

Enhancing Students' Emotional Intelligence through Project-Based Math Education

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ABSTRACT

The increasing challenges faced by students in learning mathematics, particularly in managing academic anxiety and emotional stress, highlight the need for innovative teaching methods that not only focus on cognitive skills but also foster emotional intelligence. This study aims to investigate the role of Project-Based Learning (PBL) in enhancing students' emotional intelligence, specifically within the context of mathematics education. The research employs a literature review approach, synthesizing findings from various studies to explore how PBL influences emotional and social development alongside academic performance. The findings reveal that PBL significantly improves students' self-awareness, emotional regulation, and social skills by fostering a collaborative learning environment where real-world problems are solved in teams. However, the study also identifies challenges in PBL implementation, such as the complexity of project design and insufficient teacher training in integrating emotional intelligence into mathematics learning. Addressing these challenges through targeted teacher training is essential to fully realize the potential of PBL. The conclusion emphasizes that PBL not only enhances cognitive and emotional development but also promotes educational equity by narrowing academic achievement gaps among students from diverse socio-economic backgrounds.

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1. INTRODUCTION

In education, emotional intelligence has become increasingly important due to the complex challenges students face both within and outside of the classroom. The data shows that many students have strong academic abilities, particularly in math classes, but frequently struggle with emotional intelligence, academic writing, or social interactions with peers or teachers. For example, a study on high school students found that almost 40% experienced significant academic difficulties. These difficulties eventually affected the students' learning performance, particularly in subjects like mathematics (Ashcraft, 2002).

In the context of mathematics education, emotional intelligence plays a crucial role not only in helping students overcome academic stress but also in raising their level of engagement during the learning process. According to Goleman, emotional intelligence reduces one's capacity to understand one's own emotions as well as those of others. In challenging math classes, this ability is crucial for improving students' day-to-day performance in analyzing complex problems and their capacity for teamwork in the classroom, which is crucial for project-based learning (Goleman, 1995).

However, although emotional intelligence is highly valued, its application in mathematics education is quite weak. Most of the math education that is currently being conducted in schools focuses on improving students' cognitive and analytical skills, while emotional intelligence is frequently addressed. This leads to very significant differences, especially for students who feel unable to solve mathematical problems or experience math anxiety, which gradually harms their academic performance (Ashcraft, 2002). Due to this, there is a need for new research that aims to improve students' emotional intelligence in addition to their cognitive abilities in math classes.

Current studies indicate that emotional intelligence can be developed through more collaborative and contextual pedagogical approaches, such as project-based learning (PBL). According to Zins, project-based learning enables students to interact with real people, deal with complex situations, and develop collaborative skills that can increase their emotional intelligence. PBL in mathematics education provides an environment where students may actively solve problems, communicate with teachers, and experience failure in learning, all of which can enhance their self-awareness and emotional intelligence (Zins et al., 2004)

The study aims to make a new contribution by focusing on the implementation of the project-based learning approach in mathematics education to increase students' emotional intelligence, an area that is yet mostly unexplored. Previous research has focused more on the development of emotional intelligence through general education strategies, but less research has examined how emotional intelligence might be specifically developed through mathematics education. Accordingly, it is hoped that this study will provide new insight for educators regarding the importance of integrating emotional intelligence into math lessons and how PBL might become an effective strategy to achieve such goals.

2. METHODS

This study is based on a review of the literature, which is used to identify, evaluate, and synthesize the findings from previous research on the improvement of students' emotional intelligence through project-based mathematics education (PBL). The literature that is used comes from academic articles, books, and research reports that are accessed through academic databases like Google Scholar, Scopus, and ERIC. A literature review is conducted based on the subject matter that is studied, primarily on the topic of increasing emotional intelligence in the context of mathematics education and the relationship between PBL and emotional intelligence. Only literature published in the last several years that outlines credible, academically grounded research methods is used to ensure the accuracy and applicability of the findings.

