PROJECT-BASED OF MATHEMATICS LEARNING PARADIGM IN OPEN AND DISTANCE EDUCATION

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Abstract

This research aims to elucidate the paradigm of project-based mathematics education within the context of open and distance learning. Mathematics encompasses the acquisition of knowledge, the study of precise sciences tied to reasoning, and extends beyond mere calculation. It involves problem generation and resolution, pattern recognition, linguistic aspects, cognitive processes, and evolving knowledge—a tool for evolving and dynamic comprehension, fostering autonomy and nurturing independent thinking. The significance of mathematics in life is profound, offering meaningful insights, honing analytical acumen, and furnishing solutions to diverse challenges. Applying a project-oriented approach to mathematical representation involves harnessing cognitive prowess, self-reliance, cooperative attitudes, and social interaction among peers to arrive at problem-solving solutions. This approach flourishes within the three dimensions of open and distance education: (1) accessibility to information resources, (2) self-directed learning, and (3) a structured and accountable curriculum. The research employs a qualitative methodology, employing literature review and interviews with mathematics education instructors. The combination of literature analysis and interviews yields comprehensive insights. The findings of this study underscore project-based learning as a prominent pedagogical method within open and distance education. This approach enhances comprehension, sharpens logical reasoning, hones problem-solving proficiencies, fosters creativity, nurtures self-directed learning, heightens engagement, bolsters motivation, and promotes collaborative endeavors.

Keywords: Project-Based on Mathematics Learning, Paradigm, Open Education, Distance learning.

1 INTRODUCTION

In the 21st century, education is more important than ever before. In a globalized world, where knowledge and skills are constantly evolving, it is essential for people to have access to quality education. A form of education that has gained significant traction and is experiencing swift expansion is open education. Open education refers to an educational concept that focuses heavily on the principles of open access, system inclusiveness, and transparency (Belawati, 2021). Open education transcends mere expansion of access to encompass a holistic approach, aiming to construct an all-encompassing system that ensures equitable opportunities for education across diverse demographics. The evolution of open education owes much to

technological advancement. The strides taken in information technology have fundamentally altered the dynamics of knowledge acquisition, dissemination, and administration, thereby revolutionizing the realm of education. Notably, these changes have facilitated the burgeoning of distance learning, affording learners the ability to engage in education unhindered by geographical confines (Fauziah et al., 2020).

Distance learning, often referred to as online or virtual learning, is an educational approach where students and teachers are physically separated, and instruction is using digital tools and technologies. This learning takes place in different locations, possibly even separated by a considerable distance (Wulandari et al., 2021). Its design aims to enhance accessibility, offering greater flexibility in terms of timing and location, and increased affordability. This is particularly beneficial for individuals who face challenges in accessing traditional forms of education.

Distance education has three facets of flexibility. Firstly, it offers enhanced accessibility to a wide array of information through online platforms, digital learning materials, and various resources. This enables students to engage in adaptable learning experiences unrestricted by time and location. The secondly, it promotes independent learning, empowering students to take charge of their educational journey. Learners are expected to proficiently manage their study schedules, establish their learning pace, and effectively allocate their time. This self-driven approach fosters a greater sense of responsibility for one's learning process. The third, distance education employs a structured curriculum framework that is both well-planned and accountable. This encompasses course design, learning trajectories, educational objectives, and assessment methods. Such a robust framework aids learners in purposefully attaining their learning goals. The implementation of distance learning systems extends to diverse educational contexts, including the realm of mathematics education, and has significantly influenced the way mathematics is learned and taught (Makur et al., 2021).

Mathematics learning is a science that deals with concepts, and reasoning skills. Learning mathematics encompasses more than mere numerical calculations; it entails problem-solving, recognizing patterns, and honing cognitive tools for thinking (Sadi & Lee, 2015). Mathematics serves as a framework of knowledge that consistently expands, offering widespread advantages and becoming a crucial foundation for fostering independent thought. The presence of mathematics holds immense significance in our lives, furnishing valuable perspectives, fostering analytical thinking, and presenting answers to all encountered difficulties.

Project-based mathematics learning as one of the learning models has been implemented as a learning strategy of learning. This strategy underscores the significance of connecting mathematical concepts with real-world situations and resolving authentic challenges as a means of acquiring mathematical understanding (Zainal, 2022). The utilization of project-based learning models in mathematics education is steadily gaining prominence and finding application across different educational tiers. Diverse methodologies and tactics have been conceived and put into practice to involve students in mathematical projects that have direct relevance to their daily experiences. Subsequently, the project-based mathematics learning paradigm has witnessed ongoing expansion and increasing acceptance within the realm of education. Numerous schools and academic establishments have embraced this approach as an integral component of their mathematics curriculum (Almarashdi & Jarrah, 2021; Bringula et al., 2021).

