OPEN ACCESS

GRS Journal of Multidisciplinary Research and Studies

Abbreviate Tittle- GRS J Mul Res Stud

ISSN *(Online) - 3049-0561*

https://grspublisher.com/journal-details/GRSJMRS

Vol-2, Iss-11 (Nov- 2025)

Empowering Faculty through TPACK: Technological Pedagogical Content Knowledge Incorporated in a Competency-Based Education and Training the Trainer Framework

Shahid Hassan[1], Dinah Lorde[2], Sylvester Lazarus[3], Jerome Brathwaite[4], Nathanya Smith[5], Bheemesh Vangalapati[6], Crystal Henry[7], Ahsun Rafi Kazmi[8], Gauhar Hassan[9]

[1,2,3,4,5,6,7,8,9]American University of Barbados School of Medicine.

Article History

Received: 10.10.2025

Accepted: 03.11.2025

Published: 18.11.2025

Corresponding Author:
Shahid Hassan

Abstract: The evolving landscape of medical education demands faculty who are technologically competent, pedagogically skilled, and content proficient. The Technological Pedagogical and Content Knowledge (TPACK) framework provides an integrative model that aligns with the Competency-Based Education and Training framework (CBET) philosophy emphasizing outcomes, performance, and competency as the focus of the training. This study describes the design, implementation, and evaluation of a faculty development program that integrates TPACK principles within a CBET framework in a private medical school setting. Using a mixed-methods design, the program involved a series of structured workshops, reflective practice activities, and evaluation surveys. Quantitative results demonstrated significant improvement in participants' self-rated competencies across TPACK domains, while qualitative feedback revealed enhanced confidence and readiness to design technology-enhanced CBME learning and assessment experiences. The study concludes that TPACK-informed faculty development fosters a holistic and sustainable professional learning culture in medical education aligned with the digital transformation of CBME.

Keywords: *TPACK, Competency-based, Training, Faculty development, Hybrid Teaching, Instructional design and Curriculum delivery*.

Cite this Article

S. Hassan, D. Lorde, S. Lazarus, J. Brathwaite, N. Smith, B. Vangalapati, C. Henry, A. Rafi. Kazmi, G. Hassan, Empowering Faculty Through TPACK: Technological Pedagogical Content Knowledge Incorporated in a Competency-Based Education and Training the Trainer Framework (2025) *GRS Journal of Multidisciplinary Research and Studies, Vol-2(Iss-11).57-73*

Introduction

Competency-Based Education and Training (CBET) has shifted the focus of medical education from time-based learning to outcome-based learning, emphasizing observable and measurable competencies. To meet these expectations, medical faculty must be equipped not only with clinical expertise and pedagogical proficiency but also with technological fluency that enhances learning effectiveness and assessment authenticity. The Technological Pedagogical and Content Knowledge (TPACK) framework represents a dynamic model that integrates three core domains, the content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK) and their intersections: PCK, TCK, TPK, and TPACK. The integration of these domains enables educators to design and deliver instruction that meaningfully incorporates technology to achieve intended learning outcomes. The digital transformation of learning management system has become a necessity rather than a luxury 1. (Hegazy et al., 2020, Namada 2021). Research on faculty development for online teaching using technological pedagogical content knowledge (TPACK) framework has indicated that taking on technology leadership roles can improve faculty members performance (Japal-Jemani et at., 2018). To address needs for online teaching, an adopted TPACK model incorporating contextual knowledge has been proposed for professional knowledge gain in higher education (Espinoza & Neal, 2018).

The TPACK framework has been established to be an important source for designing developing online teaching, integrating technological, pedagogical and content knowledge (Ward and Benson, 2010). It has been found to enhance educators' abilities to design students' engagement in online learning to improve their outcomes (Phan et al., 2024). TPACK has also been found essential for online teaching in professional development specially during the COVID-19 pandemic (Phan et al., 2024, Ward and Benson, 2010). The findings suggest that faculty development with experiential learning experience and reflection are key to participants' TPACK development and positive changes in teaching beliefs, e-learning attitudes, and self-efficacy (Read et al., 2019). For faculty in teaching, TPACK integration in online teaching varies across domains demonstrating adequate to high levels in content knowledge, pedagogical content knowledge and technological content knowledge (Darsih et al., 2023).

The Technological Pedagogical Content Knowledge (TPACK) model (Koehler and Mishra 2009) serves as a widely adopted framework to support faculty in the integration of technology into subject-specific teaching. Rather than using TPACK as a post-intervention assessment, this study positions it as a curriculum planning and design tool for faculty training. Embedding hypothetico-deductive approach in faculty development promotes cognitive apprenticeship and case-based teaching (Bugge D. et al., 2023). The effectiveness of faculty development is amplified through digital tools that support learning management, content creation, assessment, and collaboration. FD programs must include hands-on training on LMS platforms, interactive tools (H5P, Padlet), assessment tools (Socrative, CARE), and feedback mechanisms.

Technological Pedagogical Content Knowledge (TPACK) is a comprehensive framework that delineates the essential types of knowledge educators require to effectively integrate technology into their teaching practices. Initially introduced by Punya Mishra and Matthew J. Koehler in 2006, TPACK extends Lee Shulman's concept of Pedagogical Content Knowledge (PCK) by incorporating technological knowledge, thereby addressing the intricate interplay between technology, pedagogy, and content in educational settings. When mapped to CBME, TPACK provides a systematic approach to developing faculty competencies that align with CBME principles such as outcome alignment, feedback for learning, direct observation, entrustment decisions, and workplace-based assessment. This study aims to bridge that gap by designing and evaluating a TPACK-incorporated faculty development program guided by the CBME framework.

Conceptual Framework

The study is underpinned by the Technological Pedagogical Content Knowledge (TPACK) framework, which offers a comprehensive model for integrating technology into teaching in a meaningful and pedagogically sound manner (see table 1). TPACK conceptualizes the intersection of three core domains of content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK) and emphasizes the importance of their dynamic interplay in designing effective instructional practices (see figure 1). Within the context of this faculty development course on designing lesson plans for online teaching, TPACK serves as the guiding framework to structure the training content, inform instructional strategies, and evaluate participants' growth in integrating digital tools into curriculum planning. By adopting this model, the study aims to support educators in achieving balanced, thoughtful integration of technology that enhances both teaching and learning outcomes. The use of Gagne’s model aligns with technology underscores the importance of a structured faculty development framework imperative for future practice (Mohamad et al., 2025). Programs that follow Gagne’s sequential design from gaining attention to enhancing retention promotes learner-centred teaching reinforced with reflective practice. Together, TPACK and Gagne’s models present a complementary framework to restructure the faculty development training (Dysart and Weckerle 2015). TPACK provides the conceptual domain integration, while Gagne’s instructional events provide the operational sequence to faculty development structured design.

The digitalization of teaching online requires a comprehensive faculty training program that integrates technology, pedagogy, and content knowledge. By leveraging effective instructional models (TPACK, Gagne’s events, HD reasoning) and providing hands-on training with digital tools, institutions can enhance the quality of online education and student engagement.

