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PAPER

Perception of Engineering Students on Social Constructivist Learning Approach in Classroom

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ABSTRACT

The social constructivist approach to teaching and learning has garnered significant interest among educators and researchers. However, further investigation into its implementation and effectiveness in the classroom is still needed. This study aims to investigate engineering students' perceptions of social constructivist practices in their technology classes, using the constructivist learning environment survey (CLES) as its framework. A mixed-methods approach combining quantitative and qualitative methods was used, which included online surveys and semi-structured interviews. Analysis of data from 300 responses showed that constructivism was partially implemented in the classroom. Specifically, student negotiation emerged as the most frequently perceived dimension, while shared control was perceived as seldom occurring. Most items on the personal relevance scale were frequently perceived, highlighting the importance of integrating technology learning into students' daily lives. Similarly, the uncertainty of technology was found to be a common experience for students. In contrast, the dimension of critical voice received mixed results, emphasizing the necessity of a learning environment that fosters student expression and meaningful discussions. These findings suggest the necessity for additional investigation and integration of social constructivist practices that emphasize the enhancement of student engagement, promotion of critical thinking, and redistribution of power within the classroom setting.

KEYWORDS

constructivism, perception, engineering, students, technology

1 INTRODUCTION

In recent years, education has undergone rapid reform and paradigm shifts, challenging traditional teaching methods and calling for a learner-centered approach [1]. The aim of education has evolved from simply transmitting knowledge to promoting critical thinking and problem-solving skills in students [2–3]. This shift has led to the development of various student-centered and experiential learning approaches, with constructivism emerging as a prominent pedagogical framework [4].

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Constructivism, as a pedagogical framework, has garnered significant attention for its potential to promote deep learning and conceptual understanding [5]. Grounded in the works of influential theorists Piaget and Vygotsky, constructivism asserts that learners actively construct knowledge through interactions with their environment, collaboration with others, and reflection on experiences [6–8]. In a constructivist classroom, learners are encouraged to question, explore, and connect their existing knowledge with new information, fostering deeper engagement and cognitive development. The lecturer assumes the role of a facilitator, guiding learners toward their learning goals [9]. This pedagogical approach aims to create an engaging learning environment that enhances students' interaction with knowledge and their peers, using various tools and emphasizing the context in which learning occurs [10].

Previous research has shown that constructivist learning strategies are effective in promoting student interaction and producing positive outcomes [11–12]. Research has also explored the affective and cognitive domains of learning, including motivation and student conceptions [13]. Several studies have evaluated the effectiveness of constructivism in education, and their findings indicate its superiority over traditional teaching methods in terms of academic achievement, motivation, anxiety towards learning, and self-monitoring [14]. Moreover, research into teachers' attitudes and perspectives toward constructivist principles has revealed positive views of the constructivist teaching approach in the classroom [15–17].

While constructivist approaches to teaching and learning have garnered significant attention in publications [18], there is a scarcity of research specifically focused on students' perceptions of the effectiveness of constructivist learning approaches, especially within higher education and among engineering students [19]. This knowledge gap is particularly significant in developing economies such as Vietnam, where there is a growing emphasis on the implementation of student-centered educational approaches, such as social constructivism. Consequently, there is a lack of comprehensive studies evaluating the effectiveness of implementing this teaching method in the classroom and assessing students' perceptions of it.

This study aims to bridge this gap by investigating how engineering students perceive the implementation of social constructivist practices within their classroom environments. By examining students' perspectives, this study aims to contribute to the ongoing discussion on effective pedagogical strategies and provide valuable insights into the potential of constructivism to improve engineering education. The aim of this research is to shed light on the advantages and difficulties associated with implementing constructivist pedagogy, ultimately aiding in the identification of effective methods for applying this approach within higher education.

2 LITERATURE REVIEW

2.1 Constructivism

Constructivism is a theory of learning and meaning-making that emphasizes individuals' active role in constructing their own understanding by interacting with new ideas and knowledge in relation to their existing beliefs and knowledge [20–21]. It emphasizes the significance of learners constructing meaning that is based on their prior knowledge and experiences and is influenced by individual factors such as personal methods and experiences, as well as social factors like the learning environment and society [22–23].

