Empowering Educators Through Technology-Enhanced Cooperative Problem-based Learning (TE-CPBL)

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Abstract
In today's fast-changing educational landscape, there is a need for teaching approaches that combine technology with active, student-centered learning. This study examines how Technology-Enhanced Cooperative Problem-Based Learning (TE-CPBL) workshops can transform educators' teaching practices. Based on constructivist learning theory, the research explores how TE-CPBL training impacts teaching strategies. Using qualitative methods, data were collected through reflective journals and post-workshop surveys from educators who attended the workshops. The findings highlight significant improvements in teaching approaches, including increased confidence in using tools like Canva and ChatGPT, better integration of technology into pedagogy, and a stronger focus on student-centered learning. While participants faced challenges such as time constraints and limited institutional support, they reported greater teaching effectiveness and motivation to apply TE-CPBL strategies. This study emphasizes the importance of constructivist-based professional development in helping educators adopt innovative practices to meet modern educational needs.

Keywords: cooperative problem-based learning (CPBL); Canva; ChatGPT; teaching effectiveness; technology enhanced pedagogy.

Introduction

In the rapidly evolving landscape of education, there is an increasing demand for teaching methodologies that not only deliver content but also foster critical thinking and problem-solving skills among students. Traditional teaching and learning (T&L) strategies, often characterized by passive learning and teacher-centred approaches, have been criticized for failing to equip students with these essential competencies. Despite the recognized need for pedagogical transformation, many educators remain resistant to changing their T&L strategies due to a lack of incentives, perceived increases in workload, and insufficient training in innovative educational methods (Bronkhorst et al., 2014 & Bear, 2013)

The integration of technology in education offers a promising avenue for addressing these challenges and enhancing teaching effectiveness. Digital tools like ChatGPT and Canva can streamline the preparation process, facilitate engaging and interactive learning experiences, and support the implementation of more student-centred approaches. However, simply introducing these technologies is not enough; educators must be adequately trained to utilize them effectively within pedagogical frameworks that promote active learning (Ertmer & Ottenbreit-Leftwich, 2010)

Cooperative Problem-Based Learning (CPBL) represents one such pedagogical approach that aligns with the principles of constructivist learning, emphasizing collaboration, real-world problem-solving, and the active construction of knowledge (Yusof et al., 2012). However, the successful integration of CPBL strategies and technological tools requires targeted professional development opportunities for educators. Workshops that focus on Technology-Enhanced Cooperative Problem-Based Learning can provide educators with the necessary skills and knowledge to transform their teaching practices and foster learner-centred environments. For example, a TE-CPBL workshop for STEM educators introduced a scenario requiring participants to simulate disaster relief planning. Using ChatGPT for brainstorming logistics and Canva for creating visual communication materials, educators practiced facilitating these tools in a student-centered activity. This hands-on experience equipped them with

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practical methods for encouraging collaboration and critical thinking in their own classrooms.

This study aims to investigate the role of Technology-Enhanced CPBL workshops in facilitating this pedagogical shift among educators by gathering the qualitative responses from these educators and identifying necessary supports and scaffolding to ensure this approach can be realised.

Literature Review

Cooperative Problem-Based Learning (CPBL) is grounded in constructivist learning theory, which posits that learners construct their own understanding and knowledge of the world through experiencing things and reflecting on those experiences (Mohd-Yusof et al., 2011). CPBL emphasizes collaboration among students, the application of knowledge to real-world problems, and the role of the educator as a facilitator rather than a direct source of information. Research has documented the positive impacts of CPBL in enhancing student engagement, critical thinking, and problem-solving skills across various educational settings, underscoring its effectiveness in fostering deeper learning.

The CPBL process begins with the formation of diverse learning groups. These groups are typically organized to ensure a mix of abilities, backgrounds, and perspectives. This diversity is critical to the cooperative aspect, as it encourages students to value different viewpoints and learn from each other's strengths and weaknesses. It was suggested that heterogeneous grouping can lead to improved problem-solving skills and greater empathy among group members (Johnson & Johnson, 2009; Hmelo-Silver, 2004).

Then, a well-designed, real-world problem is introduced to the students. This problem should be complex, engaging, and relevant to the learners' lives or future professional practices. It serves as the focal point for learning and discussion, engaging students' curiosity and motivating them to seek solutions. Research emphasizes the importance of the problem's relevance and authenticity, as these factors significantly influence students' engagement and learning outcomes (Barrows, 2002; Savery, 2006).

Once the problem is introduced, students explore it from different angles, discussing initial thoughts and possible solutions. This phase is crucial for identifying learning gaps and formulating learning objectives. According to literature, guiding students to identify their own learning needs can enhance self-directed learning skills and deepen their understanding of the subject matter (Dolmans et al., 2005).