The Project-based Learning learning model is an innovative learning approach that puts the main focus on learners as the center of learning. Within this approach, educators assume the roles of motivators and facilitators, providing guidance and direction to learners throughout their educational journey. (Sumarni et al., 2019). Project-based learning provides opportunities for learners to work independently in constructing knowledge and skills. In project-based learning, learners engage in real projects that encourage problem solving, collaboration and the application of learned concepts in real contexts. These projects often involve complex problem solving, independent research and presentation of work (Priatna et al., 2022). Learners are afforded the autonomy to structure and strategize their own sequential steps, pick pertinent resources, and assume accountability for the ultimate culmination of the project. Nonetheless, it is imperative to investigate the applicability of the project-based mathematics learning framework within the context of open and distance education.

2 METHODOLOGY

This study employs a qualitative approach to discuss the implementation of project-based mathematics learning in open and distance education. Literature review and interviews are utilized to obtain in-depth data. The literature review involves exploring theories related to project-based learning, while the interviews were conducted with three mathematics professors from Open University who are well-acquainted with distance learning. Respondents were purposely selected, considering the expertise and experience of the professors in project-based mathematics teaching. Interview guidelines were developed with

open-ended questions that allowed the professors to share their insights, experiences, and perspectives regarding the implementation of project-based mathematics learning in open and distance education. Data analysis involves data reduction, data classification, coding by sorting data, and identifying patterns from the emerging themes in respondents' answers. Subsequently, the data is presented and visualized.

3 FINDINGS AND DISCUSSION

3.1 The Development of Project Based Learning

The idea of project-based learning was originally introduced by John Dewey in the early 20th century, which emerged alongside the progressivism movement. Dewey and other progressives proposed to revolutionize education by putting learners at the center of learning, which emphasizes learning through action, allows interaction with diverse real environments, and creates a curriculum that is relevant and meaningful to learners. In addition, they want to elevate the role of the teacher to be more than just an assignor in inquiry learning (Wan et al., 2022). Kilpatrick (1918) a student of Dewey, described project-based learning as learning that has a clear and relevant purpose. In the educational context of the time, examples of projects were given, such as making dresses for girls, making kites for boys, or completing realistic geometry tasks in math learning (Kilpatrick, 1918, p. 320). The project-based learning approach was further developed in the field of education within the United States, notably through educational institutions like The Claremont Colleges and McMaster University. At The Claremont Colleges, this approach is recognized as "The Claremont Plan" or "The Claremont Method," wherein projects are seamlessly integrated into the curriculum(Bédard et al., 2012). J. Thomas et al. (2015) emphasizes that in Project Based Learning, students are actually investigating the solution of a problem by building knowledge independently through active learning, interacting intensely with the environment as in constructivism theory, collaborating in groups, then educators become facilitators by directing and guiding students in producing their products. The constructivist perspective underscores that students actively construct their own knowledge and comprehension through dynamic engagement with their surroundings and educational encounters (Tascı, 2015).

Project-Based Learning gained substantial popularity during the 1970s within numerous higher education programs across the United States and various other nations. Notably,

McMaster University School of Medicine in Canada stands as a prominent example in the realm of medical education, employing the Project-Based Learning approach effectively (Servant-Miklos, 2019).

The subsequent decades of the 1980s and 1990s witnessed the diffusion of Project-Based Learning into secondary and elementary schools in multiple countries. Concurrently, select higher education programs continued refining their PBL methodologies, emphasizing interdisciplinary and collaborative learning. This period also witnessed a surge in research exploring the advantages and effectiveness of Project-Based Learning (Boss, 2011). The advent of technology since the early 2000s precipitated the widespread adoption of project-based learning, seamlessly integrated into the educational framework. The synergy of technology and access to digital resources played a pivotal role in enhancing the implementation of projectbased learning, facilitating online collaboration and enabling distance learning opportunities.

3.2 Project-based Mathematics Learning in Open and Distance Education

The application of project-based mathematics learning is one of the learning types that has been widely used. In the context of open education, this approach has long been used in the learning process (Bernard & Lundgren-Cayrol, 2001). Project-based learning has a strong connection with open education and distance learning. In the context of open education and distance learning, project-based learning offers a learning approach that matches the relevant characteristics and challenges faced by learners. Learning mathematics with a project approach through distance learning also utilizes technology as a means to facilitate interaction between learners.

