

Progressivism-Based Instruction in Mathematics: A Review of Effects on Conceptual Understanding, Procedural Knowledge, and Student Attitudes

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Abstract. This narrative review examines the application and impact of progressivism-based instruction in mathematics, focusing on conceptual understanding, procedural knowledge, and student attitudes. Drawing on foundational works by John Dewey, Jean Piaget, and other progressive theorists, the review highlights the key tenets of progressivism, including student-centered learning, inquiry-driven activities, and collaborative problem-solving. Empirical studies suggest that adopting progressivist strategies can deepen students' conceptual comprehension and enhance their motivation and confidence in mathematics. Despite these benefits, questions persist about maintaining sufficient attention to procedural fluency—an area where traditional approaches are often more explicit. Some research indicates that students may develop strong conceptual frameworks under progressive methods but may not always receive the systematic practice needed for computational efficiency or high-stakes examinations. Consequently, certain studies advocate blended pedagogies that incorporate progressive and explicit procedural strategies to balance deeper cognitive engagement and mastery of essential skills. Overall, this review underscores the transformative potential of progressivism in mathematics education while identifying gaps in research on how best to harmonize conceptual rigor with procedural fluency, thus guiding future inquiries and instructional design.

Keywords: Conceptual understanding; Mathematics education; Procedural knowledge; Progressivism-based instruction; Student attitudes.

1.0 Introduction

Mathematics remains a cornerstone of academic success and critical thinking, yet debates persist regarding fostering deep, lasting learning in this discipline (Evans & Dietrich, 2022; McDowell, 2023). Traditional, teacher-centered instruction emphasizes procedural drills and rote memorization—effective for instilling basic algorithms but often leaves students with limited conceptual understanding and low confidence (Kang, 2016; Noreen & Rana, 2019). In contrast, progressivism-based instruction advocates a student-centered, inquiry-driven approach that seeks to elevate procedural fluency and cultivate learners' curiosity, problem-solving skills, and positive attitudes toward mathematics (Dewey, 1938; Danquah, 2017). Stemming from philosophical and psychological underpinnings introduced by figures such as John Dewey, Jean Piaget, and Paolo Freire, the progressive model highlights the intertwining of real-world application, collaborative learning, and reflective practice to spark deeper engagement and autonomy in students (Piaget, 1970; Freire, 1970).

Research suggests that integrating progressive strategies into math instruction can bolster conceptual grasp, heighten engagement, and positively shift student attitudes (Hwang & Son, 2021; Bui et al., 2021). However, gaps remain regarding how progressivism-based approaches balance conceptual understanding with the procedural mastery essential for advanced mathematics and standardized assessments (Andal & Andrade, 2022; Asmida et al., 2018). This literature review thus aims to synthesize the theoretical foundations, implementation strategies, and empirical findings on progressivism-based instruction in mathematics. By contrasting these approaches with more conventional teaching methods, it seeks to identify what is already known about optimizing math performance and attitude and where further exploration is needed to ensure students achieve both robust conceptual frameworks and procedural fluency.

2.0 Theoretical Bases of Progressivism-based Instruction

Progressivism in education is a beacon of change and dynamic approaches prioritizing individuality, progress, and real-world problem-solving. Progressivism emerged in the late 19th and early 20th centuries as a philosophical movement advocating societal reform and progress through education (Anderson, 1973). At its core, progressivism posits that education should not only transmit knowledge but also foster the development of individuals as active, informed citizens capable of contributing positively to society (Dewey, 1930). Its roots are founded on philosophical and psychological theories that challenge traditional notions of education by centering curricula on students' needs, experiences, interests, and abilities (Anderson, 1973; Labaree, 2005).

As mentioned, progressivism emphasizes the importance of prioritizing individuality within educational settings. Individual differences in pedagogy reject the notion of one-size-fits-all instruction (Gillet-Swan, 2017) and consider each learner's individual needs and abilities (Bisai & Singh, 2020). Dewey (1938) asserted that education should be capable of catering to the unique qualities of each student. He further noted that such efforts promote an environment where learners can flourish intellectually, socially, and emotionally (Dewey, 1938). In short, progressivism champions the idea of continuing progress and change (Anderson, 1973). Rather than viewing education as a fixed and rigid system, progressivism sees it as subject to adaptation and change. As Rousseau (1762) put forth, education should evolve alongside the changing needs of society to prepare students to navigate the changing times.