Learners then engage in individual and collective research to address the identified learning needs. This stage is marked by the gathering of information, analysis of data, and synthesis of knowledge. Cooperative learning strategies, such as jigsaw or think-pair-share, can be effectively employed here to facilitate information sharing and collaborative learning (Aronson & Patnoe, 1997).

In the next step, groups develop solutions to the problem based on their research and analysis. This step allows students to apply their new knowledge and skills in a practical context, fostering deeper learning and innovation. Solutions are then presented to the class, providing an opportunity for feedback and further discussion. The literature highlights the role of this stage in developing students' communication skills and enhancing their ability to work effectively in teams (Fink, 2003).

The final stage involves reflection on the learning process and assessment of the solutions. Students reflect on what they have learned, how they have learned, and the effectiveness of their problem-solving strategies. This phase is critical for consolidating learning and fostering metacognitive skills. In addition, peer and self-assessment can be integrated to promote accountability and self-regulation (Boud & Falchikov, 2006).

Constructivist Learning Theory emphasizes that learners construct knowledge through active engagement with tasks, social interactions, and real-world contexts" (Mohd-Yusof et al., 2011). In the workshops, these principles were operationalized by structuring activities into scaffolded stages, such as initial readings to build foundational knowledge, collaborative problem-solving sessions using ChatGPT for idea generation, and Canva for creating visual prototypes. These tools served as cognitive scaffolds, enabling participants to actively construct and apply knowledge in authentic teaching scenarios (Farrelly & Baker, 2023).

Comparative studies between problem-based learning (PBL) and traditional learning methods have shown varied outcomes across different fields of study. In nursing and dental education, PBL has been found to be more effective in developing students' problem-solving skills, critical thinking, and internal locus of control, leading to a preference for PBL over traditional methods. Specifically, PBL improved nursing students' locus of control and problem-solving skills and was found to be an engaging, realistic, and beneficial approach for students in terms of promoting active participation and deeper understanding of the material.

However, in areas such as the obstetrics and gynecology clerkship, no significant differences in student performance were observed between the two learning approaches. These findings suggest that while PBL can enhance certain educational outcomes and is favored by students in certain contexts, its effectiveness can vary based on the subject matter and specific educational settings (Günüşen, Serçekuş, & Durmaz Edeer, 2014; Cooke & Moyle, 2002; Distlehorst & Robbs, 1998; Oderinu et. al., 2020; and Phelan, Jackson, & Berner, 1993).

Nonetheless, unlike traditional, lecture-based methods that often emphasize rote memorization,

CPBL fosters critical thinking and problem-solving by engaging learners in authentic, contextualized challenges. For example, while traditional methods may involve passive note-taking during a lecture, CPBL activities require active participation, such as brainstorming solutions to real-world classroom management issues using ChatGPT. Comparative studies have shown that such active learning strategies lead to higher levels of engagement and retention (Barrows, 1996; Dolmans et al., 2005; Greenhow & Lewin, 2016).

Despite the benefits of active, student-centered learning strategies like CPBL, many educators face challenges in adopting these methods due to constraints like time, resources, and lack of institutional support. Teachers often remain within the confines of traditional practices due to ingrained habits and uncertainty towards new approaches. The transition towards more innovative teaching, such as Problem-Based Learning (PBL), shows promise in shifting teaching practices towards more student-centered approaches, although educators' beliefs about technology use may remain static (Park & Ertmer, 2007).

The integration of technology in education, through tools like ChatGPT and Canva, provides significant opportunities to enhance engagement, accessibility, and collaboration in teaching and learning. The use of digital technologies supports the CPBL framework effectively, facilitating research, idea generation, and solution presentation, while also demanding the development of digital literacy among educators and students to ensure effective pedagogical alignment (Nawi et al., 2019).

Canva has notably impacted educational environments by enabling the creation of visually engaging content, thus promoting a more interactive learning space. The recent survey by Canva underscores the growing interest among teachers in integrating AI into their classrooms to enhance lesson productivity, student creativity, and reduce administrative tasks. However, a significant gap in how to effectively utilize these tools indicates the necessity for greater support and training in these technologies (Canva, 2023).

Furthermore, the introduction of Canva's suite of educational tools and features, including customizable classroom resources and AI-powered tools, marks a considerable advancement in educational technology. This expansion is geared towards making digital and design literacy more accessible, addressing teacher uncertainties around AI integration, and ensuring a safer, more inclusive learning environment (Small Business Trends, 2023).

The introduction of Generative AI technologies like ChatGPT in the educational sector offer opportunities to revolutionize instructional methods and personalize learning experiences. However, their integration into the educational sector requires careful consideration of ethical implications such as data privacy, bias, and the impact on educators. These concerns must be navigated to ensure responsible and equitable use of AI in education contexts (Hill & Narine, 2023).