Based on interviews with respondents who are lecturers, in general, they give the view that project-based learning is carried out with the aim of encouraging students to be able to make a final product that can be applied in the learning process they teach, because these students are prospective teachers or educators. On the other hand, it is also to train students to be able to develop their ability to solve a problem and also to encourage them to be active in the learning process. This will certainly be able to increase students' understanding and creativity as learners. (Anggraini & Wulandari, 2020).

The implementation of project-based learning in distance learning is that students are given real projects or tasks that require them to apply knowledge and skills in real-life situations.

In the process, students work in groups to complete the project. In addition, project-based learning also integrates technology and digital resources in the teaching-learning process, accommodating distance learning well. Students can access information, communicate with groups, and present project results online. This increases flexibility and engagement in learning, allowing students to learn at their own pace and learning style. In addition, the projects assigned are also tailored to the relevance of mathematics education materials or courses. Some examples of assigned projects are the development of innovative mathematics learning materials for specific educational levels, such as elementary, junior high, or high school. Other examples include analyzing the current mathematics curriculum at a particular educational level, exploring and applying technology in mathematics learning, developing effective mathematics assessment instruments and evaluation tools to measure students' understanding of various mathematical concepts, and others.

Certain perspectives regarding the implementation of project-based learning within the realm of online education, as a means of distance learning, contend that the utilization of projectbased learning methodologies has demonstrated its efficacy in facilitating students' learning experiences amidst the challenges posed by the Covid-19 pandemic (Lasamahu et al., 2021; Yuliansyah & Ayu, 2021). This pedagogical approach offers a plethora of benefits within the instructional and learning framework, particularly in terms of enhancing students' motivation while engaging in the learning process (Elisabet et al., 2019).

3.3 Principles of Project-Based Learning in Open and Distance Education

The learning process should be well designed and organized in order to achieve the learning objectives that have been set (Sale, 2015). Consequently, the implementation of project-based learning within the context of open education, as applied in distance learning, necessitates a meticulous alignment with pertinent principles. Based on the collection of data, here are some principles to considers:

1) Realistic principles involving the application's utilization of real-life challenges pertinent to both daily living and the environment (J. W. Thomas, 2000).
2) The constructivist principle that the students as the center of the learning process, motivating them to actively build their understanding and knowledge through interactive involvement.

3) The collaborative principle emphasizes the importance of teamwork and cooperation in the learning process. It promotes the idea that learners should collaborate in groups to completing projects together. (Sani, 2015).

4) The principle of communication in distance learning should ensure the establishment of effective interaction between educators and learners, as well as among the learners themselves.

5) The principle of flexibility in implementing project-based learning for distance education aims to offer students the freedom and flexibility to organize their time, location, and learning methods according to their preferences.

6) The contextual principle of project-based learning within open education for distance learning, the principle should also emphasize the cultivation of essential contemporary skills, specifically critical thinking, creativity, communication, and collaboration.

3.4 Benefits of utilizing project-based mathematics learning within Open Education on distance learning.

Several perspectives on the utilization of project-based learning in online distance learning. Generally, project-based learning has the advantages of enhancing comprehension of subject matter, reasoning skills, problem-solving abilities, creativity, self-reliance, engagement, collaboration, and cooperation, along with motivation for learning. The following is a detailed explanation of the advantages of this learning approach.

1) Improving the ability to comprehend the subject matter.

Based on the interviews conducted with participants revealed that the implementation of project-based learning consistently leads to a strong grasp of the instructed material among students. Furthermore, the mathematical projects assigned within this approach commonly exhibit direct connections to real-world scenarios or everyday situations. Nevertheless, despite a majority meeting the intended learning outcomes, a portion of students still encounter challenges in successfully executing the assigned projects. This aligns with the viewpoint of Sumarni et al. (2019), who assert that project-based learning enhances students' comprehension abilities.

2) Improve the reasoning ability

Within the framework of project-based learning in the realm of open education, executed through remote learning, the lecturer's elucidation during the interview expounds that " In project-based learning, the learning process involves students being tasked with gathering specific project-related data. Subsequently, they compile conclusions or extend the scope of their findings to encompass broader conclusions pertaining to the material or course being studied (interview with FP lecturer on Wednesday, July 20, 2023)." This illustrates that the cultivated or enhanced reasoning capability in project-based learning is that of inductive reasoning. Inductive reasoning is a cognitive approach that endeavors to arrive at overarching conclusions derived from observations of particular real-world occurrences or projects. While it doesn't guarantee absolute validity, inductive logic emphasizes deriving generalizations that possess sufficient strength to substantiate the drawn conclusions (Liliweri, 2022).