Three primary steps are used in the data analysis process: descriptive analysis, findings analysis, and critical analysis. Initially, researchers identified the strengths and weaknesses of all studies related to the effectiveness of PBL in raising students' emotional intelligence. Subsequently, these hypotheses are designed to identify similarities and differences across various studies as well as to investigate existing research hypotheses. Finally, a critical analysis is conducted to determine the methodological quality and validity of the selected literature. Thus, it is anticipated that the study's results will provide

a comprehensive overview of PBL's contribution to students' emotional development and offer fresh insights for future research.

3. FINDINGS AND DISCUSSION

Based on the results of a literature analysis, it is concluded that project-based learning (PBL) significantly increases students' self-awareness and emotional intelligence. In the context of math education, PBL allows students to explore their emotions when facing academic challenges, such as difficulty solving complex mathematical problems. In addition, PBL helps students develop the resilience to deal with stress and anxiety, which frequently arise during the learning process. By creating a collaborative learning environment, PBL fosters self-reflection and emotional resilience, which gradually contributes to students' increasing emotional intelligence (Bar-On, 2006; Stanimirovic & Hanrahan, 2012; Zins et al., 2004).

In addition, PBL is very effective in enhancing social skills and student collaboration. The learning process that cooperatively integrates teamwork and problem-solving enables students to engage in intense conversations with senior managers. This interaction not only increases communication skills but also develops empathy and conflict resolution skills, which are crucial components of emotional intelligence. Mathematical collaborative learning projects enable students to exchange ideas freely, communicate well, and work together to achieve shared goals, all of which enhance their social skills (Bar-On, 2006; Goleman, 1995; Stanimirovic & Hanrahan, 2012).

However, there are a few challenges in implementing PBL in mathematics education. Teachers frequently encounter difficulties when managing projects that not only hinder the development of emotional intelligence but also complicate complex mathematical concepts. The most important factor is time, as PBL implementation requires more time than conventional methods. Despite this, the literature indicates that with strong support and a supportive environment outside of school, these challenges may be overcome, and PBL can nevertheless contribute positively to the development of students' emotional intelligence (Ashcraft, 2002; Mortillaro & Schlegel, Project-based learning (PBL) greatly improves students' self-awareness and emotional intelligence, in line with the research results of the literature analysis. PBL allows students to examine their feelings in the context of studying mathematics when they encounter obstacles on the way to success, such as having trouble with a challenging math issue. Furthermore, PBL fosters in pupils the ability to bounce back from stress and anxiety that frequently surface during the learning process. PBL fosters self-reflection and emotional resilience by fostering a collaborative learning environment, which progressively raises students' emotional intelligence. Additionally, PBL has a great impact on students' ability to collaborate and interact with others. Students who participate in a cooperative learning process that blends problem-solving and teamwork can have comprehensive discussions with their peers. This enhances their communication skills and helps them develop empathy and solving disputes skills—two crucial aspects of emotional intelligence. Math collaborative projects help students develop their social skills by letting them freely share ideas, interact effectively, and cooperate to accomplish shared objectives. 2023).

PBL as a Means to Enhance Students' Perception of Truth and Emotion in Mathematical Education

One of the biggest challenges faced by students in math classes is academic stress, which can hinder their ability to focus and comprehend the material. This phenomenon often arises as a result of the students' high anxiety during difficult math lessons, which might impair their self-confidence and emotional stability. PBL provides solutions by shifting students' attention from final results (true or false) to collaborative, project-based learning processes. According to research by Syawaluddin et al.

(2019), students who participate in PBL are more likely to be able to identify their emotions when they encounter mathematical difficulties and are also more likely to be able to handle stress, which eventually improves their academic performance overall (Syawaluddin et al., 2019).

In PBL, students receive time to practice solving mathematical problems related to real-world situations and working together in groups so they won't feel alone while facing academic challenges. This process helps students become more aware of their emotional responses, such as frustration or helplessness, and with the support of others, they learn how to express these emotions more constructively. This study confirms that PBL does not only increase academic performance but also provides a safe and supportive learning environment where students may learn to express their emotions, which are the raw materials of emotional intelligence.

