การยกระดับการสอนทางวิทยาศาสตร์ศึกษาผ่านแนวทางคอนสตรัคติวิสม์

Enhancing Science Learning through a Constructivist Pedagogy

สุพัชรี จันทร์รักษา[1]* จิรวดี ชูตัน[2]
Supatcharee Junruksar[1]* Jirawadee Chuton [2]
[1]โรงเรียนวัดบางบัวทอง (โศภณวิทยานุเคราะห์) สังกัดองค์การบริหารส่วนจังหวัดนนทบุรี
[1]Wathbangbuathong School (Soponwittayanukra), Nonthaburi Provincial Administrative Organization
[2]โรงเรียนจันทร์ทองเอี่ยม สังกัดองค์การบริหารส่วนจังหวัดนนทบุรี
[2] Janthongaeim School, Nonthaburi Provincial Administrative Organization
*Corresponding author's e-mail: supatcharee.jun755@gmail.com

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Abstract

This study aims to analyze the application of constructivist learning theory in science education is a learning theory guiding education, emphasizing learner-initiated, developmentally appropriate learning with facilitators. It focuses on modifying mental models for novel experiences and encourages hands-on learning and the constructivist approach, involving teachers as facilitators, encourages learners to construct their own knowledge through active engagement and challenging traditional methods, enhancing learning outcomes. Important concepts emerging from this study highlight that constructivism emphasizes learning as an active process in which learners build knowledge through exploration and engagement. By participating in hands-on activities and exchanging ideas with peers and teachers, students develop deeper understanding and critical thinking skills. This approach also promotes collaboration, creativity, and problem-solving, preparing learners for lifelong learning and real-world application of knowledge

Keywords: Enhancing; Science Learning; Constructivist Pedagogy

บทคัดย่อ

การศึกษานี้มีวัตถุประสงค์เพื่อระบุแนวคิดคอนสตรัคติวิสต์สำหรับการเรียนรู้วิทยาศาสตร์ ซึ่งคอนสตรัคติวิสต์เป็นทฤษฎีการเรียนรู้ที่ชี้นำการศึกษา โดยเน้นการเรียนรู้ที่ผู้เรียนเป็นผู้ริเริ่มและเหมาะสมกับพัฒนาการ โดยมีวิทยากรเป็นผู้อำนวยความสะดวก แนวคิดนี้มุ่งเน้นไปที่การปรับเปลี่ยนแบบจำลองทางจิตใจ

เพื่อประสบการณ์ใหม่ ๆ และส่งเสริมการเรียนรู้แบบลงมือปฏิบัติจริง แนวคิดคอนสตรัคติวิสต์ซึ่งครูเป็นผู้อำนวยความสะดวก ส่งเสริมให้ผู้เรียนสร้างความรู้ด้วยตนเองผ่านการมีส่วนร่วมอย่างกระตือรือร้นและท้าทายวิธีการแบบดั้งเดิม ซึ่งช่วยยกระดับผลการเรียนรู้ แนวคิดสำคัญที่ได้จากการศึกษานี้ชี้ให้เห็นว่าคอนสตรัคติวิสต์เน้นการเรียนรู้ในฐานะกระบวนการเชิงรุกที่ผู้เรียนสร้างความรู้ผ่านการสำรวจและการมีส่วนร่วม การมีส่วนร่วมในกิจกรรมลงมือปฏิบัติจริงและการแลกเปลี่ยนความคิดเห็นกับเพื่อนและครู ช่วยให้นักเรียนพัฒนาความเข้าใจที่ลึกซึ้งยิ่งขึ้นและทักษะการคิดเชิงวิพากษ์ แนวคิดนี้ยังส่งเสริมการทำงานร่วมกัน ความคิดสร้างสรรค์และการแก้ปัญหา เตรียมความพร้อมผู้เรียนสำหรับการเรียนรู้ตลอดชีวิตและการประยุกต์ใช้ความรู้ในโลกแห่งความเป็นจริง

คำสำคัญ: การยกระดับ**;** วิทยาศาสตร์**;** แนวทางคอนสตรัคติวิสต์

Introduction

The National Education Act, 1999 aims to develop Thai people into complete human beings through physical, mental, intellectual, and moral education. It emphasizes that all students are capable of learning and self-development, and encourages students to develop their natural potential. The Act also introduces the concept of science teaching, emphasizing students learning independently and teachers as facilitators. In accordance with the Education Act, classes should be constructivist, focusing on students' maturity and experiences (Chamnanwong, & Yuenyong, 2014). Educational revolution necessitates a paradigm change in learning from teacher-centered to student-centered. According to Alam (2023) stated to a paradigm shifts from traditional teacher-centered to student-centered learning in education, influenced by technological advancements and learners' changing needs. It compares constructivism and connectivism, highlighting their strengths and limitations, and their practical implementation in classrooms. Constructivism is widely adopted, while connectivism is gaining popularity due to its ability to facilitate meaningful digital learning experiences. Both approaches can positively impact student learning outcomes, but their effectiveness depends on the specific context. Successful implementation depends on addressing factors that hinder these approaches and creating an enabling environment. This learning approach will foster lifelong skills crucial for students to thrive and survive in the global era