Constructivism, which is rooted in Piaget's theory of cognitive development, asserts that learners must construct their own knowledge based on prior knowledge and experiences. This is because knowledge is seen as residing within individuals and cannot be fully transferred from teachers to students [24]. Additionally, constructivism involves the internalization of knowledge through specific mechanisms, emphasizing the role of reflection and prior experiences in knowledge construction [25].

Constructivism provides a robust framework for comprehending how individuals internalize or develop new knowledge by actively engaging with facts and shaping their own interpretations [26–27]. Expertise is not transferred externally but is discovered and given meaning through social interaction, collaboration, and construction [28–29].

Overall, constructivism is a learning philosophy that emphasizes the active role of learners in creating knowledge through their intellectual development and personal experiences. It is a reaction to behaviorism and programmed instruction, presenting learning as an active, contextualized, and constructive process. Learners continuously create and test hypotheses, connect new knowledge to prior knowledge, and construct their own subjective or objective reality [30].

2.2 Cognitive constructivism and social constructivism

Cognitive constructivism, as proposed by Piaget [31], emphasizes the active creation of meaning by learners. Accordingly, when encountering contradictory information, learners experience cognitive dissonance and adjust their thinking to restore equilibrium. They integrate new knowledge or reorganize existing information to a more advanced level [30]. Piaget's approach integrates personal constructivism with cognitive reasoning, using logical interpretation and reasoning to connect information [32]. Perry built upon Piaget's work by introducing the concept of positionality and emphasizing that learners acquire information and perceive the world from different viewpoints [30]. The attainment of objective reality, or truth, is possible by transforming external reality into internal mental constructions [33]. The cognitive constructivist approach takes into account developmental stages and factors such as age, background, and education in the learning process [32]. According to Prawat and Floden [34], cognitive constructivism considers knowledge as an exploration of how the world functions, and its value is assessed based on its alignment with reality.

Social constructivism, according to Vygotsky [35], emphasizes the significance of social interaction in the learning process. Learning is viewed as a product of social interactions, and knowledge construction occurs through engagement with the social and cultural environment [30] [36]. Vygotsky's social constructivism emphasizes the importance of collaborative and socially interactive learning activities, while also highlighting the significance of understanding the historical context in which information is formed [35]. Social constructivism goes beyond individual logical reasoning and emphasizes the significance of knowledge derived from social interactions and communication [34] [37]. The argument is that social communication and interaction contribute to the development of thorough and dependable knowledge through shared understanding, testing, and evaluation. Communal meaning-making influences how objects and events in the world are interpreted [38].

2.3 Constructivism approach in teaching and learning

Constructivism in education encompasses "the neurological, psychological, and sociological aspects of learning." It acknowledges that knowledge construction is "a holistic process that involves social and affective elements," extending beyond mere behavioral or cognitive phenomena [39]. In the 21st century, education has shifted from a teacher-centered paradigm to learner-focused classrooms. Teaching methods are increasingly centered on the constructivist approach, which asserts that learners develop new insights by integrating their existing knowledge with new experiences [40].

Nevertheless, it is important to note that the constructivist theory should not be rigidly applied. Teachers should flexibly adapt the theory to align with their stated objectives and goals, which requires thoughtfulness and creativity to effectively implement it within their classrooms [41]. Recent advancements in information technology have provided a variety of tools that offer opportunities for meaningful learning both within and outside of the school. These tools facilitate a transformation in teaching, turning it into a dynamic process that focuses on learners actively engaging in the construction of knowledge [42].

Constructivism is in line with active learning approaches, emphasizing the significance of conversation, discussion, collaboration, and the construction of knowledge in the process of discovering and attributing new meaning to expertise [27–28]. It encompasses both cognitive constructivism, as exemplified by Piaget's work, which emphasizes the role of experience in learning, and social constructivism, influenced by Vygotsky, which underscores the critical role of social interaction in the construction of meaning [43].

Effective teaching and learning in constructivist classrooms requires teachers to understand the principles and pedagogy of constructivism [44]. They play a crucial role in creating motivating conditions, presenting problem situations, facilitating the acquisition and recall of existing knowledge, and prioritizing the learning process over focusing solely on the final outcome [45–46]. Constructivism empowers students to take responsibility for their learning, encourages reflection, and engages mental processes [47–48]. In the constructivist approach, teachers guide students in creating new information through exploratory activities, helping them make connections and draw their own conclusions [49]. This perspective is reflected in modern trends such as learner-centric education, collaborative learning approaches, and personalized learning agreements [50].