Nevertheless, Artificial Intelligence (AI) tools, such as ChatGPT, align seamlessly with constructivist principles by offering personalized and dynamic learning experiences. These tools facilitate active learning derived from personal experiences and prior knowledge, thereby enhancing student engagement and metacognitive skills (Grubaugh, Levitt & Deever, 2023).

From a constructivist perspective, these tools function as scaffolding mechanisms. ChatGPT, for instance, facilitates brainstorming and the synthesis of ideas, allowing participants to bridge knowledge gaps and generate innovative solutions. Canva, on the other hand, enables visual representation and iterative design processes, aligning with Vygotsky's Zone of Proximal Development by supporting learners as they progress from conceptual understanding to practical application (Nawi et al., 2019 & Isik, 2018).

In educational environments, fostering a culture of responsible AI use is crucial. This involves critically evaluating AI tools, aligning them with educational objectives, and addressing transparency, oversight, fairness, and privacy. Building social generative AI for education requires understanding its social implications and ensuring systems respect human teachers and learners (Sharples, 2023).

Despite challenges, generative AI can positively impact education by streamlining tasks and providing support beyond traditional settings. Clear guidelines and best practices are essential to navigate ethical and practical challenges, ensuring students produce original content and educators integrate AI tools ethically (Farrelly & Baker, 2023).

Therefore, the future of AI in education will depend on how well these ethical, privacy, and equity challenges are addressed. Ensuring that educators can incorporate AI tools effectively while maintaining academic integrity and ethical standards is crucial for leveraging AI's potential in enhancing learning experiences (Zohny, McMillan & King, 2023).

A study by Lin, Y. and Wang, W (2024) investigates the role of completeness and understandability in enhancing the effectiveness of collaborative problem-based learning (PBL) through wiki technologies. Drawing on social capital and social identity theories, the research examines how these factors influence trust, social identity, and perceived PBL performance among learners. A sample of 240 undergraduate students participated in PBL activities, leveraging wikis for coauthoring, corevising, and collaborative problem-solving. The findings reveal that completeness and understandability significantly enhance trust and social identity, which in turn improve perceived PBL performance. The study highlights the critical role of relational capital, emphasizing the importance of fostering trust and shared identity in online collaborative learning

environments. Practical implications suggest that educators incorporate well-designed wiki platforms to support interaction, critical thinking, and deeper engagement in PBL tasks. provides empirical evidence supporting the role of digital platforms like wikis in fostering collaboration, trust, and social identity—elements aligned with constructivist learning principles. Specifically, it complements discussions on using tools like Canva and ChatGPT by illustrating how digital platforms enable effective collaborative learning and critical thinking.

Professional development programs for the educators are crucial in aiding educators to blend CPBL and technological advancements such as Canva and Generative AI into their teaching strategies effectively. Such programs, through experiential learning opportunities like professional development workshops, can lead to substantial pedagogical shifts, fostering environments that prioritize learner-centered approaches. The successful adoption of such instructional materials and methods underscores the transformative impact on teaching practices and educator mindsets (Czajka & McConnell, 2019).

Application Method

This study employed a qualitative research design to explore the impact of Technology-Enhanced Cooperative Problem-Based Learning (CPBL) workshops on educators' teaching strategies and their adoption of technology-enhanced learning environments. The workshops implemented these principles by structuring activities to mirror real-world problem-solving scenarios. For example:

1. **Scaffolding and Zone of Proximal Development (ZPD)**: Participants began with foundational reading materials (e.g., Constructive Alignment and Vygotsky's ZPD) to ground their understanding. Facilitators provided guidance as participants progressed from simpler tasks (individual exploration) to more complex group activities (solution synthesis), ensuring a gradual transfer of responsibility for learning.
2. **Collaborative Knowledge Construction**: The integration of peer activities, such as creating team mind maps using Canva, enabled participants to exchange diverse perspectives. This approach reflects the social constructivist belief that collaboration enhances cognitive development by exposing learners to varied viewpoints (Johnson & Johnson, 2009).
3. **Authentic Problem-Solving**: The workshop's design challenged educators to address real-life classroom scenarios, such as designing STEM-based lessons that integrate ChatGPT for brainstorming and Canva for creating visual presentations. These tasks align with Barrows' (2002) emphasis on problem relevance and application in constructivist learning environments.

Digital tools like Canva and ChatGPT play a pivotal role in enhancing CPBL by fostering creativity, interactivity, and collaboration. As Hannafin and Land (1997) argue, technology can serve as a scaffold that enables learners to engage more deeply with the learning process. For instance:

- **Canva** facilitated the creation of visual artifacts, such as project mind maps and team presentations, allowing participants to actively engage with the material.
- **ChatGPT** supported brainstorming and iterative solution development, promoting analytical thinking and collaborative ideation.

