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Prioritizing Strategies to Enhance Teachers' Technological Self-Efficacy: A Nominal Group Technique approach

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Abstract
This study explores the enhancement of teachers' technology integration self-efficacy (TTISE) through the Nominal Group Technique (NGT), which involved seven educational experts. Recognizing the pivotal role of self-efficacy in effective educational technology integration, the study aims to develop strategies for improving self-efficacy among teachers. Findings indicate that mastery and vicarious experiences are critical in fostering self-efficacy. Conclusively, strategies such as incremental challenges and peer observation have proven effective in sustaining technology integration. Thus, further research should investigate the impact of social persuasion and emotional states on TTISE and address barriers to the full utilization of mastery and vicarious experiences.

Keywords: Nominal Group Technique; Technology Integration Self-Efficacy; mastery experiences; vicarious experiences

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1.0 Introduction

Technology integration in education has become increasingly crucial in the 21st century, transforming traditional classroom environments and pedagogical approaches. Effective technology integration is achieved when its use supports curricular goals and helps students construct knowledge in ways that would be difficult or impossible without technology (Ertmer & Ottenbreit-Leftwich, 2010). This integration process, however, is complex and multifaceted, involving not just the acquisition of technology but also changes in teaching methods, curriculum design, and school culture.The COVID-19 pandemic has accelerated the need for technology integration in schools, highlighting opportunities and challenges. Schlesselman (2020), emphasizes the need for deliberate instructional design and teacher preparation for effective online and blended learning environments.

The successful integration of technology in schools largely depends on teachers' attitudes, beliefs, and competencies. Teachers' beliefs about the value of technology for learning, their technological self-efficacy, and their pedagogical beliefs significantly influence their technology integration practices (Lai et al., 2022). Research has consistently demonstrated that teachers with higher levels of Teacher's Technology Integration Self-Efficacy (TTISE) are more inclined to infuse technology into their teaching practices. For example, Ertmer and Ottenbreit-Leftwich (2010) stated that teachers with high self-efficacy for technology integration tend to use technology more in their teaching lessons.

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One of the primary issues concerning TTISE is the gap between perceived and actual technological competence. Kruger and Dunning (1999) demonstrated that individuals with low ability in a domain often overestimate their competence, while highly skilled individuals tend to underestimate theirs. In the context of educational technology, this situation may create a gap between teachers' self-efficacy and their actual ability to integrate technology effectively. Meanwhile, Ertmer et al. (2012) stated that some teachers might have high self-efficacy for basic technology use yet low self-efficacy for integrating technology in pedagogically meaningful ways. This discrepancy can result in superficial technology integration that does not significantly enhance student learning.

Another significant issue is the rapidly changing nature of technology, which can create a moving target for teachers' self-efficacy (Saienko et al., 2020). As new technologies emerge and existing ones evolve, teachers must continually update their skills and knowledge. This constant change can lead to what Howard and Gigliotti (2016) term "change fatigue," where teachers become overwhelmed by the pace of technological advancement and lose confidence in their ability to keep up. Similarly, Mishra and Koehler (2006) argued through their Technological Pedagogical Content Knowledge (TPACK) framework that effective technology integration requires technological knowledge and an understanding of how technology interacts with pedagogy and content. Hence, the complexity of this interaction can further challenge teachers' self-efficacy, especially when faced with new and unfamiliar technologies.

The influence of contextual factors on TTISE presents another set of issues. Tondeur et al. (2017) asserted that school culture, leadership support, and resource access significantly impact teachers' beliefs about their ability to integrate technology effectively. In schools with limited resources or unsupportive administrations, teachers may develop low self-efficacy regardless of their actual skills. Conversely, Ertmer et al. (2012) noted that in technology-rich environments, some teachers might feel pressure to use technology even when they lack confidence, leading to anxiety and potentially reinforcing low self-efficacy. Therefore, balancing the provision of resources with appropriate support and expectations is crucial for fostering genuine self-efficacy.