2.4 Constructivism in engineering classes

Engineering education is widely recognized as a rigorous process that focuses on cultivating knowledge, technical competence, and professional preparation [51]. Traditionally, engineering curricula prioritized the development of disciplinary knowledge and technical skills. Recent pedagogical advances, however, emphasize the importance of constructivism in engineering education, taking into account aspects such as "learning, students, lecturers, strategies, relations, motivation, evaluation, environment, and learning skills" [52]. Li et al. [53] emphasized the importance of meaningful interactions, such as group discussions and peer reviews, in online engineering modules. This social learning approach enhances the mastery of knowledge and its practical application. Additionally, research conducted by Hong and Cho [54] and Allamsetty et al. [55] provided additional evidence of the effectiveness of constructivism in engineering education, highlighting student engagement, problem-solving, and active learning. These findings suggest that constructivism can provide innovative solutions to meet the changing demands of engineering education.

2.5 Previous studies on constructivist teaching and learning

Constructivism is "a learning approach that emphasizes students' subjective construction, interpretation, and reorganization of knowledge" [47]. It encourages students to explore, discuss, and interpret knowledge while creating a learning environment that supports their development of theories and encourages reflection on acquired knowledge and skills [48]. This approach promotes student responsibility and engages mental processes such as questioning, problem solving, and research [56]. Research has shown that constructivist learning environments have positive effects on "creativity, metacognitive skills, critical thinking, and problem solving" [57–62].

Studies have found a positive correlation between students' academic performance and their perceptions of the classroom environment [63]. Comparisons between constructivist and conventional classrooms have shown that learner achievement is better in constructivist settings. Becker and Maunsaiyat [64] found that students instructed using a constructivist approach achieved higher scores on post-tests and delayed post-tests. Akar [65] observed improved knowledge retention and essay performance among students instructed using constructivist methods. Daloğlu et al. [66] demonstrated the effectiveness of constructivist learning in knowledge retention. Bimbola and Daniel [67] reported improved academic performance and higher retention rates in the constructivist group compared to the conventional lecture group.

From the perspectives of teachers and learners, several studies have revealed positive attitudes among teachers toward the implementation of constructivist teaching in the classroom [15–16]. A recent study by Loseñara and Loseñara [19] also found that students have a positive perception of constructivism across four out of five dimensions of the constructivism framework.

2.6 Conceptual framework

Constructivism has gained popularity in education because it empowers students as active constructors and users of knowledge [68]. This contemporary educational approach emphasizes student-centered learning and active student involvement, aligning with the evolving needs of the 21st century [27].

Earlier research has provided evidence supporting the effectiveness of constructivist learning strategies in promoting student interaction and producing positive outcomes [11–12]. In addition, numerous studies have demonstrated that constructivist learning environments have positive effects on "creativity, metacognitive skills, critical thinking, and problem-solving" [57–62]. There has been a focus on exploring the emotional and cognitive aspects of learning within the constructivist framework, including elements such as motivation and student conceptions [13]. Moreover, studies have demonstrated that constructivism is superior to traditional teaching methods in terms of academic achievement, motivation, and increased self-monitoring [14].

The objective of this study is to examine how engineering students perceive the integration of social constructivist pedagogy in teaching and learning, using a conceptual framework derived from the constructivist learning environment survey (CLES). The CLES, developed by Taylor et al. [69], is commonly utilized to assess students' perceptions of their classroom environment. It assesses crucial aspects of constructivist learning environments, such as personal relevance, shared control, expression of concerns, interaction, and the acknowledgment of advancing scientific and technological knowledge [69]. By building upon this framework, the study aims to gain insights into students' perspectives on the impact of a social constructivist approach on their educational experiences.