These tools operationalize constructivist principles by enabling learners to actively engage with content, co-construct knowledge, and reflect on their learning.

These professional development workshops' structure aligns with theoretical models like Savery's (2006) problem-based learning process and Vygotsky's ZPD. The deliberate use of scaffolding techniques, such as breaking down tasks into manageable stages (e.g., problem identification, solution synthesis), ensured participants could navigate complex problems while progressively building confidence. Additionally, reflective activities anchored learning by encouraging participants to consolidate insights and evaluate their application in real-world teaching contexts.

In order to analyse the effectiveness of these workshops, qualitative approach was chosen to gain in-depth insights into participants' experiences, perceptions, and reflections on the workshops. The research was guided by two main frameworks: the Constructivist Learning Theory, which underpins CPBL, and Kirkpatrick's Model, which was used to evaluate the outcomes of the professional development workshops.

This study involved eight educators selected through purposive sampling to ensure diversity across teaching backgrounds, disciplines, and levels of experience with technology-enhanced learning. Participants included schoolteachers, college instructors, and university lecturers from STEM and non-STEM disciplines, with teaching experience ranging from 1 to 20 years. This sampling approach aimed to capture a wide range of perspectives on the integration of CPBL and technology in diverse educational contexts. Prior to the study, all participants provided informed consent, and measures were taken to ensure their anonymity and confidentiality throughout the research process.

Data were collected using two primary methods: reflective journals using Gibbs Reflective Cycle and delayed post-workshop qualitative surveys. Participants were asked to maintain reflective journals throughout the duration of the workshops,

documenting their thoughts, experiences, and perceived challenges and benefits of implementing CPBL strategies and technology tools in their teaching. Following the completion of the workshops, participants completed a qualitative survey designed to elicit detailed reflections on their learning outcomes, changes in teaching practices, and the integration of technology into their pedagogical approaches. The qualitative survey questions were aligned with the objectives of the Constructivist Learning Framework and Kirkpatrick's Model to ensure comprehensive coverage of the study's research questions.

The qualitative data from reflective journals and post-workshop surveys were analyzed using thematic analysis, guided by Gibbs' Reflective Cycle and Kirkpatrick's Model. Gibbs' Reflective Cycle provided a framework to explore participants' thoughts, challenges, and learning outcomes at each stage of the CPBL workshop. For example, reflections were coded for insights into emotional responses (initial confusion vs. clarity) and practical takeaways (strategies for implementing CPBL). Kirkpatrick's Model was used to evaluate learning outcomes at Level 2 (Learning) and Level 3 (Behavior), assessing shifts in pedagogical practices and technology integration post-workshop.

ChatGPTPlus was utilized to support data coding and interpretation by identifying patterns and recurring phrases in participant reflections. For instance, phrases like 'aha moments' were flagged as indicators of conceptual breakthroughs, while terms such as 'team collaboration' and 'student engagement' informed themes related to pedagogical strategies. The use of ChatGPTPlus expedited the thematic analysis process while ensuring consistency in coding.

The study was conducted in accordance with ethical standards for educational research. Participants were informed of the study's purpose, their rights as participants, and the confidentiality of their responses.

Findings and Discussions

This section presents the findings from the study, which include initial reflections from participants following the Cooperative Problem-Based Learning (CPBL) workshops and results from the post-delayed survey. The analysis is grounded in constructivist learning theory and Kirkpatrick's model, allowing for an in-depth understanding of the educators' experiences and the effectiveness of the workshops.

Table 1 depicts the findings made from the initial reflection from the Gibbs Reflective Cycle analysis of the selected participants after they went through the 3-Days CPBL workshop designed for them. Several themes were identified inductively from their reflections which are as follows:

1. Initial Confusion and Clarity Progression
2. Understanding and Implementation of PBL
3. Sharing and Collaboration
4. Role of Technology (ChatGPT and Canva)
5. Facilitator's Role and Scaffolding Techniques
6. Planning and Structuring Learning Activities
7. Student Engagement and Management
8. Personal Growth and Educator Strategies