TPACK Applications in Education

The TPACK framework serves as a guide for teachers to thoughtfully integrate technology into their teaching. For instance, in mathematics education, TPACK has been employed to examine how teachers incorporate digital tools to enhance student understanding of complex concepts. By aligning technological tools with pedagogical strategies and content requirements, educators can create more engaging and effective learning experiences. Assessing a teacher's TPACK involves various methods, including self-report surveys, performance assessments, and observational techniques. Instruments like the Survey of Preservice Teachers’ Knowledge of Teaching and Technology have been developed to evaluate the different components of TPACK, providing insights into areas where educators may need further development. The core components of TPACK includes.

1. **Content Knowledge (CK):** Faculty must have mastery over their subject matter, ensuring that the learning materials uploaded online are accurate, relevant, and engaging.
2. **Pedagogical Knowledge (PK):** Faculty should understand effective teaching strategies, including student engagement techniques, small group instructional design, and assessment methodologies.
3. **Technological Knowledge (TK):** Faculty need proficiency in various digital tools, including Learning Management Systems (LMS), video conferencing platforms, and content creation software.
4. **Pedagogical Content Knowledge (PCK):** Understanding how best to teach specific content, considering learner needs, course objectives, and interactive activities that can be adapted for online delivery.
5. **Technological Content Knowledge (TCK):** Knowing how technology can be used to enhance content delivery, using simulations, multimedia and adaptive learning tools.
6. **Technological Pedagogical Knowledge (TPK):** Faculty should be able to use digital tools effectively in various instructional strategies, such as flipped classrooms, online discussions, and digital assessments.
7. **Technological Pedagogical Content Knowledge (TPACK):** The holistic integration of technology into teaching to create an effective, engaging, and adaptable online learning environment.

Study Objectives

1. To design a structured faculty development program that integrates the TPACK model within a CBME framework.
2. To assess faculty participants’ self-perceived competencies across TPACK domains before and after the program.
3. To explore faculty perceptions of the relevance and impact of TPACK-informed CBME training on their teaching and assessment practices.

Table 1: The conceptual framework elements of faculty development for online teaching

Element	Role in Study

TPACK Framework	Guides faculty in integrating content, pedagogy, and technology effectively.
Gagne's Instructional Model	Structures the online lesson design into 9 effective teaching events.
Hypothetico-deductive Approach	Supports analytical thinking and hypothesis-based clinical problem-solving.
Think-Aloud Strategy	Enhances metacognition and supports faculty reflection in lesson planning.
Digital Tools	Enablers for delivering content, interaction, and assessment in online mode.
Lesson Plan Transformation	Output product of faculty development-shaped through the above inputs.

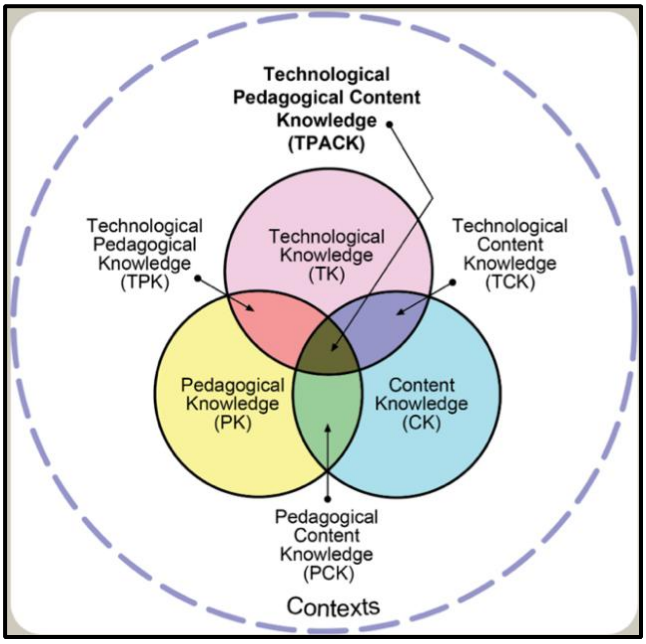

Figure 1: The conceptual framework to visually communicates how the key components connect within the study reproduced by permission of the publisher, © 2012 by tpack.org.

Methodology

Subjects

The study was conducted at a private Caribbean medical school implementing a CBME-based MD curriculum. Eight faculty members from the Basic Medical Sciences (BMS)) voluntarily participated. The TPACK incorporated CBET Faculty Development Program was conducted over eight weeks using blended delivery (face-to-face and online follow-ups engaging the external facilitator). It consisted of weekly thematic sessions aligned with the seven TPACK components and Gagne's 9-Events instructional design with hypothetico-deductive and think-aloud approach.

Research Design

Crystalizing the research objective and aligning it with an appropriate study design the current study is the part of a wider research, which is more focused, relevant and targeted to measuring the outcome of TPACK and other pedagogical models used by the trainees and summarised in table below (see table 2). A convergent mixed-methods design was employed to capture both quantitative improvements in TPACK competencies and qualitative insights into participants' experiences.

Data Collection

Based on the objective of, "designing and describing a faculty development program to guide transformation of lesson plans into an hybrid mode and readily available for online teaching integrated with TPACK, Gagne's model, Think-Aloud, and Hypothetico-Deductive reasoning" the data was collected (see table 3) as under.

The quantitative data were collected from:

1. Needs assessment survey using a validated TPACK self-assessment questionnaire to identify the gaps in knowledge and develop the intended course.
2. Evaluation of digitalisation of a classroom session to an online hybrid lesson plan incorporating TPACK, the Gagne's 9-Event instructional plan and the hypothetico-deductive and think-aloud approach using a rubric

The qualitative data emerged from

1. Focus group interview (FGDs) and reflective narratives as open-ended items in survey
2. The periodic reflection practiced on weekly basis for 8-weeks during the course.

Table 2: Summary of the study, a design-based research (DBR) developmental research as a descriptive case study

Feature	Justification
Study Type	Descriptive Case Study
Purpose	To document how the faculty development program was designed
Unit of Analysis	The process of transforming face-to-face lesson plans to online delivery
Methodology	Collection of artefacts (survey focused groups interviews with trainers, training guides, redesigned lesson plans and course documents)
Role of TPACK etc.	Used as guiding frameworks for designing the program, not as an evaluation tools
Outcome	Rich, context-specific description of the design process and resulting materials and learning resources.

Table 3: Data collection for its sources, methods employed and purpose explained

Data Source	Method	Purpose
Survey and interview	Likert scale Questionnaire	Identify the gaps in knowledge
Program design sessions	Document review, field notes and evaluation	Capture planning decisions, frameworks applied
Faculty development workshops	Observation, field notes	See how TPACK, Gagné's model, etc., are introduced
Transformed lesson plans	Document analysis for online delivery	Evaluate how theories/models were embedded
Trainer reflections	Semi-structured interviews	Understand rationale and challenges during design
Faculty reflections	Reflective journals or short surveys	Capture user feedback and ease of adaptation of training
Support documents/tools	Artifact collection from faculty assigned work	Training slides, checklists, digital tools used

Data Analysis Methods

Given the nature of the data collected, the quantitative descriptive analysis and the qualitative (see table 4) thematic coding for content analysis, depending on the data source followed. The qualitative data is analysed using content and thematic analysis, focusing on:

- Use of instructional models in redesigned lesson plans.
- Thematic synthesis of faculty experience and feedback.
- Mapping of TPACK domains and Gagne events within materials.

Coding follows a hybrid approach:

- Deductive codes from TPACK, Gagné's model, and HD framework.
- Inductive codes from reflective data and interviews.