Science teacher education in Thailand has been undergoing educational reform since 1999. The National Education Act and the 2001 Basic Education Core Curriculum addressed goals of science education in which skills in science and technology were recognized as a key

catalyst in the development of a country's human resources (Institutes for the Promotion of Teaching Science and Technology (IPST) 2002). Science education has long been seen as a basis for creativity, critical thinking, and problem-solving. However, Traditional science teaching often relies on rote memorization and teacher-centered delivery, which limits students' critical thinking and problem-solving skills. A constructivist approach, emphasizing inquiry and active participation, can address these limitations by fostering deeper understanding and meaningful learning, which hinder students' capacity to relate what they learn to practical applications. Science education needs to be rethought to go beyond information acquisition in the twenty-first century, when complicated global issues and quick technological advancements necessitate creativity and adaptation. This necessitates a change in teaching methods that actively involve students in creating their own knowledge, according to Faikhamta et al. (2018) stated to enhancing research-based student teaching internships by incorporating specific science content and enhancing constructivist teaching practices for improved understanding.

Constructivist pedagogy reshapes science education by promoting active participation, inquiry, and collaborative problem-solving. It fosters deeper understanding, critical thinking, and adaptability, aligning with a knowledge-based society where analyzing, creating, and adapting are crucial, according to Tuerah (2019) stated to the constructivism approach significantly improved elementary school students' understanding of science, leading to optimal learning outcomes and a positive influence, Zahara et al. (2024) stated to constructivist teaching methods in science enhance critical thinking, student participation, and understanding of key concepts through interactive and hands-on learning activities, demonstrating their relevance in science education and Bada (2015) stated to constructivism is a theory that asserts that learning is an activity that is individual to the learner, the teachers encourage students to constantly assess how the activity is helping them gain understanding. By questioning themselves and their strategies, students in the constructivist classroom ideally become expert learners. This gives them ever-broadening tools to keep learning. With a well-planned classroom environment.

For these reasons, Constructivist pedagogy in science education fosters learner-centered environments, promoting scientific inquiry, problem-solving, and collaboration, preparing students for real-world challenges. Moreover, integrating constructivist principles into science education aligns with broader educational policies that emphasize 21st-century

competencies and lifelong learning. The present study aims not only to contribute to the academic discourse but also to offer practical insights that can guide educators, policymakers, and institutions in reshaping science education to meet contemporary demands, can be explained in the following important points:

Constructivism

Constructivism is a set of assumptions about the nature of human learning that guides constructivist learning theories and teaching methods of education. Constructivism emphasizes learner-initiated, learner-directed, developmentally appropriate learning assisted by a facilitator. Constructivist philosophy holds that learning is basically the act of modifying our mental models to make room for novel experiences. Constructivism, as a theory of human cognition, is frequently linked to teaching strategies that encourage hands-on learning. There will inevitably be an effort to make scientific education relevant for students since it is acknowledged as a component of our lives. The idea that people build knowledge appears to be the unifying thread throughout the various interpretations of constructivism (Phillips, 1995).

In the same way, Bada (2015) explains that Constructivism is a significant education concept that emphasizes student-centered learning, based on scientific research and observation. It suggests that people build their knowledge through experiences and reflection, making it crucial for reforming education for all students, according to this theory (Bereiter, 1994) New discoveries make sense of it in light of our prior knowledge and experiences, to modify our beliefs or dismiss the new information as unimportant. In order to accomplish this, we need to investigate, evaluate, and pose questions. The constructivist perspective on learning might identify several instructional methods used in the classroom. In its broadest definition, it typically refers to motivating students to generate new information using active methods (experiments, real-world problem solving), then to assess and discuss their work and how their comprehension is evolving. The instructor ensures that the students are aware of the students' preconceived notions and directs the activity to address and then expand upon them (Oliver, 2000).

Constructivism learning theory suggests that students acquire knowledge through self-analysis, impacting educational policies and practices in elementary and secondary schools.

Allen (2022). Constructivist scholars argue that individuals cannot plan their learning and progress, promoting active student support and knowledge acquisition through current experiences. in (Duane & Satre, 2014). Instead, learning is an active approach that can be defined as students fully engaging in a positive process (Rob & Rob 2018). All of the knowledge may be made available to students so they can quickly adapt to any unforeseen conditions.