Table 1. Initial Reflections Thematic Analysis

Themes	Summary	Verbatim Responses
Initial Confusion and Clarity Progression	Participants initially confused but gained clarity later.	*"Perasaan masa mula-mula...hari kedua dah ada jawapan kepada persoalan sebelumnya."*
Understanding and Implementation of PBL	Gained insights into practical PBL implementation.	*"Sepanjang 3 hari saya telah dapat memahami bagaimana untuk melaksanakan Problem Based Learning..."*
Sharing and Collaboration	Plan to share knowledge and collaborate.	*"Rancangan saya, mungkin berkongsi dengan kawan2..."*
Role of Technology	Utilized technology for effective learning.	*"Dapat mengetahui kelebihan chat gpt...dapat mengetahui apps yg terkini..."*
Facilitator's Role and Scaffolding Techniques	Recognized importance of facilitation and scaffolding.	*"...dapat mempelajari bagaimana untuk menjadi seorang fasilitator yang tenang dan mampu menyelesaikan konflik pelajar."*
Planning and Structuring Learning Activities	Improved planning and structuring of activities.	*"Mula merancang dengan lebih baik tugasan yang hendak diberikan kepada para pelajar dengan menggunakan ChatGPT."*
Student Engagement and Management	Learned to engage and manage students effectively.	*"...bagaimana mengawal karenah pelajar, menghargai kreativiti pelajar, celebrate success student..."*
Personal Growth and Educator Strategies	Reflected on personal growth and new	*"Sepanjang 3 hari berkursus, saya dapat melihat kekurangan*

	teaching strategies.	*dalam diri ketika mengendalikan kelas..."*

After 3 to 4 months, a follow up survey was made with several questions pre-designed earlier and the output is shared as in Table 2. The followings are the key themes identified after the educators had gone through CPBL workshop after few months.

Table 2. Thematic Analysis from Post-Delayed Survey

Themes	Summary	Verbatim Responses
Overall Experience	Participants found the CPBL workshop effective, emphasizing immersive, hands-on learning experiences.	*"It was an eye-opening experience. I never thought that there are valuable stages in assisting my students in working on their project."*
Key Learnings	Educators learned practical strategies enhanced by technological tools.	*"I learned the steps to solve a complex real-world problem. PBL mengubah cara saya mengajar secara total."*
Application Plans	Plans include continuous project-based learning and integrating real-life applications.	*"Sesi pembelajaran untuk memahami kaedah PBL sangat efektif. I plan to use PBL to strengthen my students' ability to think and work constructively."*
Impact Anticipation	Educators anticipate improved student engagement and enhanced critical thinking.	*"Students will be more resilient and have a growth mindset to strive through hardship. Impak positif dari segi pemahaman dan penggunaan ilmu di dunia sebenar."*
Technology Integration	Increased confidence in using technology like Canva and ChatGPT for teaching and student collaboration.	*"Students use Canva and ChatGPT many times already in my project-based learning. Pembelajaran mengenalpasti dan analisa produk dan juga bahan di dalam pembungkusan."*
Pedagogical Insights	A deeper understanding of the integration between teaching content, pedagogical approaches, and technological tools.	*"This workshop makes problem-based learning more accessible/doable as it immersed me through clear steps."*
Aha Moments	Moments of clarity on the practical application of CPBL strategies and technology in education.	*"When ChatGPT gives me the right output after try and error for a few times. Disebabkan saya mengajar teknikal iaitu packaging design."*
Learning Environment Plans	Strategies such as fostering collaborative settings and encouraging self-guided learning.	*"Do project-based learning continuously. Saya akan meneruskan pbl semampu saya sehingga mereka boleh berfikir secara kritis."*

The thematic analysis identified key themes, including 'Aha Moments,' 'Role of Technology,' and 'Student Engagement,' which reflect significant shifts in participants' teaching practices and perceptions of CPBL. For example:

- **Aha Moments**: Participants frequently described breakthroughs in understanding how CPBL strategies could be adapted to their contexts. One educator noted, 'When ChatGPT provided structured guidance, I realized its potential for scaffolding student brainstorming activities.'
- **Role of Technology**: The integration of Canva and ChatGPT emerged as a transformative aspect, enabling participants to design engaging, interactive learning activities. An educator reported, 'Students used Canva to create realistic prototypes, bridging creativity with real-world problem-solving.'
- **Student Engagement**: Educators observed increased student motivation and collaboration when using CPBL strategies. One reflection highlighted, 'My students actively debated solutions during the group task, something I rarely saw in traditional lectures.'

To enhance comprehension, Figure 1 presents a thematic map summarizing the relationships among the identified themes.