The Proyek-based learning approach has been proven to be an effective strategy for raising students' self-awareness and emotional intelligence in math class. Projects that encourage student collaboration encourage them to better understand their own emotions when facing academic challenges, such as complex mathematical problems. According to Clarke, states that project-based learning (PBL) effectively fosters students' emotional intelligence, particularly in the areas of stress management and peer collaboration. Further analysis reveals that teacher-centered learning can enhance students' social skills, which eventually contribute to the development of students' emotional intelligence in understanding and expressing their learning experiences (Clarke, 2010).

In the context of math instruction, students learning through PBL are better able to handle academic difficulties that frequently arise during problem-solving. According to the findings of Martanto et al., emotional intelligence has a significant impact on the learning outcomes of problem-based learning (PBL), particularly in terms of enhancing students' ability to solve problems more effectively and productively. In addition, the study indicates that factors such as social support and mentorship significantly influence students' ability to manage their emotions throughout work projects that require teamwork and self-improvement (Martanto et al., 2022).

The Impact of PBL on the Development of Social Skills and Teamwork in the Context of Mathematics

Emotional intelligence isn't just about developing one's own emotions; it's also about having the ability to interact and collaborate with others. In PBL, collaboration, and social interactions are integral parts of the learning process, as students learn how to work together as a team to achieve shared goals. Research by Ilyas et al. indicates that using PBL in math lessons quietly improves students' social skills, such as effective communication, empathy, and conflict resolution (Ilyas et al., 2018, 2019). PBL students were expected to work together to solve mathematical problems, communicate with the class representative, and, most importantly, contribute to the group. This process develops academic integrity and cultivates interpersonal integrity, which is extremely important outside of academic contexts. They learn to respect other people's feelings, exchange ideas, and reach consensus—all of which are components of social cohesion. The interactions that take place during group discussions also provide students with opportunities to learn how to resolve conflicts constructively and increase their negotiation and empathy skills, which are very important in reducing emotional distress. The research findings indicate that PBL is an effective method for not only improving students' mathematical skills but also their social and emotional intelligence.

In addition to increasing emotional intelligence, PBL is also very effective at fostering students' social skills. Strong teamwork during the project's execution allows students to interact with senior managers, share ideas, and work together to achieve shared goals. According to Puspitasari et al., state that project-based learning strategies that stress clear communication and peer-to-peer peer assessment are very effective in improving students' interpersonal skills, such as their ability to resolve conflict constructively (Puspitasari et al., 2023).

On the other hand, PBL education in math classes tends to create a collaborative environment that encourages students to participate more actively in group discussions, enhancing their social skills. According to Hudiananingsih et al., there is evidence that the PBL students' involvement has a significant impact on the improvement of their communication skills, particularly in situations where they need to interact with other group members to complete tasks. According to this study, students who participate in PBL demonstrate a significant improvement in their ability to collaborate and communicate effectively while sharing mathematical ideas with other members of their class (Hudiananingsih et al., 2019).

Limitations of PBL Implementation in Mathematical Education and Problem Solving through Teacher Training

Even though PBL's effectiveness in raising emotional intelligence has already been acknowledged, there are still many practical challenges in teaching, particularly in math education. One of the most significant challenges is the imperfect teacher-student relationship in designing projects that can integrate emotional intelligence and perhaps undermine academic integrity. Many teachers experience difficulty designing projects that balance the development of cognitive and emotional skills and the need to meet deadlines for completing curriculum materials (Ilyas et al., 2020; James et al., 2017).

One way to overcome this challenge is to have more intense and focused pedagogical instruction focused on emotional development. This lesson can help teachers understand how to incorporate emotional intelligence elements into math projects, such as by implementing activities that encourage group collaboration and discussion. In their research, Pozo-Rico & Sandoval found that emphasizing emotional intelligence in instruction increases teacher effectiveness in project management and improves student learning outcomes in both academic and emotional domains (Pozo-Rico & Sandoval, 2020). Because of this, comprehensive instruction is a crucial component in overcoming the challenges associated with using PBL in mathematics education.

