The Notion of Creating New Knowledge in Science and Mathematics: A Conceptual Critique

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This paper critically examines the contested notion of "creating new knowledge" in science and mathematics education through a conceptual literature review. Drawing on a systematic search of international and South African scholarship, the review integrates philosophical debates, empirical evidence, and thematic discussions on knowledge creation in educational contexts. Three interrelated themes emerged. First, epistemological debates interrogate what qualifies as "new" knowledge, with constructivist traditions emphasizing the learner's personal construction of meaning, while realist perspectives highlight knowledge as objective and disciplinary. Second, classroom practices such as inquiry-based, problem-based, and project-based learning are discussed as avenues through which learners engage in forms of knowledge creation that, although not groundbreaking in disciplinary terms, are personally and contextually novel. Third, the analysis foregrounds the role of contextual factors, including under-resourced schools, curriculum rigidity, and assessment pressures, which both constrain and open possibilities for fostering creativity and innovation. The findings underline that while students may not generate disciplinary breakthroughs comparable to scientific or mathematical discoveries, they nevertheless construct knowledge that is new, meaningful, and transformative within their own learning trajectories. This has implications for pedagogy: a balanced orientation is required—one that ensures strong foundational knowledge while simultaneously providing opportunities for inquiry, experimentation, and creative engagement. The paper concludes by proposing differentiated pedagogical strategies that encourage critical thinking, innovation, and equitable participation in diverse learning environments.

Keywords: Knowledge creation; constructivism; realism; inquiry-based learning; science and mathematics education.

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Introduction

The concept of new knowledge creation in science and mathematics education has generated ongoing debate among scholars and educators. Central to this debate is the question of whether students can genuinely produce new insights, or whether their learning primarily involves the acquisition and reproduction of existing disciplinary knowledge (Harel, 2013; Gravemeijer, 1994). This epistemological tension raises fundamental concerns about how "new" knowledge is defined and whether student-generated understanding can be valued as novel in any meaningful sense.

The significance of this inquiry is twofold. First, it contributes to the broader philosophical discourse by clarifying how constructivist and realist perspectives frame our understanding of new knowledge. Constructivism views learners as active meaning-makers, suggesting that knowledge creation occurs when students reinterpret or reconstruct concepts in ways that are new to them. Realism, by contrast, emphasizes that knowledge exists independently of the learner, and true novelty is rare and largely confined to disciplinary advancements. Second, the debate carries practical importance for education systems such as South Africa's, where teachers and learners must balance the acquisition of foundational knowledge with the cultivation of inquiry, creativity, and problem-solving skills, often under challenging resource constraints.

This paper is motivated by the need to unpack these philosophical and practical tensions and to evaluate the conditions under which students can be considered creators of knowledge. It argues that while students may not produce disciplinary innovations, they actively contribute to knowledge creation through inquiry-based learning, problem-based approaches, and collaborative practices.

The paper proceeds as follows: the next section clarifies the research questions guiding this review. The methodology section then outlines the process used to identify and analyze relevant literature. This is followed by a presentation of findings organized around three emergent themes: epistemological debates, pedagogical practices, and contextual factors. The discussion develops practical recommendations for fostering knowledge creation in science and mathematics classrooms, with particular attention to under-resourced contexts. Finally, the paper concludes by reflecting on the theoretical, practical, and policy implications of valuing student-driven knowledge creation.

Research Questions

To guide this conceptual critique, the study addresses the following questions:

1. How is "new knowledge" defined and understood in science and mathematics education, particularly within constructivist and realist perspectives?
2. In what ways do inquiry-based and problem-based learning approaches contribute to student-driven knowledge creation?

3. How do contextual factors, such as resource availability and curriculum structures, shape opportunities for new knowledge creation in diverse educational settings?