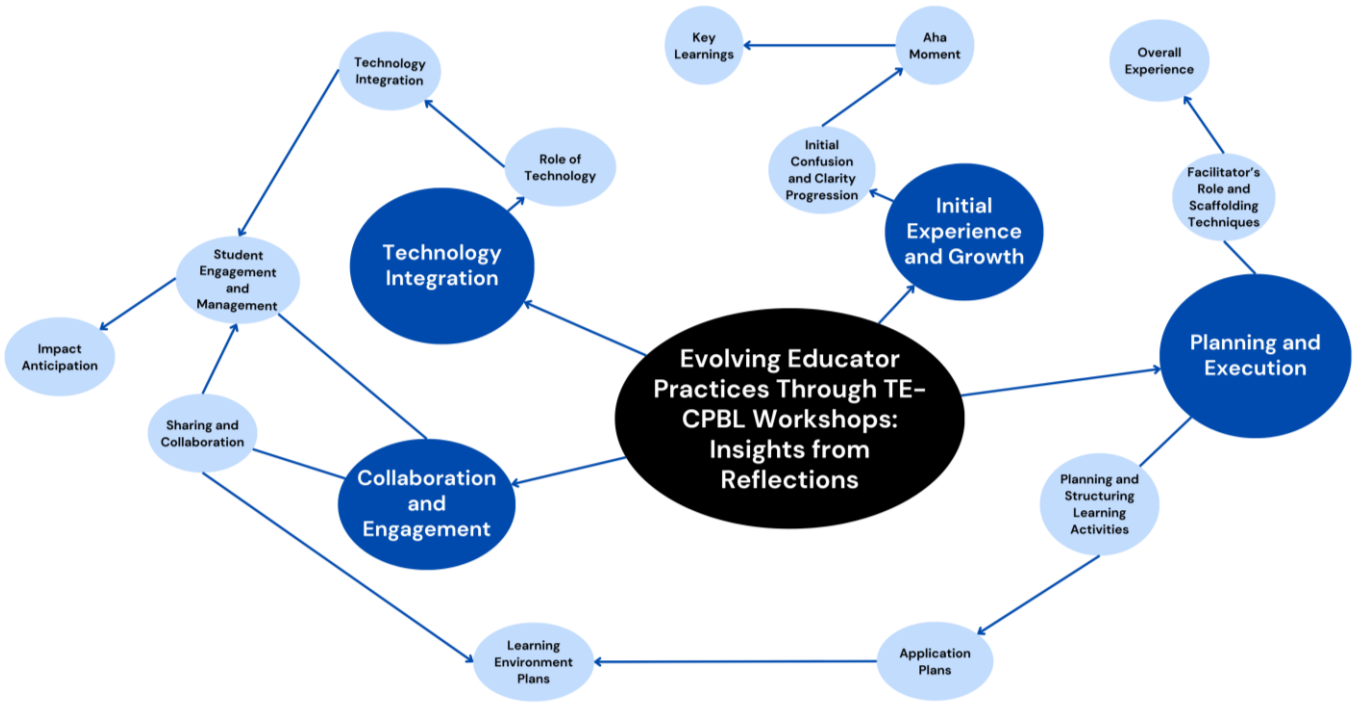

Figure 1. Thematic Map from the Findings

This thematic map illustrates the comprehensive findings derived from reflections on the TE-CPBL workshops, encapsulated within the central theme: "Evolving Educator Practices Through TE-CPBL Workshops: Insights from Reflections." The map is structured around four primary branches—Initial Experience and Growth, Planning and Execution, Technology Integration, and Collaboration and Engagement—each representing distinct but interconnected dimensions of participants' learning journeys. The Initial Experience and Growth branch captures the developmental trajectory from initial confusion, progressing through clarity and breakthroughs (Aha Moments), ultimately culminating in actionable insights (Key Learnings). This progression emphasizes the transformative impact of scaffolded learning, which builds on the constructivist principles of active engagement and reflective practice.

The other branches reinforce these findings by detailing how specific aspects interrelate. Planning and Execution highlights the evolution from structured planning of CPBL activities to application plans and enhanced learning environment strategies, guided by facilitators' scaffolding techniques. The Technology Integration branch underscores the pivotal role of tools like Canva and ChatGPT in fostering creativity and problem-solving, linking their effective use to improved student engagement and management under Collaboration and Engagement. This latter branch emphasizes the reciprocal relationship between collaboration (among educators and students), enhanced engagement, and anticipated educational impacts, such as critical thinking and resilience. The interconnected arrows indicate dynamic relationships between these themes, portraying a holistic and iterative development process that aligns with the principles of CPBL and modern educational practices.

The thematic analysis of data collected through reflective journals and delayed post-workshop surveys revealed significant insights into the educators' experiences and perceptions following their participation in the Technology-Enhanced Cooperative Problem-Based Learning (CPBL) workshops. The following depicts the verbatim responses obtained from the respondents and how each is being mapped to the respective theme.

1. Enhanced Understanding of CPBL

Participants unanimously reported an enhanced understanding of CPBL principles. They reflected on the immersive experience provided by the workshops, which allowed them to engage directly with real-world problems, mirroring the experiences their students would face. This hands-on approach facilitated a deeper appreciation of the constructivist underpinnings of CPBL, aligning with Savery's (2006) assertion of the importance of active engagement in learning.

2. Integration of Technology

Participants noted a significant increase in confidence when incorporating tools like Canva and ChatGPT into their pedagogy. For instance, one educator redesigned a lesson on sustainable development by assigning students a task to develop innovative product packaging. Students used Canva to create realistic mockups and ChatGPT to gather data on sustainability practices, effectively bridging creativity with research-driven solutions. This hands-on integration resulted in students demonstrating higher levels of critical

analysis and engagement compared to their usual project-based assignments. Specifically, the use of Canva was highlighted for its effectiveness in creating engaging visual content, while ChatGPT was praised for its role in facilitating research and generating ideas. This finding corroborates Greenhow and Lewin's (2016) discussion on the potential of digital tools to enhance student engagement and learning.

