment is student-centered, and knowledge is acquired through social interaction. A different view arises from cognitive load theory, which is built on the idea of different types of learning. Furthermore, self-directed learning helps students manage their cognitive load during the learning process (Seery & Donnelly, 2012; Turan & Goktas, 2016). Akkaraju (2016) also explains that managing students' perceived cognitive load is related to the availability of instructional guidance, which is a contradiction between cognitive load and constructivism theory.

Learning theory highlights the importance of acquiring strategies or methods. However, the process of acquiring knowledge has conflicting views between these two theories. Krischener et al. showed that constructivism theory ignores the findings of cognitive architecture literature stating that working memory has a limited capacity (Sweller, 1988). This theory tends to provide students with information that exceeds their capacity, and teachers fail to guide knowledge acquisition efficiently. Constructivism theory also states that although initial guidance is needed, encouraging students to develop an active learning process will further enhance the ability to acquire and apply conceptual knowledge. Furthermore, cognitive load theory supports students in exploring more structured learning. This can help the cognitive load experienced by students during the learning process. Based on this explanation, there appears to be a theoretical gap between cognitive load and constructivism, which provides an opportunity to develop a new theory. The basis for this development can be adjusted to improve the learning model based on analytical studies of flipped classrooms and ethnomathematics and STEM approaches.

Discussion

The flipped classroom model and the ethnomathematics and STEM approaches have advantages and disadvantages that support each other. The flexibility offered in the flipped classroom provides convenience for teachers and students in carrying out learning activities and preparing cognitive loads according to their competency levels. Furthermore, the integration of technology that becomes a virtual space for out-class also supports the implementation of learning anywhere and anytime. The exploration and development of teachers' TPACK competencies will be further honed when integrated with technology. The ethnomathematics approach can complement the learning environment and cultural context factors that are neglected in the flipped classroom model. This approach offers ease of learning by integrating cultural contexts, activities, phenomena, values, and characters that are reflected in the socio-culture that has become part of students' life experiences (Prahmana et al., 2021).

This can have a positive impact on students, where learning activities and contextual problem solving are no longer far from life experiences. The application of learning that provides problems based on contextual experiences and is sourced from cultures and traditions that are close to students will increase students' motivation and motivation to learn.

The use of culture in the context of mathematics is not something new, because it is part of local wisdom (Madusise, 2015). Culture-based mathematics or what is known as ethnomathematics makes it easier for students to do mathematical modeling based on ideas, methods, and techniques from what has been developed by the surrounding community and can be used as an alternative to introduce students more closely to the phenomena that occur in life around them (Prahmana et al., 2021). Investigating data originating from phenomena that occur in the lives around students will help develop students' mathematical reasoning abilities, so that students can better understand and appreciate the mathematics they are learning (D'Ambrosio & Rosa, 2017; Rosa & Orey, 2017). Ethnomathematics is not only learning that uses a cultural context as a presentation of informal problems given, but also learning that presents cultural values that are raised and actualized in learning activities (Rosa & Orey, 2011). In addition to the integration of ethnomathematics, the learning model should refer to the flexibility felt by students when carrying out learning. Ramadhani, Sihotang, et al. (2021) explained that this condition makes the learning process transform from face-to-face learning to distance learning that integrates technology as part of the learning process. Sumantri et al. (2020) explained that changes in the implementation of the learning process can be used as part of improving the competence and quality of educational programs that integrate implementation procedures through technology. Meanwhile, the embedded STEM approach is an educational approach where the knowledge domain is obtained through an emphasis on real-world situations and problem-solving techniques in socio-cultural and functional contexts (Robet and Cantu, 2012).