Table 4: Approach to data analysis and the analysis methods used and the outcome achieved

Data Type	Analysis Technique	Output
Questionnaire-based survey	Data collection using 4-point Likert scale	Identification of gaps in knowledge and skills
Interview transcripts and reflections	Thematic Analysis using Braun and Clarke's 6 steps (see table 16)	Themes about design rationale, challenges, faculty needs
Documents and lesson plans	Content analysis with deductive codes based on TPACK, Gagné's model	Evidence of model integration in training materials
Field notes and observation	Narrative synthesis / Event mapping	Visual timeline or process map of program development
Training materials/tools	Descriptive summary and categorization	List of resources aligned with each instructional model

Result

Quantitative Analysis

As the first step after the data was collected on a 4-point Likert-scale-based online survey administered to American University of Bardos School of Medicine faculty. In the next step each item weighted score was calculated as overall response expressed by the respondent faculty, exploring educators' perception of TPACK, and other pedagogical instructional and cognitive models (See Table 3).

Survey Section 1 (TPACK)

Overall analysis of survey data with a strongly agreed mean weighted average (MWA) of 3.22 (see table 5), a borderline difference between strong and agreement and agreement though, indicates emphasis on utilising the technology in integration with pedagogy for developing a course content for delivering both, face-to-face and online, precisely in a hybrid mood. Item 1, 2 and 3 (see table 6) has been responded from strongly agree to agree on faculty awareness and needs for a plan lesson that balances content, pedagogy, and technology available for both face-to-face and online delivery using TPACK framework. Besides, item 4, 5 and 6 about the selection of digital tools (see table 6) in the delivery of pedagogical methods as per the learning styles of trainees to meet the learning outcome has also been determined as agreed to strongly agreed on overall analysis of the data. And good to know is the item 7 strong agreement on faculty being overwhelmed by too many technological tools considered important for learning integrated with pedagogy (see table 5). Yet another nice to know is the faculty awareness and readiness with highly interested to develop skills in Artificial Intelligence (AI) and its associated tools to help develop lesson plan and usability of various digital tools in its execution and delivery of content (see table 6).

Table 5: Summary of TPACK section of the needs analysis item 1-10 with outcome response trend and key insight

Survey Item	Focus Area	Response Trend (MWA 3.22)	Key Insight
Item 1-3	Faculty awareness and need for lesson planning integrating content, pedagogy, and technology	Strongly Agree to Agree	Faculty recognize the need for integrated lesson planning using TPACK for both F2F and online modes
Item 4-6	Selection of digital tools aligned with pedagogical methods and student learning styles	Agree to Strongly Agree	Faculty value using digital tools effectively to match pedagogical strategies and learning outcomes
Item 7	Overwhelm due to too many tools	Strong Agreement	Faculty prefer curated tools and support over being burdened with too many tech options

Additional Item (8-10)	Awareness/readiness to use AI tools for lesson planning and digital content delivery	High Interest and Readiness	Faculty are eager to explore AI for improving lesson design and digital tool implementation

Table 6: Proposed faculty development training workshops based on TPACK section 1 of needs analysis

Items/Workshop Title	Objective	Format
1/TPACK in Practice	Guide faculty create lesson plans integrating content, pedagogy, and technology effectively	Hands-on Workshop
2/Designing for Hybrid Delivery	Capacity building for lesson plan to smoothly transition face-to-face to online modes	Hands-on Workshop
3/Digital Tool Selection for Learner-centred Teaching	Train faculty to match tools with teaching strategies and learning styles	Tool Demonstration
4/AI in Lesson Planning and Content Delivery (also addresses items 8-10)	Introduce AI-powered platforms (ChatGPT, Canva AI, etc.) for smarter educational planning	Practice Workshop
5/Personalized Learning Paths Using Technology	Equip faculty with strategies to personalize instruction through adaptive technologies	Strategy Workshop
7/Creating Digital Content for Online Hybrid Learning	Develop skills in creating multimedia, quizzes, and interactive content (microlearning video)	Production Workshop

Survey Section 2 (Gagne's Nine Events Instructional Model)

All strongly agreed items 11-20 (see table 7) with a strongly agreed mean weighted average (MWA) of 3.46 (see table 7), reflects on faculty unknowingly practiced Gagne's nine steps, though formally not introduced to Gagne's nine events instructions. All strongly agreed on their gaining student's attention (item 1), informing them of learning outcome (item 2), stimulating the recall prior knowledge (item 3), presenting them of learning resources (item 4), providing proactive supervision (item 5), eliciting performance and providing feedback (item 6 and 7) and finally assessing performance and transfer of knowledge for enhancing retention through reflection as shown in item 8 and 9 (see table 5). The faculty strong agreement on each of these steps is their acknowledgement to be formally introduced to these steps to the designing and developing of lesson plan incorporating Gagne's nine events instructions to effectively engage students in an online teaching session (see table 7).

Table 7: Summary of the faculty response on Gagne's 9-Events needs analysis section 2 and corresponding faculty development workshops to support skill-building in this instructional design

Item	Gagné's Instructional Step	Survey Result Summary (MWA 3.46)	Faculty Development Need
11	Gaining attention	Strongly Agreed	Creative strategies to capture learner attention
12	Informing learners of the objectives	Strongly Agreed	Clear articulation of outcomes and relevance
13	Stimulating recall of prior knowledge	Strongly Agreed	Use of questioning, analogies, concept mapping
14	Presenting the content	Strongly Agreed	Structuring learning material effectively
15	Providing learning guidance (supervision)	Strongly Agreed	Scaffolding and proactive instructional support

16-17	Eliciting performance and providing feedback	Strongly Agreed	Formative assessment and constructive feedback techniques
18-19	Assessing performance and enhancing retention	Strongly Agreed	Reflection activities, spaced learning, and transfer tasks
20	Overall acknowledgement of using Gagne unknowingly	Strongly Agreed	Formal introduction and integration into lesson planning

Survey Section 3 (Use of Digital Tools)

An overall agreement with a mean weighted average (MWA) of 3.09 for all the 5 items though sounds like a desire than actually using those digital tools for students' engagement like Poll Everywhere, Slido, Chats, Whiteboards (items 21-23), identifies the gaps in fully utilised digital tools (see table 8). Although some of them like CARE, Medico-skills are used but digital or IF-AT (Immediate Feedback Assessment Test) scratch cards are not used, even those claiming to practice team-based learning in their current F2F sessions. However, the survey analysed items on use of digital tools is a clear indication of faculty willingness to experience those technologically aided tools in in-person sessions for faculty readiness for emergency remote or a hybrid learning environment (see table 6). This will also enable faculty to provide digital learning resources online for F2F or hybrid flexible learning shown in item 24 and usability of multimedia in delivery of their content shown in item 25 (see table 8).