Theoretical Framework

This study is anchored in two interrelated philosophical traditions—constructivism and realism—which provide contrasting perspectives on knowledge creation in mathematics and science education. Constructivist theories, rooted in the works of Piaget (1950, 1970) and Vygotsky (1978), emphasize learners as active agents who construct meaning through personal experience, social interaction, and contextual engagement. From this standpoint, knowledge creation occurs when students generate insights that are novel to them, even if these insights do not advance disciplinary frontiers. Constructivism therefore legitimizes classroom-based discoveries and student-generated strategies as authentic forms of "new" knowledge (Bruner, 1996; Ernest, 1998; Sfard, 1998).

By contrast, realist traditions—including critical realism—maintain that knowledge exists independently of learners and that genuine novelty arises when new insights expand the disciplinary body of knowledge itself (Bhaskar, 2008; Matthews, 2015). Within this framework, classroom learning is primarily seen as approximating objective truths rather than producing new ones, though students' constructions are valued insofar as they align with disciplinary validity (Moore, 2009; Phillips, 2017; Taber, 2019).

The tension between these two perspectives creates a productive lens for examining how "new knowledge" is defined and valued in educational contexts. This dual framework enables the study to recognize learners' personal knowledge constructions as meaningful while also situating them within broader disciplinary expectations.

Methodology

This study employed a conceptual literature review design to critique the notion of "creating new knowledge" in science and mathematics education. A literature review was selected because the study aimed not to generate new empirical data but to synthesize existing scholarship, highlight epistemological debates, and evaluate pedagogical implications.

Search Strategy and Databases

A systematic search was conducted across major academic databases, including Scopus, ERIC, Google Scholar, and Web of Science, complemented by targeted searches in specialist mathematics and science education journals. Keywords and Boolean combinations such as *"new knowledge creation," "knowledge construction," "constructivism," "realism," "science education,"* and *"mathematics education"* were used.

Inclusion and Exclusion Criteria

The inclusion criteria required that studies: directly address knowledge creation in mathematics and/or science education; engage with philosophical perspectives such as constructivism or realism, or with pedagogical approaches such as inquiry-based or problem-based learning; and be published in peer-reviewed journals, books, or edited collections between 1990 and 2024.

Analytical Process

Empirical studies set in both South African and international contexts were deliberately included to provide comparative insights into how the notion of "new knowledge" is framed in science and mathematics education. This comparative approach is consistent with recommendations in systematic review methodology, which emphasize the value of integrating cross-national perspectives to avoid context-bound generalizations (Booth et al., 2016). Studies were excluded if they focused narrowly on technical competencies, such as specific procedural or computational skills, without engaging with broader epistemological or pedagogical implications. This decision ensured that the review remained conceptually oriented toward the underlying debates around knowledge creation, rather than drifting into skill-training discourses.

Table 1

Analytical Stages of the Review

Stage	Process Undertaken	Key Outcomes	Supporting Literature
1. Screening and Categorization	Reviewed abstracts and titles; excluded skill-focused studies; grouped retained studies into three categories: (i) philosophical debates, (ii) inquiry/problem-based pedagogies, (iii) contextual/structural constraints.	Development of three broad categories for analysis.	Booth, Sutton, & Papaioannou (2016); Grant & Booth (2009).
2. Thematic Synthesis	Identified recurring arguments and findings; coded and compared across South African and international studies; analyzed context-specific influences.	Emergence of cross-cutting themes that highlighted similarities and divergences between contexts.	Thomas & Harden (2008).
3. Conceptual Critique	Examined themes through constructivist and realist lenses; evaluated epistemological assumptions about knowledge creation and learner roles.	Clarification of how "new knowledge" is framed and the implications for pedagogy and epistemology.	Matthews (2015); Phillips (2017).

The analysis proceeded in three interrelated stages. First, screening and categorization involved reviewing abstracts and titles to identify relevant literature. Studies that engaged with philosophical discussions of knowledge, inquiry- or problem-based pedagogies, or contextual/structural dimensions of education were retained. Categorization drew on prior review frameworks that recommend clustering studies according to conceptual foci (Grant & Booth, 2009).