Finally, there is the issue of translating high technology integration self-efficacy into effective classroom practices. While self-efficacy is generally positively correlated with technology use, Ottenbreit-Leftwich et al. (2010) discovered that other factors, such as teachers' value beliefs about technology, can moderate this relationship. Teachers with high self-efficacy may still prefer not to integrate technology if they do not believe it adds value to student learning. Additionally, Tschannen-Moran and Hoy (2007) noted that novice teachers' self-efficacy beliefs are often more malleable and less predictive of their behavior than experienced teachers. This suggests that, while important, fostering technology integration self-efficacy is not sufficient to ensure effective technology use in the classroom. Hence, addressing these issues requires a multifaceted approach that considers self-efficacy alongside other factors such as beliefs, knowledge, school culture, and ongoing support.

Therefore, there is a need for a study to investigate the strategies that can be taken to improve the teacher's self efficacy to enhance the technology integration in the classroom. Previous studies stated that TTISE can be enhanced through targeted professional development and hands-on experience with educational technologies (Barton & Dexter, 2020). Thus, continuous training, peer mentoring, and collaborative learning communities can boost teachers' confidence using digital tools (Ertmer et al., 2012). Moreover, providing access to up-to-date resources and technical support further improves their self-efficacy (Karim et al., 2021). Accordingly, by implementing policies encouraging technology integration, allocating resources for training, and recognizing teachers' efforts, leaders can foster a culture of digital literacy and confidence among educators (Shepherd, 2017). While multiple factors contribute to teacher technology integration self-efficacy (TTISE), mastery and vicarious experiences play particularly crucial roles in its development (Barton & Dexter, 2020).

This study aims to develop strategies to enhance teacher's technology integration self efficacy through mastery and vicarious experiences according to expert consensus.

2.0 Literature Review

The literature on TTISE highlights several key factors influencing their ability to integrate technology into educational practices. A recurring theme is the significance of positive computer attitudes and self-efficacy among prospective teachers, as these are crucial for effective classroom technology use (Ying-chen & Kinzie, 2000). Studies emphasize the need for ongoing professional development to enhance teachers' confidence and skills, suggesting that training should be continuous and tailored to individual needs rather than one-time events (Gomez et al., 2022). This approach is supported by findings that highlight a gap between teachers' perceived TPACK and their actual implementation, indicating a disconnect that targeted professional development could address (Kıylık & Kılıç, 2023). Furthermore, cultural and contextual differences also significantly shape teachers' self-efficacy, with mastery experience being the strongest source in Japan and Finland (Yada et al., 2019). Additionally, factors such as school type and teaching context influence self-efficacy, with private school teachers and those teaching younger students often reporting higher confidence levels (Mahmood et al., 2021).

Despite these insights, several gaps remain in the literature. While there is evidence supporting a positive relationship between teachers' self-efficacy and technology use, this relationship is not universally observed and can be influenced by external factors such as infrastructure and professional development opportunities (Kundu et al., 2020)). This suggests that other factors, such as belief systems and environmental support, may mediate this relationship. Therefore, by addressing these gaps, educators and policymakers can develop more effective strategies to enhance TTISE, ultimately improving educational outcomes.

2.1 Self-Efficacy

TTISE refers to their belief in their ability to use technology in their teaching practices effectively. This concept is rooted in Bandura's (1977) social cognitive theory, which posits that self-efficacy beliefs influence behavior and performance. In the context of educational

technology, Wang et al. (2004) defined TTISE as teachers' confidence in their capacity to use technology to enhance student learning and engagement. This self-efficacy is crucial in determining the extent and quality of technology integration in classrooms.

Several factors contribute to the development of TTISE. Bandura (1977) identified four sources of self-efficacy: mastery experiences, vicarious experiences, social persuasion, and physiological and emotional states. In the context of technology integration, mastery experiences can be gained through successful implementation of technology-enhanced lessons. Vicarious experiences occur when teachers observe their colleagues effectively using technology. Notably, social persuasion involves encouragement and support from administrators and peers. Lastly, positive emotional states associated with technology use can enhance self-efficacy. Heap et al., (2020) reported that professional development programs that address these sources can effectively boost TTISE.

3.0 Methodology

The Nominal Group Technique (NGT) is the main approach used in this study. The study includes seven experts who have worked on methods to improve the TTISE. Since it is currently hard to bring together specialists in person, researchers conduct NGT sessions online via Google Meet. A two-hour session was held. Experts were consulted, and the NGT method was utilized to generate ideas and solutions based on expert perspectives. At the end of the meeting, the researcher used the NGT Plus software to do a specific computation that yielded data relevant to the study's aims.