Table 8: Proposed faculty development workshops based on section 3 (Items 21–25) about use of digital tools to address the identified gaps and readiness for digitally enhanced hybrid learning environments

Item(s)	Digital Tool/Focus Area	Summary of Response (MWA 3.09)	Faculty Development Need
21–23	Interactive Tools (e.g., Poll Everywhere, Slido)	MWA: 3.09 (Interest > Use)	Hands-on use of engagement tools like Slido, Mentimeter, Whiteboards
24	Online Digital Learning Resources	Agreement on future readiness	Designing and curating digital content for LMS and flexible delivery
25	Usability of Multimedia	Interest in multimedia use	Skills to integrate audio, video, and interactive content in lectures

Survey Section 4 (Hypothetico-deductive Approach)

A strong agreement with a mean weighted average (MWA) of 3.25, a borderline difference between strongly agreed and agreed though, on a 4-point Likert scale indicates the understanding for hypothetico-deductive strategies in critical learning as shown in item 26 and 27 (see table 9). A strongly agreed upon practice for developing a case-based lecture or lecture-based case (item 28) incorporated with problem solving task (item 29) has been identified as gaps in knowledge and skills for hypothetico-deductive approach in basic medical sciences teaching to be adopted by the faculty (see table 9). Further acknowledgement of peer and self-reflection through think aloud practice in faculty teaching practice to help create a collaborative team-based learning (item 30) for transfer of knowledge to long term retention, which can be emphasised in training workshops (see table 7).

Table 9: Needs analysis summary of items 26-30 on, "Hypothetico-deductive teaching in Basic Medical Sciences strategies and the proposed workshops.

Item(s)	Focus Area	Summary of Response MWA: 3.25	Faculty Development Need

26–27	Hypothetico-Deductive Reasoning	(High understanding, borderline difference in intensity)	Conceptual clarity and applied use in designing classroom activities
28	Case-Based Lecture or Lecture-Based Case	Strong agreement	Structuring content using patient cases or clinical scenarios
29	Problem-Solving Integration	Strong agreement, but gap in skills	Methods to develop problem-solving tasks aligned with learning objectives
30	Peer and Self-Reflection using Think Aloud	Acknowledged in practice	Think-aloud protocols to encourage reflective teaching and collaborative learning

Survey Section 5 (Think-aloud Strategy)

Yet, another very strong agreement with a mean weighted average (MWA) of 3.54 in exploring faculty understanding and practice (item 31) and demonstration (item 32) of think-aloud approach in mostly didactic lecture is difficult to imagine has been acknowledged. Besides, innovative ideas in F2F interactive session (item 33) capable for online activities in a hybrid model provided with room for open ended questions narrative (item 34) is highly encouraging to be formally introduced in teaching ready for online delivery (see table 10). A positive response to peer and self-reflection (item 35) through think aloud practice in current sessions to help create a collaborative team-based learning environment (see table 24). This has also been identified with partially practiced in presentation of assignments needs to emphasised in training workshop for recommendation of faculty development programme intended in current study.

Table 10: Summary for items 31–35 needs analysis for, "Think-aloud, strategies targeted on faculty development need strategize for online hybrid learning and reflective practice

Item	Focus Area	Summary of Response MWA: 3.54	Faculty Development Need
31-32	Think-aloud practiced in didactic lectures	Very strong agreement but acknowledged difficulty	Faculty require guidance on embedding think-aloud in traditional lecture format
33	Innovation in F2F interactive sessions	High agreement identified	Transforming F2F strategies into online activities or hybrid delivery
34	Probing open-ended question in online learning	Strong encouragement	Need to design narrative prompts for online critical thinking
35	Peer/Self-reflection via think-aloud practice	Positive response; partially practiced	Practice of in-class application and peer evaluation team-based learning

Qualitative Analysis

This qualitative analysis was conducted to explore faculty members' awareness and application of educational frameworks and strategies in their routine teaching. Out of 15 faculty members, 7 were randomly selected for semi-structured interviews. Each response was coded to reflect key sentiments or gaps. Codes were then grouped into themes (e.g., TPACK, Gagné's Nine Events of Instruction, Hypothetico-Deductive Reasoning Strategy and Digital Competency for faculty awareness). Tone was used to indicate whether the respondent sentiment was positive, negative, or mixed. The qualitative thematic evaluation was then converted to a numeric numbers (see table 11).

Table 11: Interview-based thematic analysis of faculty needs assessment for insight into design and development of online lesson plan for faculty training

Interview Focus Area	Verbatim Response	Initial Code(s)	Theme	Response (Rating)

TPACK Awareness	I've vaguely heard about TPACK, but I don't really know how to apply it in my subject area.	Lack of familiarity, need for training	Gap in faculty awareness	Negative (7/7)
Gagné's Nine Events	I'm sure we do some of these things instinctively, but I've never had formal training in Gagné's model.	Implicit use, Lacking structure	Instructional strategy Awareness	Mixed (4/3)
Hypothetico-Deductive Method	We use this in clinical setting but not in classroom teaching. Nobody trained us to do that.	Know its theoretical importance but not application	Reflective teaching practice	Mixed (4/3)
Think-Aloud Strategy	I tend to probe through open ended question, but I didn't know this as a theory.	Informal strategy not in use and a low pedagogical awareness	Clinical integration deficit	Negative (6/7)
Digital Tools Usability	I mostly use PowerPoint and CARE; other tools seem too complex without training.	Limited usage, IT discomfort and need training	Digital competency in teaching	Negative (5/7)

Key Findings

- Low awareness of structured frameworks like TPACK and Gagné's Events, despite informal or instinctive application.
- Fragmented application of clinical strategies like Hypothetico-Deductive reasoning due to lack of instructional alignment.
- Limited digital tool usage beyond basic platforms; most faculty expressed hesitation due to lack of training.
- Mixed feelings about surveys though faculty are open to participating to improve in the areas of concerned however, some of them were sceptical about the use of collected feedback.

Result in Knowledge Gaps for Course Design

Based on gaps in knowledge identified after the needs assessment survey analysis, the course was designed spanned over 10 weeks as combined activities involving instructional content, hands-on practice, and reflection. Each session was designed in a way to practice specific aspects of TPACK components and events from the Gagne's instructional model (see table 12). This structure ensured that faculty progressively develop competencies in lesson planning transformation, online teaching, and technology integration, while maintaining alignment with pedagogical objectives.

Table 12: Some of the scheduled session of CBET course on faculty development for hybrid model incorporating TPACK

Week	Focus/Theme	TPACK Elements	Gagne Event(s)	Instructional Strategy
1	Orientation and Online Teaching Fundamentals	TK, PK	Gain attention, Inform objectives	Think-aloud introduction
2	Lesson Plan Analysis and Content digitalisation	CK, PK	Stimulate recall, Present stimulus	Hypothetico-deductive scenarios
3	Interactive Content Design	TK, CK	Provide guidance, Elicit performance	Hands-on online module design
4	Technology Tools for Engagement	TK	Provide feedback	Think-aloud on tool selection

5	Online Assessment and Competency Alignment	PK, TK	Assess performance	Hypothetico-deductive reasoning
6	Peer Review and Collaborative Planning	PK, TK	Enhance retention	Reflection and discussion
7	Reflective Practice in Online Delivery	PK	Provide feedback	Think-aloud protocol
8	Troubleshooting and Problem-Solving	CK, PK	Elicit performance	Hypothetico-deductive approach
9	Integration of Competencies into Lesson Plans	CK, PK, TK	Enhance retention, Assess performance	Combined strategies
10	Capstone Presentation and Model Proposal	CK, PK, TK	Provide feedback, Retention	Think-aloud and reflective synthesis

Faculty Competency Focussed Result

The 10-week course demonstrated measurable growth in faculty competencies aligned with the CBET framework. Faculty performance was assessed using assignments rubrics, ePortfolio and ePoster presentation of their respective lesson plan for defence in an online assessment by online external examiner and on-sight internal examiner evaluating participants performance (see table 13). Qualitative analysis of think-aloud reflections and post-course feedback revealed several recurring themes (see table 14).