Second, a thematic synthesis was undertaken within each category. Recurring arguments and findings were coded inductively, with emphasis on identifying how different contexts (e.g., resource-rich versus under-resourced, or Global North versus Global South) shaped approaches to knowledge creation. This approach aligns with the "thematic synthesis" method outlined by Thomas and Harden (2008), which supports cross-comparison of qualitative and conceptual studies.

Finally, a conceptual critique was applied. Drawing on constructivist and realist perspectives, the synthesized themes were examined to evaluate how "new knowledge" is defined, legitimized, and operationalized in science and mathematics education. This critique emphasized not only what the studies reported, but also their underlying assumptions about the learner's role as a potential knowledge creator (Matthews, 2015; Phillips, 2017).

Emergence of Themes

The themes emerged through a systematic process of coding and synthesizing the reviewed literature, which allowed recurrent patterns and points of tension to be identified across diverse contexts. Using a thematic synthesis approach, studies were first coded at the descriptive level (focusing on concepts explicitly raised by authors) and then refined into interpretive categories that highlight broader debates and practices (Thomas & Harden, 2008). From this iterative analysis, three overarching themes were distilled: epistemological debates, pedagogical practices, and contextual challenges and opportunities.

1. Epistemological debates

A strong thread in the literature centers on tensions between constructivist and realist epistemologies in knowledge creation. Constructivist perspectives emphasize learners as active agents in meaning-making, with knowledge seen as socially and contextually constructed (Vygotsky, 1978; Piaget, 1970). In contrast, realist or objectivist traditions argue for the stability and universality of disciplinary knowledge, which must be transmitted to students (Moore, 2009). This divide is particularly visible in mathematics and science education, where debates on whether knowledge is "discovered" or "constructed" shape both curriculum and pedagogy (Ernest, 1991). The prominence of this tension across multiple studies elevated it as a key theme.

2. Pedagogical practices

The second theme reflects the widespread exploration of inquiry-based, problem-based, and student-centered pedagogies as mechanisms for engaging learners in knowledge creation. The literature demonstrates that these approaches can enhance conceptual understanding, critical thinking, and learner autonomy (Hmelo-Silver, 2004; Prince & Felder, 2006). For instance, problem-based learning has been shown to bridge theory and practice, fostering deeper disciplinary engagement (Savery, 2015). Within constructivist framings, such pedagogies provide learners with opportunities to co-construct knowledge through dialogue, reflection, and collaboration (Bruner, 1996). The consistent recurrence of these approaches across reviewed studies consolidated them into a distinct theme.

3. Contextual challenges and opportunities

A final theme concerned the contextual realities shaping pedagogy and epistemology. In South Africa, structural challenges such as resource disparities, large class sizes, and rigid curriculum frameworks often constrain innovative pedagogical approaches (Spaull, 2013; Sayed & Motala, 2012). International literature similarly highlights how socio-economic, institutional, and policy contexts mediate the adoption of constructivist practices (Darling-Hammond et al., 2017). At the same time, these contexts create opportunities for adaptation and innovation, such as leveraging low-cost technologies, community-based learning, and hybrid pedagogies. The recurrence of such contextual mediations across studies justified their identification as a major theme.

By mapping how these three themes cut across multiple strands of the literature, the study not only ensures transparency and rigor in synthesis but also contributes a conceptual critique of how knowledge, pedagogy, and context intersect in shaping educational practice.

Conceptual Critique

The final stage of analysis involved a conceptual critique, examining how different traditions in science and mathematics education frame the idea of "new knowledge." This stage highlighted the epistemological tensions between constructivist and realist perspectives and their implications for pedagogy.

From a constructivist standpoint, new knowledge is framed primarily as a learner-centered phenomenon. The emphasis lies in how students build personal meaning through active engagement with concepts, rather than in producing disciplinary breakthroughs (Ernest, 1998; Cobb, 2002). In this view, knowledge creation is always situated, contextual, and relational, emerging from the interaction between prior understandings, social discourse, and classroom practices. For instance, when learners solve a problem in mathematics using a method that is novel to them, constructivists regard this as the generation of new knowledge, even if the solution is already established within the discipline. This position is reflected in many empirical studies that employ inquiry-based learning or problem-based pedagogies, where the focus is on fostering students' sense-making, creativity, and agency (Hmelo-Silver, Duncan, & Chinn, 2007; Sfard, 2012).