3.1 NGT techniques step

The NGT is an organized approach to getting collective feedback on a specific subject. Debecq et al. (1975) proposed a participatory technique for social planning that included exploratory research, citizen involvement, interdisciplinary collaboration, and proposal review. NGT has been employed in various settings over the years, most notably in social science and health studies (Cooper et al., 2020). However, it has also been used in educational research (Mustapha et al., 2022). This strategy works particularly well in groups of unfamiliar people, balancing power relations and ensuring equitable participation. It aids in identifying challenges, solution research, and priority setting, making it a useful tool in group decision-making processes (Harb et al., 2021).

NGT generally consists of the following five steps:

1. During a brainstorming session, participants work independently to write down their responses to a stimulus question.
2. In a round-robin session, each participant shares one idea at a time, which is recorded on a large flip chart. Disputing the ideas is not allowed. Once submitted, sheets are pinned to the wall for everyone to see. The facilitator continues to gather ideas until all have been documented or until the group decides they have generated enough contributions.
3. Afterward, participants discuss each idea on the list to ensure they fully understand its meaning.
4. In the voting process, participants identify key concepts, rank their choices (if desired), vote on a flipchart, and evaluate voting patterns. This process encourages authentic outcomes and fosters commitment by ensuring anonymous voting alongside the listed criteria.
5. The NGT experts gather all inputs and accepted changes on flipchart pages, continuously recording the group's processes and outcomes. These sheets, when displayed, allow the group to resume discussions from their previous meeting easily. Additionally, they serve as an effective tool for updating individuals who were unable to attend all or part of the meeting (Fox, 1989).

3.2 Sampling

There is substantial dispute over the optimal sample size when conducting NGT investigations. According to some researchers, NGT can be performed on a single cohort or a big group (Lomax & McLeman, 1984). Nevertheless, it can also be divided into small groups to allow for effective communication based on the demands of the study. For this reason, the following sample sizes have been utilized by prior studies, as stated in Table 1:

Table 1: Number of experts recommendations for NGT study

Author	Sample
Van de Ven dan Delbecq (1971)	5 – 9 experts/participants
Horton (1980)	7 – 10 experts/participants
Harvey dan Holmes (2012)	6 – 12 experts/participants
Abdullah & Islam (2011)	7 – 10 experts/participants
Carney et al (1996)	Min. 6 experts/participants

Sources: (Mustapha et al., 2022)

As a result of the preceding reference, the researcher appointed seven experts to engage in the NGT procedure of this study. Considering the current circumstances that limit contacts, this number is deemed adequate for this investigation.

4.0 Findings

The findings shows suggestions and opinions from experts on strategies for developing the mastery experience and vicarious learning.

4.1 Develop TTISE by Mastery Experience and Vicarious Experience

Mastery experience is crucial in enhancing the technological self-efficacy of the teacher since it handles successful use; hence, it builds a person's confidence directly. When the teacher integrates digital tools into his teaching, the comfort level with technology will go up, and anxiety and resistance will be minimized. Such incidents build resilience and the capacity to resist challenges in the future. Furthermore, mastery experiences lead to increased motivation of teachers to be interested in learning from and exploring new technologies, entering a positive cycle of continuous improvement in technology integration practices. Following the NGT session, the researcher formulated strategies and methods to enhance TTISE based on the recommendations and insights from experts. Below is a list of recommendations derived from their views and opinions:

Table 2 : List of strategies to develop teacher's technology integration self-efficacy by mastery experience