3 METHODOLOGY

3.1 Participants

This study involved engineering students from a university in Vietnam where social constructivist pedagogy has been implemented. The participants were selected using a non-probability convenience sampling method. Online surveys were conducted using Google Forms and distributed via email. Out of 480 survey invitations sent, 300 valid responses were received. The participants included 139 (46.3%) males and 161 (53.7%) females. Regarding the year of study, there were 103 (34.3%) first-year students, 118 (39.3%) second-year students, 49 (16.3%) third-year students, and 30 (10%) fourth- and last-year students. In order to gain a deeper understanding of the students' perception of constructivism in their class, 30 out of 300 participants were selected for in-depth interviews.

3.2 Instruments

The study used the CLES, a standardized questionnaire, to assess the integration of constructivism in the teaching of the science, technology, and society (STS) subject. In this context, the study focused on evaluating the technology course, which is a mandatory component of the university's engineering curriculum. The timing of enrollment in this course varies depending on students' specific majors, accommodating individuals from their first to their final year of study. The main goal of this course is to provide students with essential knowledge and skills in technology. The course spans a 10-week teaching period and utilizes a constructive approach, incorporating various interactive activities such as small group discussions, peer reviews, and student-led teaching.

The CLES questionnaire consisted of 30 items categorized into five dimensions of constructivism: Personal Relevance, Uncertainty of Technology, Shared Control, Critical Voice, and Student Negotiation. Each dimension comprised six questions, with the last one being reverse-scored. Participants used a five-point Likert scale (1-Almost Never, 2-Seldom, 3-Sometimes, 4-Often, 5-Almost Always) to indicate their perceptions of the frequency of relevant psychosocial factors in their class.

The CLES, developed by Taylor et al. [69], was designed to assess "the extent to which a classroom's environment aligns with constructivist epistemology." The decision to use the CLES questionnaire was based on its ability to measure essential dimensions of a constructivist learning environment, such as personal relevance, shared control, freedom to express concerns, student interaction, and the dynamic nature of knowledge. The questionnaire is consistent with the importance placed on student perceptions of the classroom environment [70]. It is in line with the learning environment structures outlined by Pintrich et al. [71], which are similar to the dimensions of a constructivist learning environment. Importantly, before distributing the questionnaire to the participants, a Cronbach's alpha test was conducted to assess its reliability. The analysis revealed coefficients higher than 0.7 for all items, demonstrating that the questionnaire is reliable and suitable for the research context [72].

3.3 Data collection and analysis

This study utilized a mixed-methods approach, integrating both quantitative and qualitative methods. Online surveys were conducted using the CLES questionnaire, which was distributed through Google Forms via email invitations. Data collection took place in May 2023, resulting in 300 valid responses. Additionally, 30 participants were selected from the initial pool for in-depth interviews.

To assess participants' perceptions of social constructivist practices in their class, the weighted mean was calculated based on their responses to the CLES questionnaire. The weighted mean provided an assessment of the extent to which constructivism was utilized in teaching. Data analysis was conducted using SPSS 25 software, utilizing descriptive analysis techniques. Key statistical metrics, such as frequency distributions, means, and standard deviations, were used for each item. Subsequently, out of the 300 student responses, 30 individuals with high mean values were selected for one-on-one interviews. The interviews were recorded, coded, and transcribed for thorough analysis.

4 RESULTS

4.1 Students' perception of personal relevance in class

The results presented in Table 1 illustrate students' perceptions of the personal relevance of their technology class. The findings revealed that students generally perceive their technology education to be personally relevant in various ways. Firstly, they reported frequently learning about the world outside of school (M = 4.21, SD = 0.991). Moreover, students recognized that their new learning often begins with problems and scenarios related to the world outside of school (M = 4.49, SD = 0.752). They also commonly understood how technology can be a part of their lives outside of school (M = 4.51, SD = 0.691) and felt that their comprehension of the world beyond school was improved through their technology education (M = 4.63, SD = 0.665). Although slightly lower, students found the technology class to be a source of interesting information about the world outside of school (M = 4.16, SD = 0.835). However, a subset of students occasionally expressed the perception that the technology knowledge they acquire has limited relevance to their lives outside of the school environment (M = 2.67, SD = 0.718). This suggests that some students may not fully relate the content learned in their technology class to their daily experiences. The overall mean score for all statements was 4.11 (SD = 0.358), indicating that students generally found their technology class to be personally relevant. These results demonstrate the significance of integrating real-world connections and applications in technology education. Students recognize the value of connecting their learning to their experiences outside of school.