Table 13: Pre-course F2F Conventional and Post-course TPACK anchored competency scores

Competency	**Conventional F2F Lesson Plan Mean (SD)**	**TPACK Anchored Lesson Plan Mean (SD)**	**Improvement (%)**
Lesson Plan Adapted Structure	2.3 (0.8)	4.2 (0.5)	82%
Technology Integration	1.8 (0.6)	4.0 (0.6)	122%
Pedagogy Alignment	2.5 (0.7)	4.1 (0.4)	64%
Reflective Practice	2.0 (0.9)	4.3 (0.5)	115%

Table 14: Key themes as obtained from faculty reflections and problem solving assignments

Theme	**Illustrative Quote**	**Attainment**
Increased Confidence in Online Hybrid Teaching	"I now feel capable of transforming my lectures into interactive online sessions, though faced a number of challenges in acquiring technology"	50%
Pedagogical Awareness	"Using Gagne's framework helped me structure my lesson with clear objectives and would like to have more such workshops"	87.5
Technology Adoption	"I learned new tools that I can integrate seamlessly into my teaching however, prefer gradual capacity building	75%
Reflective Problem-Solving	"The hypothetico-deductive tasks forced me to anticipate and resolve teaching challenges."	87.5%

Overview of Data Trends

The results from the 10-week faculty development program reveal a progressive improvement in participants' competencies as measured through weekly scores. Both, the table of average competency scores (see figure 2) show a clear upward trajectory across the training period. The mean competency score increased from 2.0 in week 1 to 4.3 in week 10, indicating steady growth and eventual consolidation of skills. This progression reflects the faculty's increasing ability to integrate content knowledge, pedagogy, and technology within the CBET framework.

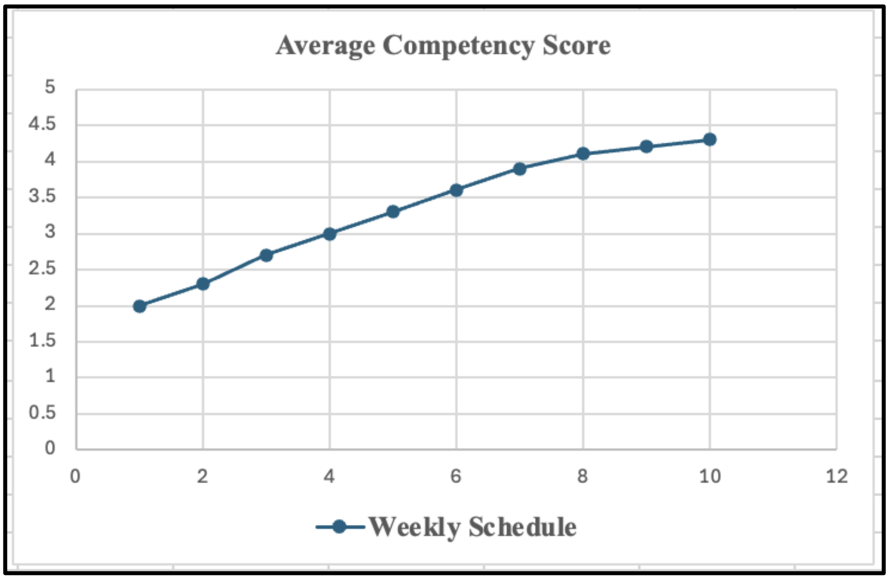

Figure 2: Weekly Competency Progress line graph showing average competency scores per week, illustrating growth trends.)

Performance Data Analysis

Analysis of faculty artifacts, assignments, reflective logs, e-portfolios, and e-poster presentations revealed both high engagement and process-oriented learning. The data (see table 15 and figure 3) was obtained from the faculty engagement observed as the average competency scores over the course of the 10-week training program. The trend showed a steady increase in competencies related to lesson plan adaptation, technology integration, pedagogical alignment, and reflective practice.

Table 15: Data sources and their contribution to faculty development using a CBET framework.

Data Source	%Faculty Engagement	Themes Identified	Implications for Faculty Development
Assignments	75% submitted	Demonstrated application of TPACK in hybrid lesson planning	Indicates value of structured tasks for building applied skills. Faculty development should integrate task-based learning.
Reflective Practice Logs	62.5% produced artifacts	Showed evolving perceptions of hybrid teaching and self-awareness in technology use	Reflection cycles support process-driven growth. Development programs should emphasize reflective practice.
Artifacts (lesson plans, teaching materials)	75% consistent entries	Evidence of contextual adaptation to teaching modes	Suggests the importance of hands-on design workshops in faculty development.
ePortfolio	87.5% maintained regularly	Captured longitudinal growth and alignment with TPACK elements	Supports need for digital platforms that document growth; can be embedded in faculty development initiatives.
ePoster Presentations	71.42% presented at seminar	Highlighted descriptive, future-oriented perceptions of hybrid teaching	Demonstrates dissemination and peer-sharing as effective strategies; faculty development should include presentation forums.

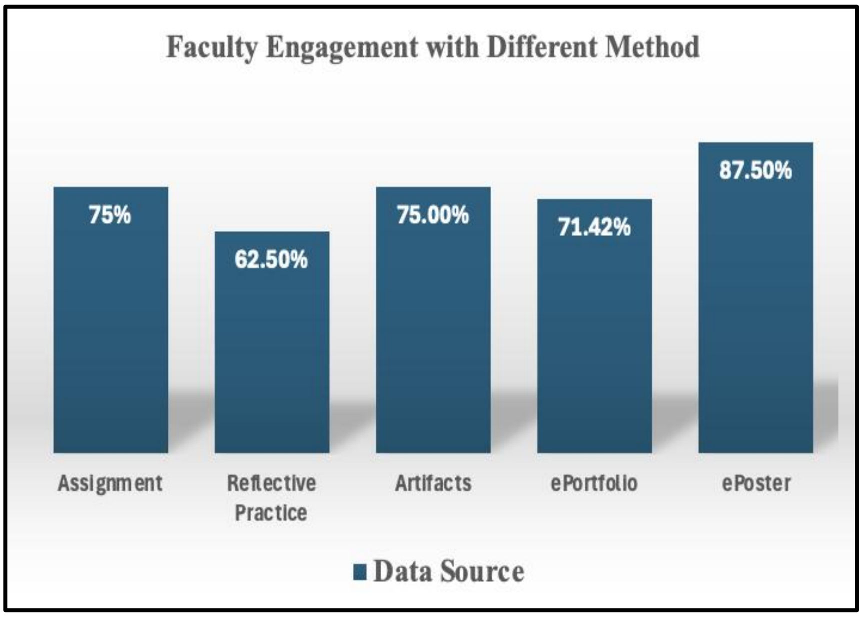

Figure 3: Percentage distribution of faculty engagement by methods in faculty development training

Analysis of one of the assignment on digitalization of lesson plan incorporating TPACK and Gagne's instructions with pedagogical and technological knowledge domains break up (see table 16 and figure 4) shows students achieved a mean performance score of 3.5**,** with a slightly higher score in Pedagogical Knowledge (3.7) than in Technological Knowledge (3.3)**.** The ePortfolio reflected noticeable improvement, with an overall mean performance of 4.0**.** The Pedagogical Knowledge score (4.4) was distinctly strong, indicating students' deepened understanding of teaching and learning processes and reflective practices. The Technological Knowledge score (3.6), though improved, still trailed behind pedagogical mastery, implying ongoing development in confidently embedding technology into their reflective documentation. The highest performance was observed in the ePoster activity, with a mean score of 4.2**,** showing an upward trend in overall competency. Here, Pedagogical Knowledge (4.5) remained the strongest domain, reflecting students' ability to convey teaching ideas clearly and meaningfully in a visual presentation. Importantly, Technological Knowledge (3.9) reached its peak among all activities, suggesting that students have become more adept at using digital tools and platforms creatively and effectively to communicate academic content.