Constructivism Framework

Kanuka & Anderson (1999) conducted a review of the literature related to constructivist framework consists of two dimensions and four positions, examining subjective reality and objective reality, and determining information creation from social, cultural, or contextual sources.

Figure 1. Constructivism Dimensions and Positions: Epistemological Constructivism Positions (Kanuka & Anderson, 1999 as cited in Allen, 2022).

Transition towards Constructivist Approaches in Science Education

The constructivist approach views teachers as learning facilitators, providing a didactic

lecture and guiding learners to understand content. Teachers lecture from the front, provide guidelines, and create an environment for learners to reach their own conclusions. According to Chan et al. (2024). Stated to teachers foster active engagement through carefully planned learning episodes that connect prior knowledge with new material. Questioning is used to stimulate reflection, collaboration, and deeper understanding. Constructivist-based assessments help evaluate conceptual grasp, knowledge creation, and interdisciplinary integration. The findings highlight the need to review and align curricula with constructivist principles.

Constructivist learning involves learners actively constructing their own knowledge through materials and activities, with the teacher's role being to challenge students' conceptions of reality. Meaningful learning occurs through this approach, despite research suggesting traditional teaching methods. According to Kumar (2019) Stated to the increasing use of constructivist teaching signifies a shift away from traditional models, which often failed to challenge learners' understanding and meet student needs. On the other hand, Constructivist teaching practices necessitate educators to be more cautious about its definition and application, avoiding confusion with student-centered teaching or assuming lack of content expertise, and Ering et al. (2024) stated to the study emphasizes the importance of incorporating constructivist strategies into teaching practices, teacher training programs, and curriculum development for equitable learning outcomes and suggests expanding research to diverse subjects and regions.

As more studies on constructivist practices in classrooms reveal the need to examine current practices in schools, allowing educators to understand evidence and improve methods, thereby enhancing learning outcomes. According to Deng (2025) stated to Constructivism theory in education promotes active knowledge construction through interaction and practice. However, challenges like task design complexity and increased cognitive burden in classrooms hinder its effectiveness, to suggests developing support tools and optimizing task design to reduce faculty burden and improve constructivist teaching application and Fitria et al. (2021) stated to Constructivism teaching involves students actively constructing meaning and knowledge, aiming to provide students with a comprehensive understanding of science concepts and principles.

From the above reasons, it can be concluded that the constructivist approach positions teachers as facilitators who guide and create environments for learners to construct their own knowledge. Learners actively engage with materials and activities, while teachers challenge their existing conceptions to promote meaningful learning. Despite the persistence of traditional methods, research underscores the importance of examining classroom practices to refine constructivist strategies and improve student learning outcomes

Constructivist Perspectives on Science Learning

The rapid advancement of science and technology, coupled with the increasing demand for scientists, has accelerated the need for a more comprehensive approach to teaching and learning. Science promotes thinking ability through process skills, emphasizing hypothesizing, manipulating physical world, and reasoning from data. These transferable abilities are applicable across various disciplines and reflect scientists' reflective behavior. According to Allen (2022) stated to the educator's role is to ensure students are grounded in theory, compare their experiences to the theory, and construct new knowledge based on this, navigating the dissonance between theory and application.

Science is a dynamic, expanding body of knowledge, and its interest lies in student participation. Conventional teaching methods emphasize passive knowledge, while constructivism views learning as an active process where learners discover principles, concepts, and facts for themselves, according to Fitria et al. (2021) stated to the constructivism is a learning approach that emphasizes students building knowledge through experience, promoting effective learning of science. It views learning as an active process, requiring students to connect instructional content to previous concepts and solve contextual problems and Renninger (2024) stated to the integration of constructivist principles in teaching and learning is crucial for student success. By combining theory and practice, educators can develop critical thinking, creativity, and resilience in students, preparing them for a complex world. This approach fosters a lifelong love for learning and empowers students to actively participate in their education.

From the above reasons, it can be concluded that the rapid advancement of science and technology has led to a need for a comprehensive teaching approach. Science promotes thinking skills, focusing on process skills and student participation. Constructivism, a method

that views learning as an active process, combines theory and practice to develop critical thinking, creativity, and resilience, preparing students for a complex world

Conclusion

Constructivist scholars view learning as an active process where learners discover principles, concepts, and facts for themselves. Activities aid students in achieving goals, developing skills, and fostering flexible classroom interactions that accommodate personal experiences and questions. The teacher's role is to engage children in hands-on activities, encourage their ideas, and establish good communication, creating a conducive learning environment. Thus, meaningful learning happens through the constructivist approach in science education has been extensively researched, leading to the development of deeper understandings and the need for radical changes in curriculum design and implementation. constructivist approaches shift science education from memorization to inquiry-based learning. It offers both theoretical perspectives and practical examples, helping educators design learner-centered curricula that foster critical thinking and problem-solving

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