Dewey (1930) mentioned how progressivism centers curricula on students' needs, experiences, interests, and abilities. This “student-centered approach” focuses on active engagement and ownership of learning, enabling learners to take charge of their educational journey (Kilpatrick, 1918). Such an approach provides learners with meaningful learning experiences that resonate with a more profound understanding and retention of knowledge (Freire, 1970). Moreover, progressive pedagogy places a strong emphasis on real-world problem-solving activities. Instead of passively absorbing information, learners are encouraged to apply their knowledge to solve authentic problems, thus bridging the gap between theory and practice (Dewey, 1938).

Several theorists have championed progressivism or contributed to how it is known today. As the father of progressive education, John Dewey advocated for experiential learning and integrating education with democratic ideals (Williams, 2017). Dewey's pragmatic approach to education emphasized hands-on learning experiences and curriculum integration with real-life situations. Kilpatrick (1918) then expanded upon Dewey's ideas and advocated for using projects and activities that are meaningful and relevant to students' lives.

Progressive pedagogy upholds learner individuality, autonomy, and exploration, all key elements of Rousseau's “natural education” (Bardina, 2017). Rousseau believes education is an unfolding process where children are free to discover knowledge naturally at their own pace, unhindered by rigid structures. This means that children, by their nature, can learn better when given ample time and space. Jean Piaget, the pioneer proponent of cognitive development theory, also contributes to progressivism-based instruction. Piaget promotes active learning and the construction of knowledge through firsthand experiences or constructivism (Pakpahan & Saragih, 2022). Piaget's theory of constructivism posits that learners actively construct their understanding of the world through interaction with their environment. Constructing one's knowledge is a sign of critical thinking. Freire's critical pedagogy also challenged traditional power dynamics in education. His methods advocate for dialogue,

reflection, and action to promote social justice and equity (Sta, 2021). According to Freire, students must be empowered to critically examine societal norms and structures as a way of learning.

Maria Montessori and Friedrich Froebel similarly promoted student-centered approaches to early childhood development. They championed the importance of self-directed exploration and discovery led by learners themselves (Lillard, 2020; McNair & Powell, 2021). Montessori's pedagogy, grounded in the principles of respect for the child and the importance of a child-friendly environment, emphasizes hands-on learning experiences and the cultivation of independence and intrinsic motivation. Similarly, Froebel, the founder of the kindergarten movement, advocated for play-based learning and the use of manipulative materials to facilitate the holistic development of young children (Flemig & McNair, 2022)

Progressivism continues to serve as a theoretical foundation for educational research and practice. The pioneering work of theorists mentioned herein laid the groundwork for student-centered learning, experiential education, and the cultivation of critical thinking skills. Considering the enduring relevance of progressivism in informing innovative approaches to teaching and learning, the current study finds its theoretical anchor in the tenets of progressivism. Drawing upon the principles of progressivism, the study seeks to explore the implications of progressivism-based instruction for mathematics teaching and learning, aiming to contribute to the developing body of knowledge on effective educational practices.

3.0 Progressivism-based Instruction: Conceptual Framework and Implementation Strategies

Progressive-led instruction is a learning theory rooted in the practices of active learning, problem-solving, and critical thinking. Grounded in the work of John Dewey, this method promotes student-centered learning with an emphasis on inquiry, exploration, and collaboration (Dewey, 1938). Progressivism is different because it does not encourage the monotonous rote memorization that traditional methods promote; it focuses on an alternative that encourages curiosity and stimulates understanding. It was noted in mathematics that this is probably the best way to increase conceptual understanding and procedural knowledge — key elements of mathematical performance (Danquah, 2017).