In contrast, realist perspectives (including critical realism) situate knowledge creation within the broader ontological and disciplinary structures that exist independently of learners. From this angle, new knowledge is not simply what is new to the learner, but rather what extends the frontiers of mathematics or science itself (Bhaskar, 2008; Matthews, 2015). While realists acknowledge the pedagogical importance of learners' constructions, they stress that such constructions must be evaluated against disciplinary truths and epistemic validity. Thus, for realists, classroom activities that stimulate inquiry are valuable not because they produce novelty per se, but because they scaffold learners toward approximating objective disciplinary knowledge.

This critique reveals a productive tension: constructivist framings highlight the legitimacy of learners' personal and contextual knowledge, while realist approaches safeguard the disciplinary rigor that defines mathematics and science. A balanced interpretation, therefore, recognizes that students may not generate disciplinary breakthroughs but can nevertheless create knowledge that is "new" and meaningful in their learning contexts, while also being guided toward epistemically robust understandings. This dual recognition aligns with recent calls for integrative pedagogies that combine constructivist engagement with realist accountability (Phillips, 2017; Taber, 2019).

Findings and Discussion

Defining "New Knowledge" in Science and Mathematics Education

The definition of "new knowledge" in science and mathematics education remains highly contested and layered, reflecting deeper philosophical debates about the nature of knowledge and learning. From a realist perspective, new knowledge is conceived as an objective discovery that advances disciplinary frontiers—such as proving a new theorem in mathematics or developing a groundbreaking scientific theory. This interpretation situates knowledge creation as a rare occurrence, typically confined to professional researchers and scholars, and suggests that students rarely create genuinely new knowledge in this strict disciplinary sense (Kirschner, Sweller, & Clark, 2006). Conversely, constructivist perspectives emphasize that knowledge is not transmitted in a fixed form but actively constructed by learners through interpretation, reflection, and social interaction. From this viewpoint, what counts as "new" may be locally or personally novel, even if it already exists within the broader academic community (Sfard, 1998; Piaget, 1950; Vygotsky, 1978).

This study takes the position that student-driven knowledge creation is best understood as the generation of personally or contextually new insights. While students may not revolutionize mathematics or science disciplines, they contribute to knowledge creation when they reinterpret established concepts, reconstruct knowledge through their own experiences, and apply principles in novel contexts. For example, when learners design alternative proofs for the Pythagorean theorem or develop unique strategies to solve quadratic equations, they are not producing disciplinary innovations but are nonetheless engaging in meaningful acts of knowledge creation (Brodie, 2010; Ndlovu, 2013). Recognizing these acts as valid forms of knowledge creation affirms the view that learning is an active, meaning-making process rather than a passive reception of information. Recent research further emphasizes this point by showing that students' personal discoveries foster deeper engagement, critical thinking, and long-term retention of concepts (Leikin & Levav-Waynberg, 2021; Luria & Kaufman, 2023).

Pedagogical Practices that Enable Knowledge Creation

The literature demonstrates that particular teaching approaches enable students to act as creators of knowledge, even within contexts that present significant resource constraints. One powerful approach is Inquiry-Based Learning (IBL), which emphasizes student-driven questioning, hypothesis formation, and experimentation. By designing their own experiments or mathematical strategies, students engage in processes that allow them to experience discovery and validate ideas. For example, South African studies indicate that when students design simple physics experiments, such as pendulum models to investigate motion, they often develop unique problem-solving strategies that are new to them, even though the principles confirm known scientific laws (Nyathi & Moyo, 2017; Meiers & Brauer, 2022).

Problem-Based Learning (PBL) similarly provides fertile ground for knowledge creation by immersing students in authentic, real-world challenges. When learners address open-ended problems such as designing sustainable housing solutions or diagnosing complex medical cases, they apply disciplinary principles in ways that generate contextually new knowledge and encourage interdisciplinary thinking (Savery & Duffy, 2019; Vacca & Padilla, 2023). This process nurtures not only technical skills but also creativity, collaboration, and intellectual autonomy, which are essential attributes of knowledge creators.