Table 16: Assignment 4 digitalization of lesson plan incorporating TPACK and Gagne's instructions

No	**Data Source**	**Mean Score**
1	Assignment 4 Performance	3.5
	Pedagogical Knowledge (PK)	3.7
	Technological Knowledge (TK)	3.3
4	ePortfolio Performance	4
	Pedagogical Knowledge (PK)	4.4
	Technological Knowledge (TK)	3.6
5	ePoster Performance	4.2
	Pedagogical Knowledge (PK)	4.5
	Technological Knowledge (TK)	3.9

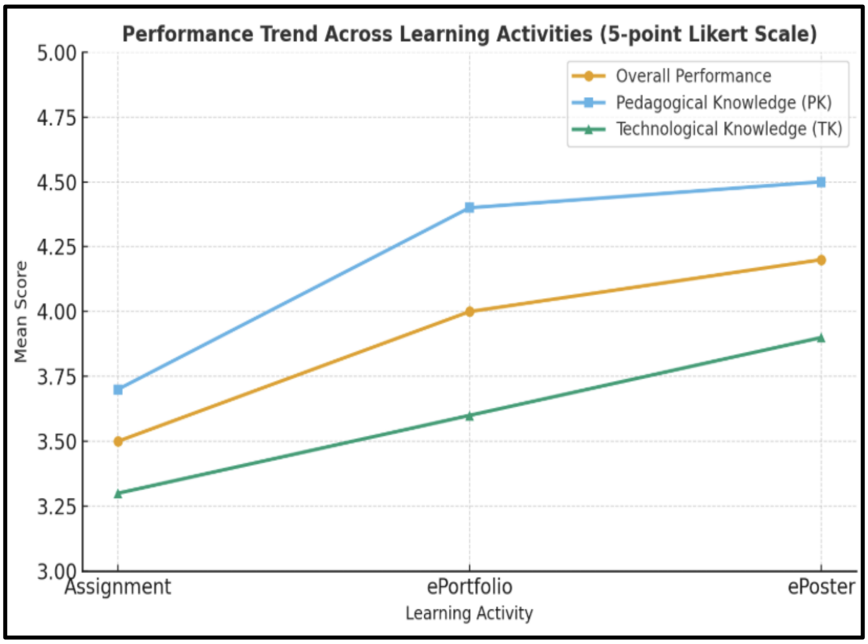

Figure 4: A graphical summary (line chart) to represent the trend between Knowledge domains of Technology (TK) and Pedagogy (PK) across a total performance in Assignment, ePoster and ePortfolio.

TPACK Component Profile by %Method

The overall performance (out of 100%) for each method distributed among the six components of TPACK and the TPACK itself across the task identified as data source (see table 17) show different attainment. Also developed as bar chart (see figure 5) shows the e-Portfolios with highest attainment (92.86%), meaning they scored the strongest overall. e-Posters have the lowest (71.43%), suggesting they are less effective in demonstrating TPACK competencies. Assignments (89.29%) also performed well, while Reflective Logs (78.57%) and Artifacts (75%) were in the mid-range.

Bar chart is also presented as the line and the radar charts. Each line chart (see figure 6) represents one TPACK dimension (TK, PK, CK, TPK, TCK, PCK, TPACK).Across all methods. TK (Technology Knowledge) stays stable at 3 → students consistently demonstrated a baseline level of tech skills. CK (Content Knowledge) and TPACK (integrated knowledge) peaked at 4 in Assignments and E-Portfolios, but dropped to 3 in others. TCK (Tech–Content Knowledge) is the weakest, dipping to 2 for Artifacts and E-Posters. The radar chart (see figure 7) compares all TPACK dimensions (7 axes) for each method in one visualization. E-Portfolios stand out with consistently higher values across all dimensions, showing strong balance. Assignments also form a wide, well-rounded shape, showing good integration. E-Posters and Artifacts have smaller, uneven shapes, especially weak in TCK and TPACK, meaning less integration between technology and content. Reflective Logs are mid-level but slightly stronger in PCK (Pedagogical Content Knowledge).

Table 17: Understanding the TPACK scoring sheet using 1- 4 scale rubric (need improvement, satisfactory, good and excellent

Method	TK	PK	CK	TPK	TCK	PCK	TPACK	Total	%
Assignments (Mean)	3	3	4	3	4	4	4	25	89.28
Reflective Logs	3	3	3	3	3	4	3	22	78.571
Artifacts	3	3	4	3	2	3	3	21	75.000
E-Portfolios	3	4	4	4	3	4	4	26	92.857
E-Posters	3	4	4	3	2	3	3	20	71.429

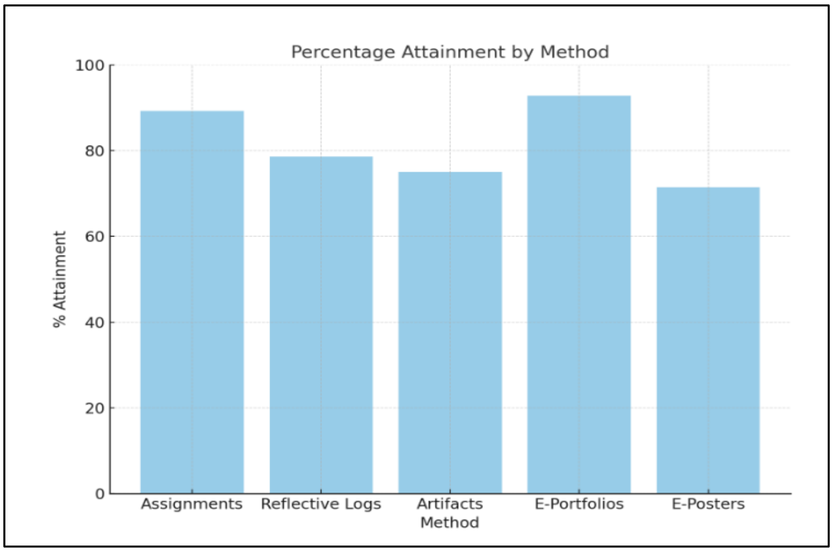

Figure 5: The bar chart for quickly spotting which method leads to better overall TPACK achievement