No	Expert opinion and suggestions	Source
1	**Incremental Challenges**: Start with simple technology tasks likely to result in success, gradually increasing the complexity as teachers become more confident. This step-by-step approach helps build a solid foundation of successful experiences.	Expert
2	**Hands-On Workshops**: Organize practical, hands-on workshops where teachers can experiment with new technologies in a supportive environment. These workshops should focus on real classroom applications, allowing teachers to see the direct benefits of technology integration.	Expert
3	**Pilot Programs**: Encourage teachers to participate in pilot programs where they can test new technologies in their classrooms. These programs provide a structured environment for experimentation and learning, with the added benefit of peer support and feedback.	Expert
4	**Reflective Practice**: After implementing technology, it is essential to encourage teachers to reflect on their experiences, focusing on what worked well and what could be improved. Reflection aids teachers in internalizing their successes and learning from challenges, which reinforces their sense of mastery.	Expert
5	**Mentorship and Collaboration**: Pair less experienced teachers with mentors who have successfully integrated technology. Collaborative projects and peer observations can provide additional opportunities for teachers to learn from each other's successes.	Expert
6	**Recognition and Celebration**: Acknowledge and celebrate teachers' successes in using technology. Recognition from peers and administrators can reinforce positive experiences and motivate teachers to continue developing their skills.	Expert

Table 3 : List of strategies to develop teacher's technology integration self-efficacy by vicarious experience

No	Expert opinion and suggestions	Source
1	**Peer Observation**: Arrange opportunities for teachers to observe colleagues who are proficient in using technology in their classrooms. Seeing peers successfully implement technology can inspire confidence and provide practical examples of effective integration.	Expert
2	**Mentorship Programs**: Establish mentorship programs where experienced teachers guide and support less experienced colleagues in technology use.	Expert
3	**Showcase Success Stories**: Highlight and share success stories of teachers who have effectively integrated technology. This can be done through newsletters, staff meetings, or professional development sessions, providing teachers with relatable role models.	Expert
4	**Collaborative Learning Communities**: Create professional learning communities where teachers can collaborate, share experiences, and learn from each other. These communities foster a culture of shared learning and provide a platform for teachers to observe and discuss successful technology integration.	Expert
5	**Video Demonstrations**: Use video recordings of effective technology integration practices in classrooms. These can serve as valuable resources for teachers to observe and learn from, especially when in-person observations are not feasible.	Expert
6	**Workshops and Conferences**: Encourage participation in workshops and conferences where teachers can observe presentations and demonstrations by experts in educational technology. These events provide exposure to innovative practices and successful implementations.	Expert

4.2 NGT analysis result for mastery experience and vicarious experience

Table 4 : NGT result for Mastery Experiences

Items / Elements	Voter 1	Voter 2	Voter 3	Voter 4	Voter 5	Voter 6	Voter 7	Total item score	Percentage	Rank Priority	Voter Consensus
Incremental Challenges	3	3	3	3	3	3	3	21	100	1	Suitable
Hands-On Workshops	3	2	3	3	3	3	3	20	95.24	2	Suitable
Pilot Programs	3	3	3	3	2	3	3	20	95.24	2	Suitable
Reflective Practice	2	3	3	3	3	3	3	20	95.24	2	Suitable
Mentorship and Collaboration	3	3	2	2	2	2	3	17	80.95	4	Suitable
Recognition and Celebration	3	2	3	3	3	2	3	19	90.48	3	Suitable

Table 4 summarizes the components of strategies to develop the TTISE through mastery experiences: Overall scores gained from the perspective of an expert. The results of this study have briefly revealed that all the percentages of the elements assessed are at a

proper level for use since the percentage value has exceeded 70%, as required by studies (Dobbie et al., 2004). From here, the researcher can conclude that all study participants agree that all the main components in the developed model by mastery experiences are acceptable and can be used. Strategies as incremental challenges have been ranked the highest, and all the experts agree that a step-by-step approach to integrating technology can develop the teacher's self-efficacy in using technology during the teaching and learning process. The modified technique of NGT differs from the Delphi method in that through this approach, researchers retrieve information in less time since there are no rounds of evaluation sessions among experts.