In addition, collaborative and blended learning environments enhance students' opportunities to construct knowledge collectively. Peer collaboration allows learners to challenge and refine each other's reasoning, while digital tools—such as simulations, adaptive platforms, and virtual labs—create interactive spaces for exploration and innovation. Studies show that students working with blended learning technologies often devise alternative solution paths or develop novel visual models that enhance conceptual understanding (Cobo & Moravec, 2019; Hershkowitz et al., 2023). For instance, in blended mathematics classrooms, interactive graphing software has enabled students to visualize non-linear functions in ways that support deeper comprehension and encourage innovative problem-solving (Willingham et al., 2021).

These approaches reveal that pedagogy mediates the space between realism and constructivism: while students may be rediscovering existing principles, the processes of inquiry, collaboration, and creative problem-solving allow them to construct knowledge that is genuinely new to their personal or social learning context.

Contextual Factors Shaping Knowledge Creation

The findings also highlight the central role of context in shaping processes of knowledge creation in science and mathematics education. In resource-rich educational settings, students benefit from sustained access to laboratories, interactive simulations, small-group tutorials, and digital platforms that encourage exploration and experimentation. Such environments provide diverse pathways to constructing meaning, supporting deeper engagement, collaboration, and creative problem-solving (Case & Marshall, 2015; Chittleborough, Gonsalves, & Treagust, 2022). Importantly, the availability of technological tools and flexible curricula in these contexts often enables teachers to integrate inquiry-based and project-oriented pedagogies that extend beyond rote learning and encourage authentic engagement with disciplinary concepts.

By contrast, under-resourced schools—particularly within the South African context—face persistent structural constraints, including overcrowded classrooms, rigid syllabi, inadequate laboratory facilities, and shortages of teaching and learning materials. These systemic barriers limit the extent to which teachers can implement open-ended inquiry-based methods, often compelling them to prioritize examination preparation and syllabus coverage at the expense of exploratory learning (Ngubane & Maharaj, 2019; Dlamini, Nkosi, & Mthethwa, 2022). The result is that opportunities for students to develop critical and creative capacities are often curtailed, reinforcing inequities between learners in different educational environments.

Nevertheless, evidence from practice shows that innovation remains possible even in resource-constrained settings. Teachers who creatively adapt by using low-cost, locally sourced materials to design practical science demonstrations (Mabaso & Mthembu, 2023) or who incorporate culturally relevant, community-based projects into the curriculum (Mahlangu & Mkhize, 2022) have demonstrated that students can still meaningfully engage with concepts and generate novel insights. These adaptive strategies highlight the agency of educators who navigate systemic limitations to provide opportunities for students to act as knowledge creators, albeit in contextually specific ways.

A broader comparative perspective further illustrates these dynamics. In India, for instance, rural schools often face similar constraints of overcrowding and limited infrastructure; yet, innovative pedagogies such as the use of “low-cost science kits” have enabled learners to engage in hands-on experimentation despite material scarcity (Anuradha & Singh, 2021). Likewise, in Kenya, community-driven approaches to science education have drawn on indigenous knowledge systems and everyday problem-solving practices to contextualize learning, fostering forms of knowledge creation that resonate with local realities (Wanjala & Orwenjo, 2020). These cases echo South African experiences, reinforcing the idea that resource limitations, while constraining, can also inspire contextually grounded innovations that enhance knowledge construction.

Such examples underscore the importance of adopting differentiated pedagogical strategies that are responsive to context. In resource-rich schools, the focus may lie in leveraging advanced technologies, interdisciplinary projects, and global networks of knowledge exchange, while in under-resourced environments, approaches must emphasize accessibility, adaptability, and cultural relevance. A contextualized understanding of pedagogy is therefore essential for ensuring that all learners—regardless of their educational setting—are recognized and empowered as potential contributors to knowledge creation. This nuanced approach moves beyond simplistic dichotomies of “resourced” versus “under-resourced” schools and instead calls for a recognition of diverse forms of innovation that emerge within specific sociocultural and institutional conditions.