3. Shifts in Teaching Paradigms

The workshops acted as a catalyst for educators to reassess their traditional teaching approaches. For instance, educators implemented real-world problem scenarios in their lessons, such as analyzing real business case studies using Canva and ChatGPT. These activities encouraged students to collaborate, research, and present innovative solutions, demonstrating a significant departure from traditional lecture-based methods. Educators observed that such activities not only increased student engagement but also fostered a deeper understanding of subject matter through applied learning, echoing the constructivist approach where students' active participation in constructing their own understanding is emphasized (Hmelo-Silver, 2004).

4. Challenges and Barriers

Despite the generally positive experiences, educators faced several challenges in implementing CPBL and technology-enhanced learning. Time constraints emerged as a critical barrier, as participants struggled to balance their existing workload with the additional time required for planning and executing CPBL activities. Additionally, the lack of institutional support, such as limited access to technology or professional development opportunities, inhibited the widespread adoption of these methods. Resistance to change among peers and administrative hurdles also surfaced as significant challenges, consistent with Ertmer and Ottenbreit-Leftwich's (2010) findings.

5. Professional Development and Support

The critical role of continuous professional development and peer support in adopting new teaching strategies was a recurring theme. Participants expressed a need for ongoing training and collaboration to effectively integrate CPBL and technology into their pedagogical practices.

6. Observable Changes in Teaching and Learning

The educators reported noticeable improvements in student engagement and motivation, as well as enhanced critical thinking and problem-solving skills, particularly when CPBL strategies supported by technology were employed. For example, a participant teaching technical design shared how integrating Canva to create visual prototypes and ChatGPT for brainstorming ideas during a CPBL session transformed their classroom dynamics. Students actively engaged in peer reviews and refined their designs collaboratively, showcasing improved critical thinking and teamwork. This contrasted sharply with the traditional approach of completing individual assignments, where engagement was minimal. This aligns with the literature suggesting that CPBL can lead to higher levels of student involvement and cognitive development (Kim, Belland, & Lefler, 2020).

Discussions

The findings from this study reinforce the principles of constructivist learning, demonstrating the efficacy of Challenge-Based Problem Learning (CPBL) in fostering environments where students actively engage in problem-solving and knowledge construction. The educators' shift towards student-centered approaches and the observed improvement in students' critical thinking skills are in line with constructivist theory, which posits learning as an active, constructive process (Scott, 2011 & Yuen & Hau, 2006).

The challenges identified by participants, particularly those related to time constraints and institutional support, mirror the broader issues faced by educators attempting to innovate their teaching practices. These barriers must be addressed by educational leaders and policymakers to create an ecosystem that supports and rewards pedagogical innovation. This reflects broader educational trends and challenges (Hendry, Frommer, & Walker, 1999).

The emphasis on professional development and peer support found in this study underscores the necessity for educational institutions to provide educators with the resources and community necessary to transition to CPBL and technology-enhanced methodologies. This aligns with findings on the effectiveness of experiential, collaborative professional development in fostering pedagogical change, although specific comparable studies were not directly identified, the concept is supported by the constructivist educational framework.

The positive outcomes reported by educators in this study suggest that CPBL workshops can significantly impact teaching practices and student learning. However, to facilitate wider adoption, there is a need for comprehensive support systems, including professional development, peer networks, and institutional backing. Future research should explore longitudinal impacts of such workshops, quantitative strategies to benefit larger and wider audiences, and investigate strategies to overcome the barriers to implementation of CPBL and technology integration in diverse educational settings.

While this study provides significant insights into the role of technology-enhanced CPBL in educator development, it is important to acknowledge its limitations. First, the small sample size of eight educators limits the generalizability of the findings, as the experiences captured may not fully represent the

diversity of perspectives in broader populations. Second, the short-term evaluation of outcomes, based primarily on reflections and surveys conducted shortly after the workshops, does not provide insights into the long-term sustainability of the observed changes in teaching practices. Future research should incorporate follow-up assessments conducted six months to a year post-intervention to evaluate enduring impacts.

Additionally, the reliance on self-reported data, such as reflective journals and surveys, may introduce bias or overstate positive outcomes. Incorporating direct classroom observations or student feedback would enhance the robustness of future evaluations. Furthermore, the study's emphasis on specific technologies—Canva and ChatGPT—limits its ability to generalize findings to other platforms or tools. Future studies could address this by exploring a wider array of technologies to evaluate their relative effectiveness. Finally, the study's focus on TVET educators within a specific cultural and institutional context may restrict its applicability to other educational systems. Adapting the CPBL framework to different cultural and institutional settings would provide a more comprehensive understanding of its global potential.