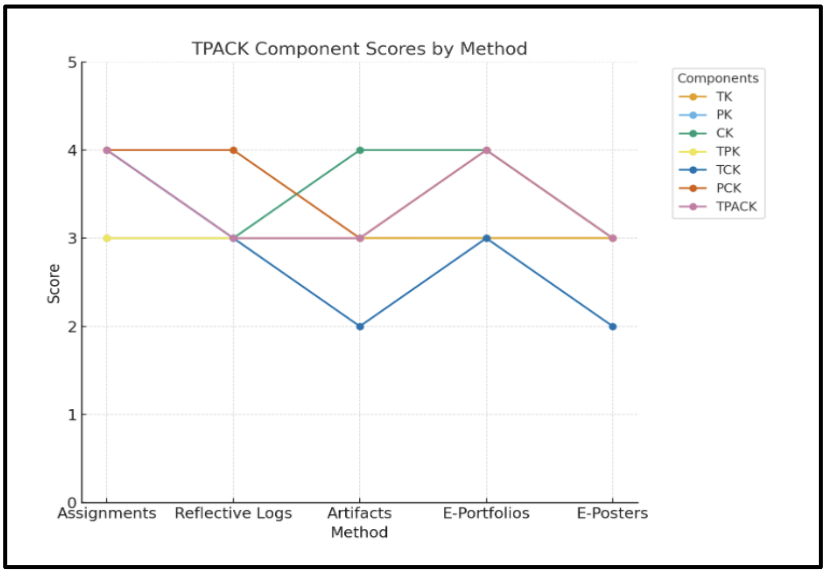

Figure 6: The line chart to show the strengths and weaknesses per knowledge dimension across different learning methods

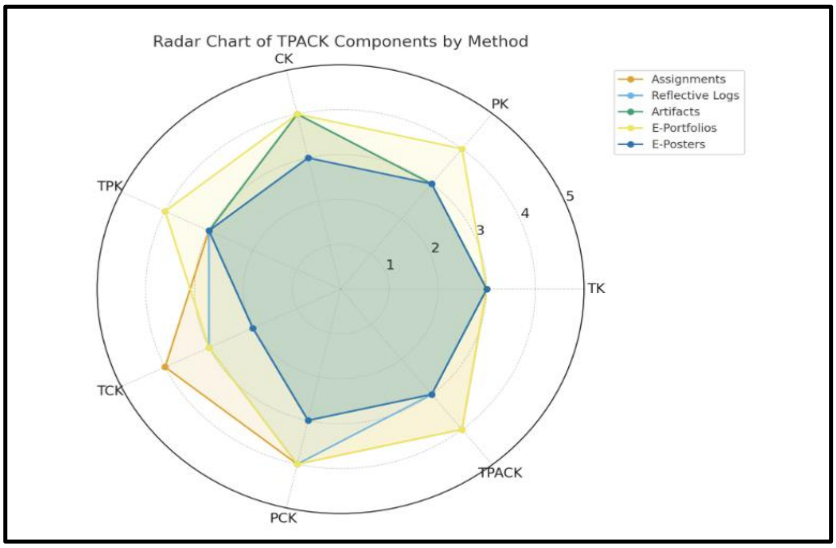

Figure 7: The radar chart highlights the holistic balance of TPACK across methods, making it easy to see which method fosters broader integration.

The process-driven nature of the findings is clear and the faculty emphasized on iterative learning. Nearly 70% of respondents reported that opportunities for reflection after lesson implementation were essential to their growth. As one participant explained, “It’s not just about learning tools; it’s about revisiting what worked and refining it for the next hybrid class.” Embedding TPACK principles into these iterative cycles ensures that faculty development is theoretically grounded and practically relevant. Over all artifacts and Assignments are strong on applied knowledge and contextualization (high on CK, PCK, TPACK). Reflective Logs strong on pedagogy and reflection are high on PK, PCK. And e-Portfolios strong for integration and longitudinal growth are high on TPACK, PK, TK. e-Posters being moderate overall is seen as useful for dissemination of occupational work and long retention of acquired knowledge and skills. Together, these results highlight that future faculty development design should be sustainable, context-sensitive, iterative, and aligned with hybrid teaching and technology

Discussion

Integration of TPACK Frameworks and Gagné’s Model:

Building on the implications identified in the results, the findings reinforce the necessity of adopting a structured, competency-based approach to faculty development grounded in the Technological Pedagogical Content Knowledge (TPACK) framework and Gagné’s Nine Events of Instruction. Evidence from the Competency-Based Educational Training (CBET) program demonstrates that effective faculty training must extend beyond mere technological proficiency to include pedagogical reasoning and content alignment with digital tools. Integrating technology through a coherent instructional design model allows faculty to design learning experiences that foster engagement, conceptual understanding, and long-term knowledge retention.

Moreover, embedding TPACK principles within a Competency-Based Education and Training (CBET) framework creates a productive interface between teaching competence and professional accountability to incorporate technology as the best fit for enhancing learning experience. Faculty development thus shifts from being an isolated event to an ongoing process of reflective professional growth, consistent with the current movement toward evidence-informed, learner-centred education in medical schools. Within this context, TPACK and Gagné’s models function as complementary anchors, the former conceptualizing the dynamic relationship between technology, pedagogy, and content, and the latter offering a structured instructional sequence that promotes cognitive engagement and skill mastery.

Synthesis of Literature and Theoretical Alignment:

Recent scholarship underscores that workshops focusing solely on digital tool proficiency often fail to produce sustained pedagogical change, primarily because they overlook the integration of technology with content and context (Koehler and Mishra, 2009). In contrast, TPACK-based faculty development initiatives cultivate strategic technology use, ensuring that digital tools support, rather than dominate, the learning process. Such interventions enable educators to align technology selection with pedagogical goals and disciplinary content, promoting coherence and instructional purpose.

Similarly, the application of Gagné’s Nine Events with TPACK in faculty development highlights the value of a systematic, process-oriented model that scaffolds instructional planning and learner engagement (Mohamad et al., 2025). Programs that employ Gagné’s sequential stages from gaining attention to promoting retention, advance learner-centred teaching and foster reflective practice among faculty. The integration of these two frameworks establishes a dual foundation for faculty training: TPACK defines the conceptual underpinnings of technology integration, while Gagné’s model operationalizes these concepts through structured instructional events. Together, they provide a comprehensive framework for reimagining faculty development as an iterative, evidence-based practice (Dysart and Weckerle, 2015).

Empirical Insights and Pedagogical Implications:

The results of this study reveal that faculty members who participated in CBET activities demonstrated measurable growth in integrating technological tools within pedagogically intentional and content-precise contexts. This finding underscores the value of a layered developmental model, beginning with the exploration of TPACK domains (Read et al., 2019), followed by guided implementation based on Gagné’s instructional design principles. Such sequencing enables faculty to evolve from basic awareness toward strategic and confident use of digital tools that enhance teaching effectiveness. The findings indicate that faculty participants in the Competency-Based Educational Training (CBET) program demonstrated measurable advancement in their capacity to integrate technological tools within the pedagogical and content-specific contexts of their teaching practice. This outcome highlights the effectiveness of adopting a layered developmental trajectory in faculty training beginning with conceptual understanding and exploration of the TPACK domains**,** and progressing toward guided implementation informed by Gagné’s instructional design principles (Vannatta and Beyerbach, 2000).

The CBET course, purposefully designed to align with both TPACK and Gagné’s frameworks (McNeill and Fitch, 2023), provided an authentic context for building faculty competence. Participants’ reflections and performance data indicated heightened awareness, confidence, and capability in aligning technology with pedagogy and content. This transition reflects a movement from technology adoption to technology integration, where digital tools are used to amplify learning rather than replace traditional instruction.