Implications for Science and Mathematics Education

The synthesis of these findings yields several implications for science and mathematics education. First, educators must move toward redefining novelty, recognizing student-generated insights as legitimate forms of new knowledge at the personal or classroom level, even when they fall short of disciplinary breakthroughs. This shift not only validates student agency but also fosters engagement and ownership of learning.

Second, effective pedagogy requires balancing foundational knowledge and inquiry. Cognitive Load Theory reminds us that without adequate scaffolding, learners may become overwhelmed in inquiry-based environments (Sweller, 1988; Kirschner et al., 2006). Therefore, teaching should integrate explicit instruction of foundational skills with opportunities for creativity and problem-solving, ensuring that students are prepared to engage in meaningful knowledge construction.

Third, context-sensitive strategies are essential. Educators and policymakers must acknowledge disparities between urban and rural, resource-rich and resource-limited schools, and adopt differentiated approaches tailored to these diverse realities (Baloyi & Louw, 2021; Becker, Lentz, & Schreiber, 2022).

Finally, teacher agency emerges as a critical factor. Teachers serve as mediators between constructivist and realist expectations, balancing content mastery with the facilitation of inquiry, collaboration, and exploration. Empowering teachers through professional development and supportive policies is therefore central to fostering environments in which students can thrive as knowledge creators (Leikin & Zazkis, 2010; Berland & Reiser, 2021).

Limitations

While this study offers important insights into the notion of new knowledge creation in science and mathematics education, several limitations must be acknowledged. First, as a conceptual literature review, the analysis is limited by the availability and scope of published studies. Although major databases such as Scopus, ERIC, and Web of Science were searched, relevant research outside peer-reviewed journals—such as unpublished theses, grey literature, or classroom-based teacher reports—may not have been included. This may narrow the range of perspectives represented.

Second, the review inevitably reflects a degree of selection bias. Despite efforts to apply systematic inclusion and exclusion criteria, the choice of themes and emphasis on constructivist and realist perspectives may have excluded other theoretical frameworks, such as critical pedagogy or sociocultural learning theories, which could also enrich understandings of knowledge creation (Nasir & Hand, 2020).

Third, the discussion of contextual factors, particularly within South African education, cannot capture the full diversity of school settings. While rural–urban and resource-rich vs. resource-limited distinctions were highlighted, each school operates within unique cultural, historical, and socio-economic dynamics. Overgeneralization remains a risk, and future empirical studies should adopt fine-grained, comparative approaches to explore these contextual variations more deeply (Dlamini et al., 2022).

Finally, because the study is conceptual, it does not present original empirical data. While the critique draws on empirical studies to illustrate arguments, it cannot assess the effectiveness of pedagogical strategies in practice. Future research should therefore include classroom-based interventions and longitudinal studies to test how inquiry-based and problem-based approaches support student-driven knowledge creation in varied educational environments.

Despite these limitations, the review provides a valuable foundation for ongoing dialogue and empirical inquiry, highlighting both philosophical debates and practical strategies that can inform science and mathematics education

Practical Recommendations

Building on the findings of this review, several practical recommendations can guide teachers, curriculum designers, and policymakers in fostering meaningful knowledge creation in science and mathematics education:

1. *Promote inquiry and problem-based tasks within curriculum constraints.*

Teachers can integrate small-scale inquiry projects and problem-solving activities into existing lessons without overhauling the entire curriculum. Even short activities where students generate hypotheses, test simple experiments, or design multiple approaches to solving a mathematical problem can create opportunities for contextual knowledge construction (Meiers & Brauer, 2022; Leikin & Levav-Waynberg, 2021).