The implementation of the flipped classroom model provides space for students to interact not only with each other, but also between students and teachers, and between students and the content of the material (Attard & Holmes, 2020; Fernández-Martín et al., 2020). Students can explore the material presented by the teacher while still collaborating with each other to increase students' self-confidence, interest, motivation, and adaptation in utilizing technology in learning (Abeysekera & Dawson, 2015). The implementation of the flipped classroom model also provides flexibility of time and place for students to collaborate and explore the material. Meanwhile, the ethnomathematics and STEM approaches present meaningful learning that is close to informal problems based on culture and traditions in students' lives. The flipped classroom model that can be integrated with the ethnomathematics and STEM approaches is an interesting learning model innovation and has a significant impact on the development of students' mathematical competence. Ramadhani, Syahputra, et al. (2021) added that the support of constructivist learning theory, self-determination theory, cognitive load theory, and self-regulation theory proves that the integration of the flipped classroom model and the ethnomathematics approach has a real influence on students to be more motivated to be active in learning, increase students' self-confidence and self-efficacy, gain freedom in exploring learning, and there is collaboration between students which creates the expected social interactions in learning.

The Flipped Learning Etno-STEM (FLES) model begins by ensuring learning readiness in terms of adaptation to the technology used and the environment. Learning activities in this model are student-centered and provide opportunities to explore materials according to their level of ability. Exploration of problems that are close to cultural characteristics, phenomena, and activities helps students identify, reduce, visualize, analyze, and predict the data presented. Meanwhile, the investigation and collaboration scheme is very important and is carried out in stages by utilizing the cultural characteristics of students to obtain character and moral values. Tiered collaboration is carried out by grouping students according to their level of ability. This scheme is designed in the Flipped Learning Etno-STEM model to maximize and solve problems. The tiered collaboration scheme also helps students improve self-regulated learning and provides space to increase social interaction during the learning process. Furthermore, the Flipped Learning Etno-STEM model also allows students to apply their socio-cultural character values to solve problems in the given context. Elaboration can also be done by connecting the problem solving obtained with existing theories and concepts. Students are invited to carry out further validation and confirmation with the teacher to strengthen their understanding of the concept and procedure of problem solving. The Ethno-STEM Flipped Learning model also allows students to evaluate and reflect after participating in a series of flexible, meaningful and multidisciplinary learning activities. This study recommends the development of a learning model that provides flexibility and meaningfulness of learning through the cultural context applied in mathematics that is more dominant than other disciplines in STEM (Science, Technology, Engineering and Mathematics). Ethno-STEM integrated flipped learning is a recommended learning model to optimize flexible mathematics, integrated with meaningful STEM, and based on culture. Furthermore, this model maintains student-centered, collaborative, creative, and innovative learning and trains students to develop positive social interaction skills. The development of this flipped learning model reconciles cognitive load and constructivism theory. The Social-Cognitive-Cultural Constructivist Learning Theory (CSCC) is formed from the development of the flipped learning model. Further analysis related to the development of the theory of the ethno flipped classroom model can be carried out in an analytical study.

Conclusion

The Flipped Learning Ethno-STEM model was developed by combining the flipped learning method, ethnomathematics and STEM approaches. This model was developed by analyzing theoretical studies and the results found that learning theories overlap with the methods and both approaches. However, the learning theories that support it have not played an optimal role in its implementation. The theoretical study also found a gap between theory and studies. Personal and Behavioral Factors are related to the less than optimal role of learning theories that support the flipped learning model. An environment that does not offer flexibility and meaningful learning and multidisciplinary science is also an obstacle based on the ethnomathematics-STEM approach. Meanwhile, cultural exploration is at the level of cultural artifacts and character and cultural moral values have not been properly actualized.

This study also concluded that there is a contradiction between the learning theories that support the flipped learning model and the ethnomathematics-STEM approach. Cognitive load and Constructivism theory require further analysis to help students manage their ability levels. The results of this study offer an Ethno-STEM Flipped learning model to maximize flexible and meaningful learning and manage multidisciplinary knowledge gained through cultural and traditional contexts. Several limitations need to be considered in interpreting the results of this study, which are limited to exploring theoretical analysis and have not been based on direct implementation results. This study focuses on analytical studies to develop new learning models that provide flexibility and meaningfulness in a learning process. Finally, further studies are needed to develop the theories that emerge in the Ethno-STEM flipped learning model.

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