3) Improving the problem-solving ability

Based on an interview with Professor RL (July 28, 2023) it was revealed that the learning process typically commences by presenting or addressing prevalent real-world issues. For instance, a common issue is the difficulty students often encounter in grasping fundamental mathematical concepts. Faced with this challenge, students, as educators, are required to devise suitable teaching solutions and transform them into instructional development projects that can facilitate student understanding. This signifies that project-based learning, designed to confront challenges and provide practice, offers a platform for students, in their roles as educators, to enhance problem-solving skills by formulating innovative teaching strategies. The presence of student difficulties in comprehending basic mathematical concepts serves as a catalyst for students to delve deeply into the root causes of the problem and seek appropriate approaches to enhance student understanding. Through instructional development projects like these, students are provided with an opportunity to explore and apply the learning theories they have studied to real-world situations (Dewi, 2021).

4) Improve the creativity skill

Based on interviews conducted with participants, the gathered data indicates that the outcomes of students' work or projects are generally of a satisfactory quality, albeit not universally so. This observation underscores a noticeable uptick in overall creativity. As

outlined by Amabile (1983), factors fostering creativity encompass proficiency and expertise, the surrounding milieu and the encountered challenges, the latitude for uninhibited thinking, as well as cooperation and collaboration. The adoption of project-based mathematics instruction within the realm of remote learning contributes to honing skills and delving deeper into specific subjects (Wahyuni et al., 2022), This inevitably contributes to an augmentation in creative aptitude. Furthermore, project-based learning exposes students to real-world predicaments, thus presenting authentic challenges that can significantly elevate their creative prowess.

5) Enhancing Self-Directed Learning

Project-based learning typically highlights elements of autonomy, active student participation, as well as student collaboration and cooperation (Haryanti, 2020). The concept of autonomy within open education plays a pivotal role in facilitating students' efficient attainment of learning objectives (Belawati, 2021). Autonomy within the context of open education refers to individuals' capacity to structure and oversee their own learning experiences, without relying solely on educators or educational institutions (Budiwan, 2018).

6) Improve the learning activity

The implementation of project-based learning can encourage students to take a more active role in the learning process (Anggraini & Wulandari, 2020). By presenting interesting and relevant projects, students are encouraged to actively participate in finding solutions to concrete problems, improving problem-solving skills and developing creativity. This active participation includes planning, executing and evaluating projects independently, which encourages them to take initiative and be responsible for their learning outcomes.

7) Increasing Learning Motivation

Several pieces of literature state that project-based learning enhances learning motivation (Arimbawa et al., 2013; Hapsari & Airlanda, 2018; Serin, 2019). This is because this type of learning assists in creating an engaging, relevant, and meaningful learning environment for students. Ultimately, this will boost the motivation to continue learning.

8) Enhancing Collaboration and Cooperation

The implementation of project-based learning can enhance collaboration and cooperation among students as the learning process takes place in online discussion settings through

educational media. This form of learning encourages interaction among students, enabling them to engage in discussions and share knowledge (Rahayu et al., 2019).

3.5 Problem and challenges implementation project-based mathematics learning within Open Education on distance learning.

While Project-Based Learning offers several benefits, Implementation project-based mathematics learning within Open Education for distance learning can present several challenges and problems. Here are some of the challenges and problems that have been identified:

1) Limited access and resources

   Project-based learning often involves collaboration and interaction among students, which can be challenging in distance education. Limited access to the internet, devices, and other resources can hinder students' ability to work together and access necessary learning materials (Yeh & Tsai, 2022).

2) Difficulty in supervision and guidance

   Project-based learning, teachers typically play the role of facilitators and guides. However, in distance education, direct supervision and guidance from teachers can become more challenging. Students may face difficulties in obtaining the assistance and feedback needed to steer their projects (Meng et al., 2023).

3) Lack of social interaction

   Project-based learning often involves collaboration and interaction among students. In distance education, students may experience a lack of social interaction with classmates and teachers. This can impact students' motivation and engagement in the learning process (Donelan & Kear, 2023).

4) Evaluation challenges

   Evaluating projects in project-based learning usually involves qualitative assessment and assessment based on the produced project outcomes. In distance education, project evaluation can be more difficult to carry out objectively and comprehensively. Teachers may encounter difficulties in monitoring and accurately assessing students' progress (Dong & Warter-Perez, 2010).

4 CONCLUSSION

The findings demonstrated that project-based mathematics learning within the context of open education and distance learning can serve as a viable model for implementation. This is due to its capacity to enhance comprehension of the subject matter, to elevate reasoning aptitude, to refine problem-solving abilities, to stimulate creativity, to foster greater self-reliance in learning, to promote active engagement, to boost learning motivation, and facilitate to increased collaboration and cooperation. Implementation project-based mathematics learning have challenges and problems, limited access and resources, difficulty in supervision and guidance, lack of social interaction, evaluation challenges.

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