European Journal of Education Studies
ISSN: 2501 - 1111
ISSN-L: 2501 - 1111
Available online at: www.oapub.org/edu

DOI: 10.46827/ejes.v12i9.6192 Volume 12 | Issue 9 | 2025

TRAVAILS OF DIGITAL IMMIGRANT EDUCATORS IN NAVIGATING MODERN TECHNOLOGICAL EDUSCAPES

Danielle Denise P. Amigo[1i],
Jackie B. Cagutom[1],
Joanna Christine B. Gervacio[1],
Jocelyn B. Bacasmot[2]
[1]College of Teacher Education,
University of Mindanao,
Davao City, Philippines
[2]PhD,
College of Teacher Education,
University of Mindanao,
Davao City, Philippines

Abstract:
This phenomenological study aimed to describe the struggles made by digital immigrant educators in navigating modern technology with a focus on contributing to the fourth Sustainable Development Goal: Quality Education. The study utilized a qualitative research design using a phenomenological approach, with 17 secondary educators selected through a purposive sampling tool. The results revealed that the struggles of digital immigrants in navigating modern technology are associated with themes such as Issues in Technological Tool Utilization, Impediments in Technology Integration, and Engagement Issues in the Learning Environment. Moreover, the study revealed how teachers cope with their struggles along with their experiences with the themes: Adaptive Practices, Seeking Support, E-learning, and Self-Tailoring Strategies. Furthermore, the digital immigrants' insights about the evolving technology showed the following themes: Rapid Emerging Technology, Work Efficiency, and Technological Adaptability in Learning. The analyzed findings of this study unveiled the different experiences of digital immigrant educators with technology and how they cope. Hence, this study contributed significant knowledge not only to stakeholders and administrations but also to future researchers.

Keywords: education, technology navigation, digital immigrant educators, phenomenology, Philippines

[i] Correspondence: email d.amigo.524154@umindanao.edu.ph

1. Introduction

The rapid development of technology requires the development of digital competence of every person —especially for teachers— as digital skills are vitally important. Schools have slowly integrated technology for academic purposes, requiring teachers to introduce technology into their teaching practice. Furthermore, the recent COVID-19 pandemic has further institutionalized the application of digital technologies in education. Hence, this has made a paradigm shift in the entire education system (Haleem *et al.*, 2022), forcing teachers to hold classes online and navigate unfamiliar digital tools. The issue primarily affects educators—identified as digital immigrants—who face numerous challenges in incorporating technology into educational practice.

The study by Lipsett (2008) revealed that one-third of the 1,000 teachers surveyed struggled to use technology effectively due to a lack of necessary skills. Another study conducted by Gressard and Loyd in 1985, cited in Raja and Nagasubramani (2018), emphasized that to utilize technology in education successfully, teachers need to have a positive attitude towards technology. However, some barriers prevent teachers from successfully integrating technology into education. Several authors point out the obstacles that hinder digital immigrants from fully integrating technology into their teaching practice. These barriers include a lack of pedagogical training, limited technology resources (Moses *et al.*, 2022), restricted access and network connection, limited technical support, and a lack of teachers' competency (Ghavifekr *et al.*, 2016).

The barriers above may affect the teachers' diligence and self-efficacy, leading to them performing poorly, reduced resourcefulness, and difficulty in adapting to and integrating technology into their teaching practices (Mikusa, 2015). From a global perspective, Moses *et al.* (2022) found that insufficient pedagogical training significantly hindered Namibian secondary school teachers' (eastern region) confidence and ability to effectively integrate technology into their teaching, a finding supported by Ghavifekr *et al.* (2016). Limited access to essential technology resources —printers, interactive whiteboards, projectors— and the burden of repairing and troubleshooting outdated and malfunctioning computer equipment significantly hinders effective technology integration in education.

Among the challenges mentioned, the study concluded that the lack of pedagogical training is a significant factor in the impediment to technology integration in education. Another survey from Africa revealed that most teachers need more essential knowledge when it comes to technology. It has also been discovered that extensive professional development is necessary for teachers to successfully utilize and apply technology in teaching (Aluko, 2019); hence, emphasizing educators' digital literacy for their effectiveness is essential.