In another study, Rader indicates that teachers who are involved in PBL education and mentoring see an increase in their self-awareness and competence in managing project-based learning groups. This lesson provides the necessary guidance to design projects that not only improve students' mathematical skills but also strengthen their emotional intelligence. The study's findings indicate that well-trained teachers are more likely to create supportive and understanding learning environments that enable students to grow academically and emotionally (Rader, 2020).

PBL as a Tool to Improve Academic Performance and Decrease Student Enrolment

One of the most important aspects of PBL research is its ability to measure academic performance among students from various socioeconomic backgrounds. Project-based education allows students to work in real-world contexts that are relevant to their daily lives, increasing student motivation and engagement in the learning process.

In addition to its benefits for enhancing emotional intelligence and social skills, PBL also has a positive effect on reducing academic stress among students from different social and economic backgrounds. According to a study conducted by Holmes and Hwang, students from minority and risky backgrounds benefit greatly from PBL, particularly in terms of learning motivation and developing critical thinking skills (Holmes & Hwang, 2016). PBL provides more engaging and motivating lessons for students who typically struggle in traditional classroom settings, encouraging them to become more actively involved in the learning process. According to Silver et al. (2023), PBL has a positive impact on the development of emotional intelligence in students from all backgrounds, particularly in enhancing their ability to work in a team environment and overcome challenges together in a collaborative manner.

PBL enables students to work in a real-world context, which helps them understand how what they are learning relates to their daily lives. This is crucial for students from low-income social and economic groups who frequently feel that their educational experiences don't align with their actual circumstances. By raising issues that require creative and collaborative thinking, PBL can encourage students to think critically and actively participate in the learning process. Further research by Farida and Rasyid reveals that PBL has a crucial role in establishing the foundation of education as well as improving students' cognitive abilities. In their research on the social development of Asian American children, they found that PBL significantly increased student involvement resulting from relatively stable economic backgrounds, helping them to develop the social and emotional skills necessary for success in school (Farida & Rasyid 2019).

The research findings indicate that PBL is beneficial not only for improving academic and emotional skills but also for fostering a critical mindset in students by fostering a sense of community among students from various backgrounds. In this way, PBL can be considered an effective tool for addressing socioeconomic concerns in education while also promoting holistic emotional growth among students.

Discussion

Results of the study indicate that Project-Based Learning, or PBL, has a significant positive impact on students' emotional intelligence, particularly in the areas of emotional intelligence, emotional intelligence development, and social skills. Facts presented in the study indicate that many students experience stress and anxiety when learning mathematics because they feel overwhelmed by the complexity of the material being studied. This is supported by research conducted by Ashcraft, which found that students' academic performance was significantly impacted by their arithmetic proficiency. PBL, through collaborative learning and a project-oriented approach, enables students to concentrate more on problem-solving in a structured and cooperative manner, hence reducing anxiety and enhancing emotional intelligence (Ashcraft, 2002). According to Syawaluddin et al. (2019), integrating emotional intelligence into PBL math lessons not only increases student engagement but also improves overall arithmetic scores because students are more engaged and motivated to learn. (Syawaluddin et al., 2019).

The primary factor in the effectiveness of PBL in raising emotional intelligence is a collaborative learning environment that enables students to engage in intense conversation with peers. On the other hand, students who are engaged in projects tend to be more adept at expressing their emotions in academic settings that are encouraging and capable of communicating with more effectiveness in group settings. This is explained by Ilyas et al., who points out that peer pressure in PBL increases students' metacognitive abilities and helps them become more serious about their learning process (Ilyas et al., 2019).

However, the field phenomenon also indicates that PBL implementation has some challenges, particularly in terms of time and resources. Many teachers have difficulty coming up with projects that not only increase students' cognitive abilities but also have the potential to hurt their emotional state. Teachers often have difficulty integrating emotional intelligence into problem-based learning, which hinders the best possible implementation (Ilyas et al., 2020; Jalaluddin et al., 2020).