Table 1. Mean scores of students' perceptions of personal relevance of technology class

Statement	Mean (M)	SD	Interpretation
"I learn about the world outside of school"	4.21	.991	Often
"My new learning starts with problems about the world outside of school"	4.49	.752	Often
"I learn how technology can be part of my out-of-school life"	4.51	.691	Often
"I get a better understanding of the world outside of school"	4.63	.665	Often
"I learn interesting things about the world outside of school"	4.16	.835	Often
"What I learn has nothing to do with my out-of-school life"	2.67	.718	Seldom
Overall Mean	**4.11**	**.358**	**Often**

The interview findings revealed that a majority of the interviewees agreed that the knowledge they gain in class is relevant to their lives outside of school. However, the mean score of the last statement indicated that students perceived that what they learn in technology class has limited relevance to their lives outside of the class. This connection makes the class even more engaging because students can apply what they learn to real-life problems they encounter.

Student 3: "*I particularly enjoy the role-play activities in the class because they provide us with opportunities to learn from real-world problems. They enhance our critical thinking and creative thinking skills as we work toward finding solutions*."

Student 8: "*The discussion activities in the class enable us to gather information and develop practical skills that are undoubtedly valuable in our real lives*."

Student 9: "*I believe the knowledge I gained in class is valuable in my daily life*."

4.2 Students' perception of uncertainty of technology

The findings presented in Table 2 indicate that most students agreed with the statements. Firstly, they often recognized that technology cannot provide perfect solutions to all problems (M = 4.20, SD = 0.871). Moreover, the students showed a strong consensus that technology has evolved over time (M = 4.16, SD = 0.906). They also commonly acknowledged the influence of people's values and opinions on technological knowledge (M = 4.28, SD = 0.835). Furthermore, students often mentioned that they learn about the diverse technologies utilized by individuals in different cultures (M = 4.22, SD = 0.962). Additionally, they perceived modern technology as distinct from the technology of the past (M = 4.04, SD = 0.926). Furthermore, students acknowledged that technology involves creating theories, albeit with a slightly lower mean score of 4.25 (SD = 0.869). The average score for all statements was 4.19 (SD = 0.395), indicating a strong consensus among students about the presence of uncertainty in their technology class. These results imply that students perceive technology as a dynamic and evolving field, influenced by human values, culturally diverse, and characterized by the creation of theories.

Table 2. Mean scores of students' perceptions of uncertainty of technology

Statement	Mean (M)	SD	Interpretation
"I learn that technology cannot provide perfect answers to problems"	4.20	.871	Often
"I learn that technology has changed over time"	4.16	.906	Often
"I learn that technology is influenced by people's values and opinions"	4.28	.835	Often
"I learn about the different technology used by people in other cultures"	4.22	.916	Often
"I learn that modern technology is different from the technology of long ago"	4.04	.962	Often
"I learn that technology is about creating theories"	4.25	.869	Often
Overall Mean	**4.19**	**.395**	**Often**

During the in-depth interviews, it was discovered that students recognize the evolving nature of technology over time. They also acknowledged that the comprehension of technology is not confined to tangible concepts, as it can be shaped by people's values, opinions, and cultural factors. It became evident that technology does not always provide definitive answers to all the problems people encounter in everyday life, and it is susceptible to the influence of their values and opinions.

One student (Student 5) expressed that during the discussions and problem-solving activities in the class, they learned that technology cannot be rigidly applied to every situation. Another student (Student 10) stated that technology encompasses more than just a collection of technical and objective facts. In class, they discovered how technological knowledge can challenge established societal views on ethical practices. They also realized that evolving ethical stances can, in turn, influence the direction of technology research.

4.3 Students' perception of critical voice in class

The results presented in Table 3 demonstrate how students perceive their ability to express their critical voice in various aspects of their learning experience. The mean scores indicated that students find it acceptable to occasionally inquire why they need to learn certain topics (M = 3.58, SD = 0.569). Similarly, students occasionally indicated that they feel comfortable questioning the way they are being taught (M = 3.25, SD = 0.651). Moreover, students reported that it is sometimes acceptable to complain about teaching activities that are confusing (M = 3.54, SD = 0.544). They also expressed that it is often acceptable to complain about anything that hinders their learning (M = 4.00, SD = 0.677). Moreover, students perceived it as appropriate to express their opinions (M = 4.02, SD = 0.649) and to speak up for their rights (M = 4.00, SD = 0.672). The overall mean was 3.73 (SD = 0.328), indicating that students generally perceive their ability to express their critical voice as occasional rather than frequent in the class. These findings emphasize the significance of establishing an environment that fosters students' ability to express their critical perspectives and participate in meaningful discussions.