Conclusion

This study explored the impact of Technology-Enhanced Cooperative Problem-Based Learning (CPBL) workshops on educators' approaches to teaching and learning. Through qualitative analysis of reflective journals and delayed post-workshop surveys, several key themes emerged, providing valuable insights into the transformative potential of integrating CPBL strategies and digital tools like Canva and ChatGPT in educational settings.

The findings demonstrate that TE-CPBL workshops significantly enhanced participants' understanding of CPBL and its constructivist underpinnings through practical, real-world applications. For instance, educators who participated in the workshops shared specific success stories, such as using Canva to design student-driven marketing campaigns or leveraging ChatGPT for collaborative brainstorming sessions in engineering problem-solving activities. These examples highlighted a clear shift from traditional, lecture-based methods to student-centered, interactive approaches. This paradigm shift not only aligns with contemporary educational theories but also reflects the transformative potential of integrating technology with collaborative pedagogy to address real-world challenges in the classroom.

Technology integration emerged as a central theme, with participants expressing increased confidence in incorporating tools such as Canva and ChatGPT into their pedagogy. These digital resources were recognized for their ability to facilitate creative expression, enhance student engagement, and support the collaborative nature of CPBL. The study underscores the importance of equipping educators with the skills and knowledge to effectively leverage technology in fostering dynamic and interactive learning environments.

However, the research also highlighted several challenges, including time constraints, lack of institutional support, and resistance to change, which can impede the adoption of innovative teaching strategies. Addressing these barriers is essential to enabling widespread implementation of CPBL and technology-enhanced learning approaches. To address these challenges, several strategies can be implemented:

1. **Time Management and Planning Support:** Provide structured templates and pre-designed activity modules for CPBL sessions. For example, educators can utilize pre-built lesson plans incorporating Canva and ChatGPT, reducing preparation time and ensuring pedagogical alignment.
2. **Peer Collaboration and Communities of Practice:** Establish peer support groups where educators can share resources, experiences, and solutions. This approach fosters a collaborative culture and mitigates resistance to new methodologies by building collective confidence and shared expertise (Johnson & Johnson, 2009).
3. **Institutional Incentives and Support:** Encourage institutions to offer incentives such as reduced teaching loads, recognition programs, or access to additional funding for innovative projects. Providing technology access and training, including workshops on tools like Canva and ChatGPT, can also ease the transition.
4. **Professional Development Programs:** Offer ongoing professional development opportunities that emphasize experiential learning. For instance, conducting follow-up workshops to address specific challenges faced by educators can provide targeted support and sustain momentum.
5. **Administrative Advocacy:** Engage administrators in the pedagogical change process by demonstrating the benefits of CPBL through pilot programs and presenting evidence of improved student outcomes. This can help secure institutional backing and reduce bureaucratic resistance.

Professional development, as demonstrated by the CPBL workshops, plays a crucial role in supporting educators through this transition. Continuous learning opportunities, peer support, and practical experiences are vital in helping teachers navigate the complexities of modern educational paradigms and integrate new tools and methodologies into their practice.

This study offers valuable insights into the potential of technology-enhanced CPBL workshops for educator development. However, future research could extend these findings by exploring the long-term impacts of CPBL on both educators and students. For

instance, longitudinal studies could examine how sustained CPBL implementation influences students' critical thinking, collaboration, and problem-solving skills over multiple academic terms. Additionally, investigating the scalability of CPBL in institutions with varying resource levels—particularly those with limited access to digital tools—would provide a broader understanding of its applicability in diverse educational settings.

Comparative research between CPBL and other active learning strategies, such as flipped classrooms or inquiry-based learning, would also offer valuable insights into the relative effectiveness of these approaches in fostering educator development. Furthermore, future studies could explore alternative generative AI tools and platforms beyond Canva and ChatGPT, assessing their potential to complement or enhance CPBL methodologies. These directions for future research would build on the current study's findings while addressing its limitations and extending its contributions to the field.

In conclusion, the study reaffirms the value of CPBL and technology integration in promoting student-centered learning. By fostering environments that encourage collaboration, critical thinking, and problem-solving, educators can better prepare students to navigate the challenges of the 21st century. Future research should continue to explore effective strategies for overcoming barriers to pedagogical innovation and further investigate the long-term impacts of CPBL and technology-enhanced learning on student outcomes.

As educational landscapes continue to evolve, the insights gained from this study contribute to the growing body of knowledge on best practices in teaching and learning. By embracing the principles of CPBL and harnessing the power of technology, educators can create more engaging, effective, and meaningful learning experiences for their students.

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Conflict of Interest

The authors declare no conflict of interest.

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