Understanding in mathematics refers to a student's overall grasp of fundamental mathematical principles. It relates to everyday experiences, while procedure knowledge represents the formal algorithms and problem-solving methods system. Progressivism-based instruction shall help students see basic mathematical ideas through hands-on exercises, discussions, and real-world problem-solving (Park, 2022). Tippet and Lee (2019) posited that progressive education aids students in making a conceptual understanding at their own pace along with procedural aspects, particularly of how the calculation is carried out and equations are solved (Qetrani et al., 2021). Such a balance requires mixing the two dimensions, which progressivism-based instruction naturally accommodates.

Teachers can craft exploration and critical thinking experiences in math class essential in progressivism-based instruction. For instance, project-based learning has been found to support students in working on math tasks for an extended period while drawing upon their understanding of the big ideas and specific procedures they need (Gay, 2022). Collaborative group work with problem-solving tasks makes this experience even richer because students can teach one another the concepts needed and try out the various approaches there are for solving a particular task. The teacher is a facilitator in this model, leading students through their inquiry and asking them to think critically about mathematical ideas (Ebby et al., 2024).

An important component of any progressivism-based instruction is that formative assessments evaluate conceptual understanding and procedural knowledge (Karaman, 2021). The tradition of assessment is mostly procedural, like solving problems; progressivism demands that it should always be continuous and reflective. Almost all its demonstrations show the teaching and learning of mathematical concepts so that teachers can track where a student is with those understandings while at the same time identifying domains where procedural practice may be needed (Demosthenous et al., 2021; Bucella, 2022). This adaptive formative assessment allows teachers to personalize their practice in response to the strengths and weaknesses of each student, leading to better mathematics performance both within schools and nationally.

Progressivism-based instruction provides a holistic method of increasing performance in mathematics as it integrates both conceptual understanding and procedural knowledge (Pokhrel, 2018). As stated by Siller and Ahmad (2024), project-based learning and cooperative activities, along with varied formative assessments (Chigonga, 2020), help students learn how to solve mathematical problems and why mathematics works. This emphasizes improving students' math knowledge and understanding to improve academic achievement. However, it also takes the longer view: getting students ready for what lies down the road in mathematics and beyond.

4.0 Progressivism-based Instruction Versus Conventional Instruction

Progressive instruction and traditional, conventional instruction are two opposing forms of practice in educational philosophy packaged in an easy way to teach or learn. Progressive instruction prioritizes student-driven activities, active learning techniques, and real-world problems. It promotes critical thinking, collaboration, and inquiry-based learning led by students and allows them to take an active role in their learning process. Conventional instruction, sometimes referred to as traditional or teacher-centered instruction, on the other hand, focuses on well-defined learning, often a rigid curriculum with direct teaching and rote memorization and evaluation using standardized tests (Garrett, 2008). Both approaches are shared within an educational setting, though the effect on student outcomes (especially in areas like math) can differ drastically.

Research shows that a progressivism-based mode of instruction can also help develop students' mathematical concepts and thinking skills. This method allows students to investigate mathematical ideas through inquiry-based methods, project-based learning techniques, and real-life application – as a result, creating individuals who understand math in a way in which they apply the core principles (Evans & Dietrich, 2022). Other studies show that students experiencing progressive practices in math are more likely to cultivate a growth mindset around the subject because they are doing problems they can relate to their daily lives. Here, procedural knowledge is emphasized compared to traditional instruction, where students are taught explicit algorithms and formulas that help them solve problems without a deeper conceptual understanding (Manandhar et al., 2022; Braithwaite & Sprague, 2021).

While progressivism-based instruction has many benefits, it can also be problematic. Bell and Cui (2023) examined the teachers' understandings of patriotism, compassion, and creativity from these two metaphors based on a voice study of 15 English teachers at four universities in China. They discussed some implications for Sfard's concepts as well. These findings reveal that Chinese educators depend primarily on traditional modes of knowledge transmission but gradually use more innovative practices, with constructivist approaches better developed than participation-based ones. The fact that reforms in education policies promote active learning has contributed to this, as there is still a gap between expectations and practice about how students participate in their classrooms.