In the short term, such integrative faculty development manifests in more purposeful lesson planning, improved use of technology to achieve learning goals, and enhanced student engagement (Derri and Kioumourtzoglou, 2014). Over time, it contributes to curricular transformation, institutionalized innovation, and sustained pedagogical improvement across programs (Bower et al., 2013). To ensure this progress, continuous evaluation and feedback mechanisms should be embedded within development programs to measure outcomes and inform ongoing refinement.

Future Directions and Institutional Commitment:

Moving forward, institutions should prioritize longitudinal and scalable faculty development models that integrate TPACK and Gagné’s frameworks as central design elements. Future research may explore the sustainability of such models across varying contexts and their impact on learner outcomes over time. Establishing structured mentoring systems, peer observations, and reflective learning communities can further strengthen faculty engagement and continuity of practice. Ultimately, faculty development must evolve from episodic or tool-centred training into a conceptually grounded, contextually adaptive, and outcome-driven process (Cherrstrom et al., 2017). By anchoring professional growth in the synergy of TPACK and Gagné's instructional model, institutions can foster educators who are technologically adept, pedagogically strategic, and content-competent, a combination essential for advancing teaching excellence and educational innovation in medical education. Significant improvements were observed across all seven TPACK domains ($p < 0.001$). The largest mean differences in quantitative findings were seen in Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK), reflecting enhanced confidence in integrating digital tools using CBET framework for skills training. The qualitative findings revealed four themes of increased confidence in hybrid teaching, pedagogical awareness, technological adoption and reflective practice for sustainability and integrated collaborative learning.

Conclusion

The findings indicate that faculty engagement in TPACK-informed CBET for faculty development significantly enhances their capacity to integrate technological, pedagogical, and content knowledge in a structured and meaningful way. Faculty members demonstrated measurable growth across all seven components of TPACK incorporated as TK, PK, CK, TPK, TCK, PCK, and TPACK as the centre of intersection suggesting that a layered, scaffolded approach to professional development fosters deeper understanding and practical application. This study underscores the importance of aligning faculty development with competency-based educational frameworks, ensuring that technological tools are not only adopted but are purposefully integrated to support learner outcomes. Future initiatives should continue to employ a dual-model approach, combining awareness and exploration of TPACK domains with guided application through instructional design principles, thereby promoting sustainable, high-quality teaching practices within CBME programs.

References

1. Bower, M., Highfield, K., Furney, P., & Mowbray, L. Supporting pre-service teachers' technology-enabled learning design thinking through whole of programme transformation. Educational Media International, (2013). *50*(1), 39–50. https://doi.org/10.1080/09523987.2013.777183
2. Bugge D., Rutberg J., Ahmed S. H., Zisk R., Jammula D. Development of hypothetico-deductive skills in an ISLE-based lab taught by novice instructor. The physical Editor; 2023, 58(3):035013DOI:10.1088/1361-6552/acb9ca
3. Cherrstrom, Catherine A.; Richardson, Ra'sheedah; Fowler, Debra; Autenrieth, Robin; and Zoran, Mark J. (2017) "Creating Teaching Opportunities for STEM Future Faculty Development," *Journal of STEM Teacher Education:* Vol. 52: Iss. 1, Article 7. Available at: https://ir.library.illinoisstate.edu/jste/vol52/iss1/7
4. Derri, V., Vasiliadou, O., & Kioumourtzoglou, E. The effects of a short-term professional development program on physical education teachers' behaviour and students' engagement in learning. European Journal of Teacher Education, (2014). 38(2), 234–262. https://doi.org/10.1080/02619768.2014.947024
5. Dysart, S., & Weckerle, C. Professional development in higher education: A model for meaningful technology integration. Journal of Information Technology Education: Innovations in Practice, (2015). 14, 255-265 Retrieved from http://www.jite.org/documents/Vol14/JITEv14IIPp255-265Dysart2106.pdf
6. Darsih, E., Agustiana, V., & Rahmatunisa, W. (2023). Exploring the integration of technological pedagogical content knowledge (TPACK) in online teaching among EFL lecturers. English Review: Journal of English Education, 2023; 11(2), 561-570.
7. https://doi.org/10.25134/erjee.v11i2.7570
8. Espinoza B. D., Neal M. Incorporating Contextual Knowledge in Faculty Professional Development for Online Teaching. Journal on Centres for Teaching and Learning, 2018 Vol. (10) 24-44.
9. Hegazy, N. N., Soliman S. S. A, Ahmed S. A., Ahmed M. M. A Virtual Medical Faculty Development Program for Remote Teaching, Pilot for Replication. Research Square Preprint; 2020: https://doi.org/10.21203/rs.3.rs-73257/v1
10. Jaipal-Jamani, K, Figg, C., Collier, D., Gallagher, T., Winters, K., & Ciampa, K. Developing TPACK of university faculty through technology leadership roles. Italian Journal of Educational Technology, 2018. 26(1), 39-55 doi: 10.17471/2499-4324/984
11. Koehler, M. J., Mishra, P., & Cain, W. (2009). What is technological pedagogical content knowledge (TPACK)? Journal of Education, 193(3), 13–19.
12. McNeill, L., Fitch, D. Microlearning through the Lens of Gagne's Nine Events of Instruction: A Qualitative Study. *TechTrends* **67**, 521–533 (2023). https://doi.org/10.1007/s11528-022-00805-x
13. Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record, 108(6), 1017–1054.
14. Mohamad S. A., , Zaharudin R., Ariffin H. F., Deli M. M. Gagne's Instructional Design in Vocational Training: Insights from A Bibliometric Analysis. International Journal of Research and Innovation in Social Science (IJRISS), 2025. 9(03), 289-302. https://doi.org/https://dx.doi.org/10.47772/IJRISS.2025.90300024
15. Namada, J. M. Learning Management Systems in the Era of E-Learning. In Z. Gulzar & A. Leema (Eds.), Machine Learning Approaches for Improvising Modern Learning Systems, (2021). (pp. 169-190). IGI Global Scientific Publishing. https://doi.org/10.4018/978-1-7998-5009-0.ch007
16. Phan T. H., Tran H. V., Truong T. D., Le H. T., Phan D. Developing Information Technology Competence in Online Education with the TPACK Approach. Vietnam Journal of Education. 2024; Volume 8, Issue 2, 166-176 https://doi.org/10.52296/vje.2024.361
17. Read, M. F., Morel, G. M., Butcher, T., Jensen, A. E., & Lang, J. M. Developing TPACK Understanding Through Experiential Faculty Development. In M. Niess, H. Gillow-Wiles, and C. Angeli (Eds.). Handbook of

Research on TPACK in the Digital Age , (2019). (pp. 224-256). IGI Global Scientific Publishing. https://doi.org/10.4018/978-1-5225-7001-1.ch011

18. Vannatta, R. A., & Beyerbach, B. Facilitating a Constructivist Vision of Technology Integration among Education Faculty and Preservice Teachers. Journal of Research on Computing in Education, (2000). *33*(2), 132–148. https://doi.org/10.1080/08886504.2000.10782305

19. Ward C.L., Benson S. N. K. Developing New Schemas for Online Teaching and Learning: TPACK. MERLOT Journal of Online Learning and Teaching. 2010; Vol. 6, No. 2, 482-490.