Table 3. Mean scores of students' perceptions of critical voice of technology class

Statement	Mean (M)	SD	Interpretation
"It's OK for me to ask the teacher: Why do I have to learn this?"	3.58	.569	Sometime
"It's OK for me to question the way I'm being taught"	3.25	.651	Sometime
"It's OK for me to complain about teaching activities that are confusing"	3.54	.544	Sometime
"It's OK for me to complain about anything that prevents me from learning"	4.00	.677	Often
"It's OK for me to express my opinion"	4.02	.649	Often
"It's OK for me to speak up for my rights"	4.00	.672	Often
Overall Mean	**3.73**	**.328**	**Sometime**

The perceptions of engineering students regarding critical feedback in their technology class varied. More than half of the students confirmed that they generally had the opportunity to express their preferences for teaching and learning activities in the classroom. However, some students have expressed feeling demotivated to speak up and have questioned the relevance of certain topics being taught. The majority of students rejected these activities, deeming them irrelevant to their needs.

A couple of students (Student 6 and Student 29) mentioned that their teacher frequently organized activities aimed at fostering self-reflective thinking, which they found interesting and beneficial. However, another student (Student 22) acknowledged that there are some topics that they perceive as irrelevant to learn about. However, they hesitated to discuss these matters with their teacher, believing it would be challenging to bring about changes in the curriculum.

4.4 Students' perception of shared control in class

The results presented in Table 4 pertain to students' perceptions of shared control in the classroom. This measures the extent to which students feel involved in decision-making processes, such as planning their learning, assessing their progress, and selecting suitable activities [69]. The analysis results indicate that students perceived their level of shared control as infrequent. Across all items, the mean scores indicate a low level of perceived participation in shared control. Students reported infrequently helping the teacher plan their learning (M = 2.56, SD = 0.560), deciding their level of understanding (M = 2.47, SD = 0.581), determining suitable activities (M = 2.60, SD = 0.585), allocating time for learning activities (M = 2.55, SD = 0.579), selecting activities (M = 2.48, SD = 0.539), and assessing their own learning (M = 2.58, SD = 0.774). The overall mean score of 2.54 (SD = 0.262) indicates that students generally perceive their participation in shared control as infrequent or restricted in the classroom. These results indicate the need to improve student participation and shared decision-making in various aspects of their learning experience. It is noteworthy that all items received similar mean scores, indicating that students perceive a lack of control across various dimensions. This finding emphasizes the significance of providing opportunities for students to have more control over their learning processes, fostering a sense of ownership and agency.

Table 4. Mean scores of students' perceptions of shared control in class

Statement	Mean (M)	SD	Interpretation
"I help the teacher to plan what I'm going to learn"	2.56	.560	Seldom
"I help the teacher to decide how well I am learning"	2.47	.581	Seldom
"I help the teacher to decide which activities are best for me"	2.60	.585	Seldom
"I help the teacher to decide how much time I spend on learning activities"	2.55	.579	Seldom
"I help the teacher to decide which activities I do"	2.48	.539	Seldom
"I help the teacher to assess my learning"	2.58	.774	Seldom
Overall Mean	**2.54**	**.262**	**Seldom**

When asked about the extent to which students perceived shared control with their teacher in terms of their learning activities, most of the interview participants expressed that they had limited opportunities to participate in the classroom management of their own learning. They felt that their input in selecting teaching strategies was often disregarded. However, some students admitted that as the course progressed, there were instances where the teacher encouraged them to modify their teaching strategies. One student (Student 1) mentioned the challenges students encounter when requesting changes to the teaching methods or grading assessments from the teacher. A couple of students (Student 18 and Student 25) shared that they occasionally suggested ideas for modifying the social constructivism teaching and learning method in the class. However, they felt that their suggestions did not result in significant changes or increased effectiveness to the extent they desired.