Table 5: NGT result for Vicarious Experiences

Items / Elements	Voter 1	Voter 2	Voter 3	Voter 4	Voter 5	Voter 6	Voter 7	Total item score	Percentage	Rank Priority	Voter Consensus
Peer Observation	3	3	3	3	3	3	3	21	100	1	Suitable
Mentorship Programs	3	3	3	3	3	2	3	20	95.24	2	Suitable
Showcase Success Stories	2	3	3	3	3	2	2	18	85.71	4	Suitable
Collaborative Learning Communities	3	3	3	3	3	3	3	21	100	1	Suitable
Video Demonstrations	3	2	3	3	3	3	2	19	90.48	3	Suitable
Workshops and Conferences	3	3	3	3	3	3	2	20	95.24	2	Suitable

Table 5 also provides the strategies for developing the TTISE based on vicarious experiences from the perspectives of the experts. The value of the percentage also has exceeded 70% has been required. Therefore, the researcher can conclude that all the experts agree that the components mentioned in the developed model by vicarious experiences are effective for teacher's technology integration self-efficacy. Strategies such as peer observation and collaborative learning communities have gained experts' full agreement as the strategies are crucial to inspiring confidence and fostering a learning community culture to develop TTISE.

5.0 Discussion

The study shows that Both mastery experiences and vicarious learning is essential to enhance the TTISE.

5.1 Mastery Experiences

The NGT results reveal strong support for all mastery experience elements, with incremental challenges leading to 100% consensus. Three elements (hands-on workshops, pilot programs, and reflective practice) tied for second at 95.24%, while mentorship and Recognition components also received high approval. All elements were deemed suitable, emphasizing their collective significance in mastery development.

In the context of mastery experience, its significance in developing TTISE is observed through hands-on workshops, pilot programs, and reflective practices, which allow teachers to gain firsthand experience with technology. These experiences are highly ranked as a priority and are suitable for professional development. This is supported by Ahadi et al., (2021) that professional development workshop is primarily influencing the effectiveness of teaching skills and student's learning outcomes. Notably, by successfully using technology in such controlled and supportive environments, teachers can build confidence and develop resilience, which are key aspects of self-efficacy (Ghazali et al., 2024). As teachers gain more mastery experiences, their ability to integrate technology into teaching improves, making it more likely that they will continue exploring and adopting new technological tools.

5.2 Vicarious Experiences

The NGT results for vicarious experiences indicate two elements achieving perfect 100% scores: peer observation and collaborative learning communities. Following closely are mentorship programs and workshops/conferences at 95.24%, demonstrating strong voter alignment on these approaches. At the same time, video demonstrations (90.48%) and showcase success stories (85.71%) also received notable support.

Vicarious experiences, such as peer observation and mentorship programs, are highly valued in professional development for enhancing teacher technology integration self-efficacy. Observing peers or mentors effectively using technology in the classroom provides teachers with models of successful technology integration, which helps them believe they can achieve similar success. Gcabashe & Ndlovu, (2022) mentioned that technology peer mentoring enhance teacher's technology skill and efficacy. Collaborative learning communities and video demonstrations also effectively allow teachers to see technology used in various teaching contexts (Ramos et al., 2021). Findings from Cattaneo et al., (2022) also supported that video based collaborative learning can enhance the effectiveness of teaching pedagogy and confidence.These experiences allow teachers to learn from others' successes, boosting their confidence in adopting new technologies in their classrooms.

6.0 Conclusion & Recommendations

Mastery experiences consistently high scores across activities, including incremental challenges, skills workshops, and hands-on workshops, indicate their effectiveness in enhancing skills and confidence. Regarding vicarious experiences, the observation of peers and collaborative learning communities also received unanimous positive feedback, indicating their vital role in perceiving and learning from other people's successes. Consequently, strategies such as professional development programs, technology peer mentoring, video-based collaborative learning, and structured peer feedback mechanisms are essential for cultivating TTISE among teachers.

The current study has various limitations that must be noted. First, while the study extensively explored mastery and vicarious experiences in the development of TTISE, it lacked to effectively address Bandura's other two sources of self-efficacy that are verbal persuasion and emotional/physiological states. This narrow focus may have resulted in an insufficient understand of the broad range of factors influencing teacher technology integration self-efficacy.Further studies should explore Bandura's lesser-studied aspects of verbal persuasion and emotional/physiological states, examining their impact on teacher self-efficacy in technology integration alongside investigating potential barriers that prevent teachers from fully engaging in mastery and vicarious experiences mastery and vicarious experiences**.**

Paper Contribution to Related Field of Study

This study identifies and prioritizes effective strategies for building teachers' technological self-efficacy through empirically validated mastery and vicarious experiences, emphasizing incremental challenges and peer-based collaborative learning approaches.

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