On the other hand, Khadim et al. (2023) discussed how the Pakistani curriculum framework can resonate with progressivism, which focuses on critical thinking, social betterment, and cooperative learning practices. Drawing from 10 years of research, this study reports that by emphasizing hands-on learning and tying lessons to real-world issues and experiences students are interested in, we bring more relevance and engagement into education. Adopting these principles would create the possibility of teaching students in a way that leads toward careers and models citizenship.

Moreover, while the models under the progressive label might improve conceptual understanding a few times compared to traditional methods, they often tend to ignore that students need focused practice time to develop procedural fluency. Most of the time, traditional instruction is good at repetition and practice, one aspect essential for students who need accuracy and efficiency in performing arithmetic tasks (Kang, 2016; Noreen & Rana, 2019).

Regarding mathematics achievement, one needs to be aware of the effect of the two methods on learning. Instruction based on progressivism leans towards conceptual understanding, while instruction based on conventional is often more procedure-based. However, research has shown that mixed methods incorporating aspects of both progressive and conventional methods work best. For example, combining inquiry-based learning with direct instruction can provide both a solid conceptual foundation and procedural fluency that meet the problem-solving demands of students (McDowell, 2023). With both theory and application in play, the blended

style gets closer to the best of both worlds, encouraging better learning while providing the necessary traits for academic success.

Each teaching method based on progressivism and conventional (Singh, 2023) has merits and demerits. Progressivism encourages lower-level critical thinking and engagement and a more in-depth understanding of mathematical concepts, whereas conventional methods can build the discipline required for procedural mastery. On the other hand, a combination of both approaches may be more beneficial in equipping students with competencies in their mathematical study, such that they may not only comprehend but also be able to do mathematics where it is required (Capuno et al., 2019).

5.0 Impact of Progressive-based Instruction in Mathematics on Student Learning

Following on from the previous distinction about teaching methodology, not only is progressivism considered different from conventional instruction, but it holds that a progressive approach does result in effective mathematics learning. Due to their curiosity and purposeful exploration of learning. Progressive-based instruction provides better development of math concepts. Rather than the more procedural-focused teaching of conventional methods, this approach focuses on developing students' understanding and problem-solving ability. Studies have also shown that students who have been educated through this method of teaching typically excel in subjects that require a high level of reasoning and utilizing numerical skills within real-life situations (Ling & Chang, 2022). Connecting what is taught to real-world situations is valuable not only in assessments but also in the overall academic journey of students.

Progressive-based instruction helps students perform well in their mathematics and overall development. Many studies have discussed progressive-based instruction and its impacts on students. Studies have shown that conceptual understanding improves when people learn mathematics using progressivism-based instruction, i.e., based on exploration and inquiry, emphasizing the transfer of learning to real-world situations (Bui et al., 2021). Bui et al.'s experimental study demonstrated that a realistic mathematics education approach positively impacted some skills required for students in teaching statistical content.

Research by Mat and Jamaludin (2024) has shown that progressivism-based instruction is very effective in improving students' critical thinking and reasoning as it focuses more on student-centered activities and problem-solving. The findings showed that student-centered teaching methods improve primary school students' academic skills, critical thinking, and motivation to participate actively and co-operatively in learning. Similarly, research by Dekker (2020) showed that students believe they enhance their critical-thinking abilities by referencing various perspectives on problems and issues, leading to skepticism towards uncontested knowledge claims and openness to many perspectives.

Hwang and Son (2021) also noted that students in a progressive-based environment had more positive attitudes toward mathematics. Through integrating mathematics in real-world contexts and a hands-on approach to learning, students experienced math as observable and connected to everyday life. Furthermore, their study confirmed a positive relationship between attitudes and mathematics achievement, indicating that students with enjoyment of math (attitude), perceiving the value of math, and having confidence in math (affective aspects) are likelier to do well in math. Therefore, teachers need to measure the attitude of students and make objective help study a positive view of mathematics.