4.5 Students' perception of students' negotiation in class

Table 5 presents the results of students' perceptions of negotiation among students in their class. The Student Negotiation Scale, as conceptualized in this study, assesses the extent to which students are given the chance to participate in discussions, share ideas, and work together with their peers. It involves activities such as discussing problem-solving approaches, explaining understandings, and seeking explanations from others.

The results indicate that students perceive a high level of negotiation among their peers in the classroom. All items in the survey received "often" responses, indicating that students frequently engage in negotiation activities. The mean scores indicate that students reported having the opportunity to converse with other students (M = 4.03, SD = 0.890) and participate in discussions about problem-solving (M = 4.38, SD = 0.786). Furthermore, students expressed that they frequently explain their understandings to their peers (M = 4.28, SD = 0.900) and ask others to explain their thoughts (M = 4.31, SD = 0.834). Similarly, they reported that other students ask them to explain their ideas (M = 4.40, SD = 0.834) and provide explanations of their own ideas (M = 4.07, SD = 0.895). These findings suggest that a positive classroom climate encourages open communication, collaboration, and knowledge sharing among students. The high overall mean score of 4.24 (SD = 0.429) reflects the importance placed on student-to-student interaction and the active involvement of students in constructing knowledge together. By engaging in discussions, students have opportunities to refine their understanding of concepts, consider alternative perspectives, and collectively build knowledge.

Table 5. Mean scores of students' perceptions of students' negotiation in class

Statement	Mean (M)	SD	Interpretation
"I get the chance to talk to other students"	4.03	.890	Often
"I talk with other students about how to solve problems"	4.38	.786	Often
"I explain my understandings to other students"	4.28	.900	Often
"I ask other students to explain their thoughts"	4.31	.834	Often
"Other students ask me to explain my ideas"	4.40	.834	Often
"Other students explain their ideas to me"	4.07	.895	Often
Overall Mean	**4.24**	**.429**	**Often**

During the interview, students reported having frequent opportunities to negotiate with their peers in the technology class. All engineering students agreed that in this specific class, they felt increasingly at ease sharing their personal thoughts and opinions because they realized that their viewpoints would be listened to in an empathetic manner. During small group activities, students generally expressed their emotions and ideas assertively yet constructively as they engaged in the process of reaching a consensus on controversial issues.

One student (Student 12) showed a high level of confidence in sharing their own opinions with other group members and the entire class. They observed that their ideas were given genuine consideration and attention. In addition, other students (Student 26 and Student 29) highlighted the comfort they experienced within their group when expressing disagreement with others' opinions or ideas. They emphasized that the discussions were constructive and assisted them in identifying the most suitable solutions for their problems. Through these interactions, they discovered the value of learning from their peers.

5 DISCUSSION

The findings of this study reveal that students often perceive three out of five dimensions of constructivism. Among them, student negotiation emerged as the dimension with the highest perceived level of occurrence. This finding emphasizes the significance of promoting student communication and collaboration, allowing them to share their ideas, discuss problem-solving strategies, and explain their understandings to peers. These results align with previous research that emphasizes the significance of student engagement and active participation in their learning journey [18] [69] [73] [74]. Leow and Neo [75] argued that the prevalence of student negotiation activities supports the constructivist approach, which emphasizes the social construction of knowledge and active student engagement. Educators should foster student negotiation skills by encouraging group discussions, cooperative problem-solving, and peer presentations. Engaging in such activities enhances student engagement, deepens understanding, and cultivates vital skills in communication, critical thinking, and collaboration.

In contrast, the occurrence of the shared control dimension was perceived as rare, which is consistent with the findings of several studies [19] [74]. This indicates that students perceive limited control over the planning and decision-making aspects of their learning experiences. This outcome may be attributed to cultural differences, as Asian students often exhibit passive learning habits and a strong reliance on their instructors for content delivery, particularly in traditional classroom settings [76].

This finding emphasizes the importance of teachers and educational policymakers reassessing traditional power dynamics in the classroom and working towards a more equitable distribution of control between teachers and students. Empowering students to participate in the planning of their learning activities can cultivate a sense of ownership and engagement in the learning journey [77]. By promoting shared control, educators can create a student-centered and engaging learning environment where students feel motivated, empowered, and invested in their own education [78]. In light of these findings, educators should consider implementing strategies that promote student participation and shared control. This may involve engaging students in co-designing learning activities, offering choices and autonomy, and cultivating a collaborative and inclusive classroom culture. By doing so, educators can facilitate the development of critical 21st-century skills and create an environment where students feel valued and empowered as active participants in their own education.