2. *Use low-cost and locally available materials in under-resourced contexts.*

In schools with limited laboratory facilities, teachers can adapt by using everyday resources to simulate scientific principles—for example, using bottles and sand to model pendulums or locally available seeds to investigate plant growth. Such practices have been shown to support student agency and creativity while overcoming resource constraints (Mabaso & Mthembu, 2023).

3. *Embed culturally relevant and community-based projects.*

Teachers can design tasks that draw on learners' local contexts—such as investigating water quality in nearby rivers, studying patterns in traditional crafts, or exploring community energy needs. These projects not only deepen engagement but also validate students' cultural knowledge as a legitimate resource for inquiry (Mahlangu & Mkhize, 2022).

4. *Leverage blended and digital learning tools where possible.*

When schools have access to technology, digital simulations, graphing software, and virtual labs should be integrated into teaching. These tools allow students to experiment with variables, visualize concepts, and test ideas in interactive ways, promoting both procedural fluency and conceptual understanding (Cobo & Moravec, 2019; Hershkowitz et al., 2023).

5. *Strengthen teacher professional development for knowledge facilitation.*

Teachers require ongoing professional development to confidently balance explicit instruction with facilitation of inquiry and creativity. Training should emphasize strategies for scaffolding inquiry, managing group-based projects, and linking theoretical perspectives such as constructivism and realism to everyday practice (Berland & Reiser, 2021).

6. *Encourage differentiated approaches across contexts.*

Policy and practice must recognize that strategies effective in resource-rich schools may not be directly transferable to under-resourced settings. Tailored approaches—ranging from high-tech digital simulations to culturally relevant low-cost tasks—are necessary to ensure equitable opportunities for knowledge creation across diverse contexts (Baloyi & Louw, 2021).

By implementing these recommendations, educators can create learning environments that balance foundational knowledge acquisition with inquiry, collaboration, and creativity, thereby positioning students as active contributors to knowledge construction in science and mathematics.

Conclusion

This paper has critically examined the notion of "creating new knowledge" in science and mathematics education, highlighting both the philosophical debates and the pedagogical practices that shape its meaning. From a realist perspective, new knowledge is viewed as disciplinary innovation, rare and reserved for professional scholarship. From a constructivist standpoint, however, knowledge creation occurs whenever learners generate personally or contextually novel insights through reinterpretation, reconstruction, and application of concepts. Adopting this latter perspective, the study has argued that student-driven knowledge creation should be valued as legitimate, even when it does not amount to disciplinary breakthroughs.

The findings demonstrate that pedagogical practices such as inquiry-based learning, problem-based learning, and collaborative engagement create opportunities for learners to act as knowledge creators. These approaches position students as active participants in the meaning-making process, while also balancing the need for foundational knowledge to prevent cognitive overload. Furthermore, contextual analysis revealed that opportunities for knowledge creation are not equally distributed: resource-rich environments often enable sustained inquiry, while under-resourced contexts constrain it. Nevertheless, evidence of innovation in low-resource schools—such as the use of locally available materials and culturally relevant projects—shows that knowledge creation remains possible with adaptive teaching strategies.

The study's contribution lies in reframing student-generated knowledge as contextually novel and in bridging the gap between philosophical debates and classroom realities. By foregrounding the importance of pedagogy and context, it emphasizes that all students, regardless of educational setting, can be positioned as co-creators of knowledge. This stance has important implications for both teachers and policymakers: teachers must balance foundational mastery with opportunities for inquiry, while policymakers must support differentiated strategies that account for diverse educational contexts.

At the same time, the limitations of this review must be acknowledged. The analysis is shaped by the scope of available literature, a reliance on constructivist and realist frameworks, and the absence of original empirical data. Future research should therefore test these insights in practice through classroom-based interventions, comparative studies across varied school contexts, and explorations that draw on additional theoretical perspectives such as sociocultural or critical approaches.

In conclusion, while students may not always generate knowledge that is new in a disciplinary sense, they can create knowledge that is new to them, their peers, and their learning communities. Recognizing and nurturing these forms of novelty affirms learners' agency, fosters creativity, and prepares them to contribute meaningfully to the advancement of science and mathematics education in both local and global contexts.

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