Self-efficacy in math, which is critical for performance in this academic area, also increased under progressive-based instruction. Findings from a study by Kaur and Pendergast (2022) showed a statistically significant increase in students' self-confidence and enjoyment in math due to the short writing intervention (for more details on mean scores of the pre- and post-intervention questionnaire). Qualitative reflections from students also revealed that they generally viewed writing as a helpful communication tool in the mathematics classroom. This implies that educators should aim to include writing as a means of communication and reflection in math classrooms, resulting in improved math attitudes. In addition, addressing the affective domains of students can enhance learning outcomes, help them understand mathematical concepts at a deeper level, and increase their interest in the subject.

Niu et al. (2022) indicated that a perceived supportive learning environment (PSLE) is associated with self-regulation autonomy, creativity, and mathematical achievement. It also showed that aspects of PSLE indirectly affect math results through autonomous self-regulation and creative thinking. The inferences from these findings indicate that constructs promoting a somewhat affirming learning culture could positively influence individuals' autonomous self-regulation, creativity, and mathematical success on their roads to full participation in mathematics classrooms.

However, not all research supports these positive outcomes (Asmida et al., 2018) and highlights challenges between principles underlining progressive methods and the evidence-based approach required for procedural fluency. Progressivism-based instruction centers on deep conceptual understanding, but sometimes, students do not get enough practice with the procedural side of math, i.e., how to calculate stuff quickly or solve equations efficiently (Andal & Andrade, 2022). This gap shows the need for practice using manipulatives with structure within an instructional progression that supports students in attaining both conceptual understanding and procedural fluency.

Studies overwhelmingly point to progressiveness-based instruction having a very positive impact on what students learn and understand doing math, how strategic behaviors they adopt while working that involve thinking critically are fostered by study habits and beliefs, and their capability to navigate through mathematics. Nevertheless, the question remains about reconciling the more extensive learning with progressivism-based instruction and the procedural fluency essential for complete mathematical understanding.

6.0 Summary and Gap

Previous research has offered important and interesting findings on the impact of progressivism-based instruction on children's mathematics achievement and development. Progressivism-based instruction has always been proven to build better conceptual clarity and develop critical and analytical skills in both young adults and adults, forming the basis of some earlier known studies. This teaching style also has a beneficial effect on student attitudes toward math, and creating a relevant and engaging subject improves motivation and positivity. Studies reveal that optimal learning environments also increase self-efficacy and encourage social relationships through collaboration or cooperation, enhancing academic and interpersonal skills.

Nevertheless, there are gaps in the literature. Although the advantages of progressive-based teaching have been established concerning conceptual understanding and student engagement, less is known about how it impacts procedural knowledge, another critical component of mathematical performance. The authors reference several studies that are silent on how this could work in practice. However, the balance is needed given that research cited earlier that deeper exploration usually comes at the expense of procedural fluency. Moreover, much more work must be done to articulate how progression affects students' assessment of topic-based procedures (e.g., standardized tests). Endeavoring to fill the gaps could lead to a more complete picture of how progressive and conventional practices can work together in mathematics education most effectively.

7.0 Conclusion

This literature review highlights the potential of progressivism-based instructional approaches to enrich mathematics learning by centering on active engagement, real-world problem-solving, and student autonomy. The collective findings suggest that progressive methods can foster deeper conceptual understanding, enhance student motivation, and improve attitudes toward the subject—key precursors to sustained success in mathematics. However, questions remain about balancing conceptual exploration and procedural fluency often associated with traditional instruction. In particular, while inquiry-driven activities and collaborative tasks can ignite curiosity and promote critical thinking, insufficient attention to systematic practice may leave students without the technical skills vital for advanced coursework and standardized evaluations. Addressing these dual needs points to the value of blended or mixed approaches, where progressive methods and explicit procedural instruction operate in tandem. Therefore, future research should explore structured yet flexible models that harness the strengths of both paradigms and investigate the effects of progressivism-based strategies across diverse student populations, educational levels, and cultural contexts. Such inquiries will help refine mathematics pedagogy, guiding educators toward instructional practices supporting robust conceptual frameworks and the procedural competencies essential for long-term academic achievement.

8.0 Conflict of Interests

The author declares that there are no conflicts of interest.

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