Regarding students' perceptions of personal relevance, the majority of items in the Personal Relevance Scale were frequently perceived. This suggests that students recognized the connection between technology learning and their everyday lives, consistent with several previous studies [19] [79]. These findings support the idea that learning experiences should be designed to address real-world contexts and establish meaningful connections to students' interests and experiences. Incorporating students' out-of-school experiences and interests into technology instruction can enhance their engagement and foster a deeper understanding of technological concepts.

Furthermore, the findings related to the Uncertainty of Technology dimension indicated that students frequently encountered uncertainty and ambiguity in their technology class, which is inherent in the technological inquiry process. This result, in accordance with previous studies, suggests that students were actively engaged in exploring new concepts and grappling with the complexity and uncertainty inherent in scientific and technological investigations [19] [74].

The findings related to the Critical Voice dimension were diverse, with some items being frequently perceived while others were only occasionally perceived. While students felt encouraged to challenge and express concerns, there is a need for improvement in establishing a consistent environment where students feel empowered to voice their opinions. As revealed in a study by Loh and Teo [76], it is essential to maintain classroom harmony to create conducive learning environments in Asian classrooms. Hence, it's unsurprising that students in Asian countries such as Vietnam do not question instructors' pedagogical strategies in this study. Similarly, students in a study [17] indicated a preference for learning environments that are characterized by a welcoming atmosphere, promote collaboration between students and teachers, and provide engaging yet challenging activities. These findings underscore the significance of creating an environment that encourages students to express their critical perspectives and facilitates meaningful discussions [74]. Educators should foster a supportive and inclusive classroom environment where students feel empowered to ask questions, challenge concepts, give feedback, and actively engage in the learning process. This promotes critical thinking, deepens understanding of technological concepts, and motivates students to actively contribute to their learning journey.

6 CONCLUSION

This study investigated the perspectives of engineering students on the integration of social constructivist practices in their technology classrooms. The study employed a mixed-methods approach, combining quantitative data gathered through an online survey with qualitative data obtained through semi-structured interviews. The findings of this study provide valuable insights into how engineering students perceive social constructivist practices within their classroom environments. The results suggest that although some aspects of constructivist principles have been adopted, there is still potential for further improvement and integration of these practices in the classroom. Among the dimensions examined, students frequently identified student negotiation, personal relevance, and the uncertainty surrounding technology. This emphasizes the importance of promoting student engagement and creating links between learning and real-world situations. However, the dimension of critical voice yielded mixed results, highlighting the significance of fostering an environment that encourages students to voice their concerns, ask questions, and participate in meaningful discussions. In contrast, the dimension of shared control was perceived as rarely occurring, indicating the need to reassess power dynamics in the classroom and empower students in the planning and management aspects of their learning experiences. These findings suggest the necessity for additional investigation and integration of social constructivist approaches to emphasize the improvement of student engagement, foster critical thinking, and reassign power within the classroom environment.

7 LIMITATION AND RECOMMENDATION

This study has encountered several limitations. Initially, the study focused on engineering students, which may limit the generalizability of the findings to other academic fields or educational levels. Secondly, the study relied on self-reported perceptions, which could be susceptible to individual biases or subjective interpretations. Furthermore, the study was conducted within a specific context, and it is possible that cultural or contextual factors may have influenced the results.

Therefore, several recommendations can be proposed for future research. Firstly, similar studies should be conducted at various educational levels, including primary and secondary education, to examine the early implementation of constructivist practices. In addition, research should explore the effectiveness of specific strategies and interventions that improve student negotiation, shared control, personal relevance, and critical voice. Finally, conducting longitudinal studies to examine the long-term impact of constructivist practices on academic achievement and career outcomes would offer valuable insights into their sustainability. By implementing these recommendations, future research can contribute to the continuous development and implementation of constructivist practices in diverse educational settings, promoting critical thinking, collaboration, and meaningful connections to the real world.

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