A few researchers, such as Pozo-Rico & Sandoval (2020), assert that teacher education on emotional intelligence is crucial in addressing this issue. This training not only helps teachers understand the importance of emotional intelligence in teaching but also increases the effectiveness of PBL instruction. In the end, the study's results were impacted by students' increasing academic performance after teachers trained them to use an emotional intelligence-based teaching method (Pozo-Rico & Sandoval, 2020). In addition to that, PBL is also expected to help reduce the arithmetic mean difference between minority students and risky students, as stated by Holmes & Hwang. This study indicates that PBL is beneficial not only in the context of emotional development but also in fostering a sense of community among students from diverse social and economic backgrounds (Holmes & Hwang, 2016).

PBL provides comprehensive and effective solutions to address emotional difficulties and enhance students' emotional and social skills in math classes. Even though there are still some implementation-related challenges, solutions like teacher training and collaborative learning environments might help optimize this method's application in the context of contemporary education.

Project-based learning, or PBL, gives students in math classes a comprehensive and effective solution for dealing with emotional difficulties as well as an increase in their emotional and social intelligence. During PBL research, students are not only disadvantaged in academic subjects but also given opportunities to address emotional issues that arise while facing intellectual challenges, such as frustration or difficulty solving complex problems. This allows students to develop their emotional intelligence, including the ability to identify and express emotions, both in private and in social interactions with their elders.

However, even though the benefits of PBL in raising students' emotional and social intelligence are acknowledged, there are certain challenges in putting them into practice, particularly in the context of math education. The primary advantage is the teacher's ability to facilitate effective project-based learning. Many teachers still haven't fully embraced the PBL methodology, especially when it comes to balancing the emotional response to the desired academic results. Due to this, students greatly benefit from more intensive and ongoing tutoring to enable them to complete projects that not only help them overcome emotional difficulties but also enhance their mathematic skills.

In addition to teacher training, collaborative learning environments might also be a potentially useful solution to maximize PBL implementation. A supportive environment that fosters collaboration enables students to learn through conversations with peers, which not only increases their ability to solve mathematical problems but also their social skills, such as communication, empathy, and conflict resolution. Engaging in conversation with others or a group is also crucial in developing a sense of self-awareness and emotional resilience in students when faced with academic challenges. Students may always provide emotional support through teamwork, which eventually strengthens their emotional intelligence both within and outside of the classroom.

4. CONCLUSION

Based on discussion and analysis, it can be concluded that project-based learning, or PBL, is very effective at raising students' emotional intelligence, particularly in the areas of emotional intelligence, emotional intelligence, and social skills. PBL allows students to participate in more collaborative and in-depth learning, which helps them develop their emotional intelligence and manage their emotions when facing academic challenges, particularly in math classes that are sometimes difficult. In addition to this, PBL enhances students' social skills by encouraging teamwork in the workplace, effective communication, and more skillful resolution of conflicts within the learning process. PBL implementation challenges, such as complex project designs and insufficient teacher training, can be addressed with intensive instruction that focuses on integrating emotional intelligence.

Theoretically, this reinforces the theory of emotional intelligence developed by Goleman and Cáceres, which states that emotional intelligence plays a critical role in academic and social success (Cáceres Carvajal et al., 2019; Goleman, 1995). PBL provides educational programs that support the development of emotional intelligence, such as emotional intelligence and emotional intelligence awareness, which are frequently undervalued in traditional educational programs. All of this also reinforces the belief that social interactions in collaborative learning maintain an important role in the development of emotional intelligence. In this way, the research contributes to the development of educational theories based on emotional intelligence, particularly in the context of mathematics education.

Based on a practical point of view, this gives teachers—especially math teachers—a head start in adopting PBL as an effective teaching method that raises students' academic and emotional maturity. PBL teaching methods are not only beneficial for improving student learning outcomes but also for helping students overcome academic stress and anxiety that frequently arise in math classes. An important factor in increasing the effectiveness of PBL implementation is teacher training that emphasizes the integration of emotional intelligence. The teacher must be resolute in leading projects that not only enhance students' cognitive abilities but also foster their emotional and social development. In addition, PBL can be used more broadly as a strategy to improve student learning outcomes, particularly among students from low-income social and economic backgrounds.

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