A study in the Philippines delved into the challenges and struggles of public senior high school teachers during the pandemic's shift to online learning (Geverola *et al.*, 2022). The sudden transition, necessitated by the pandemic's restriction on face-to-face classes to minimize the spread of the virus (Crawford *et al.*, 2020; DepEd, 2020), created

numerous difficulties. The study revealed several key challenges: a lack of teaching resources—particularly impacting developing countries; the difficulties of managing a virtual learning environment; and the overall adaptation of teaching and learning to the new normal. This highlights the need for accessible instructional methods in developing countries (Geverola *et al.,* 2022).

Several studies have also shown significant reasons why digital immigrant educators are afraid of change, such as fear, anxiety, danger, and reluctance (Fullan, 2006; Prensky, 2001). This shows the need for an in-depth focus and research to create a meaningful effect on technological, pedagogical, and content knowledge (TPACK), especially for digital immigrant educators. Also, more comprehensive qualitative research needs to focus on the struggles experienced by digital immigrant educators, especially in Davao City. While there may be existing studies about technology integration, there may be a need for more in-depth exploration of digital immigrants' struggles. Through this qualitative study, we will procure profound information about the phenomenon. Thus, this descriptive phenomenological study intends to fill the gap by thoroughly examining digital immigrants' struggles toward digital transformation in the 21st century.

This study sought to (1) determine the struggles experienced by digital immigrants in educational technology integration, (2) determine how teachers cope with their struggles along with their experiences, and (3) determine the insights of the non-digital educators towards the evolving technology.

2. Material and Methods

2.1 Research Design

Descriptive phenomenology highlights the 'pure' description and interpretation of people's experiences and the experiences that participants have in a particular phenomenon (Matua & Der Wal, 2014; Creswell, 1998). Moreover, qualitative research is a subjective approach used to describe and analyze people's life experiences and give meaning to them to understand their connection to human social problems better (Creswell, 1998).

This research employed Colaizzi's method of data analysis to formulate meanings and themes based on the responses of digital immigrants in the modern learning landscapes. Based on Colaizzi (1998), as cited in Morrow *et al.* (2015), a specific seven-step process provides accurate analysis that sustained the study's credibility: (1) familiarization, (2) identifying significant statements, (3) formulating meanings, (4) clustering themes, (5) developing an exhaustive description, (6) producing the fundamental structure, and (7) seeking verification of the fundamental structure. Colaizzi's method of data analysis allows for discovering occurring themes and their interwoven relationships (Wirhana *et al.*, 2018) since it is a good way to gather people from common backgrounds or experiences to discuss a distinct scope of interest wherein it is not statistically explained instead it will generate a rich understanding of

participants' experiences and beliefs through the focus groups and semi-structured interview (Mishra, 2016).

A section intended to contain a detailed description of all the methods, materials, collaborators and participants at the study. The protocols used for data acquisition, techniques and procedures, investigated parameters, methods of measurements, and apparatus should be described in sufficient detail to allow other scientists to understand, analyze and compare the results. The study subjects and participants should be described in terms of number, age and sex. Statistical methods should be described in detail to enable verification of the reported results. This section could contain a separate sub-section that comprises the explanation of the abbreviated terms used in the study.

2.2 Research Participants

The researchers of this study were secondary education teachers who were digital immigrants struggling with technology. The research participants comprised ten secondary educators from a public school for a Focus Group Discussion and seven (7) secondary educators from a private school in Davao City for an In-Depth Interview. Anzari *et al.* (2012) found that secondary educators use technology more than elementary educators. This finding emphasizes that secondary educators are viable participants in the study. Creswell (2013) recommended that the sample size for a phenomenological study range from 3 to 25 participants who have experienced the phenomenon. The results can combine individual accounts of educators' experiences and search for common themes to capture the essence through reflecting a shared understanding of the phenomenon. Furthermore, the participants were chosen through purposive sampling, which provided quality and valuable insights based on how they expressed their lived experiences as digital immigrant educators accurately and honestly, excluding elementary and higher education teachers. They are limited only to secondary education teachers (Sooleen, 2023).

2.3 Research Instrument

The researchers used focus groups and semi-structured interviews as research instruments for the study. The focus group setting is calm and inclusive, with six to eight people sitting in a circle, and naturally, respondents are more willing to express open, honest thoughts to questions because there is no pressure to answer, hence the authenticity of a helpful method for gathering rich, insightful information from the participants (B2B International, 2022). On the other hand, an in-depth interview explores the respondent's point of view, experiences, feelings, and perspectives, emphasizing the value of our research. In addition to the follow-up questions based on the participants' responses, an interview guide was used, which produced a natural discourse in which participants were free to express their experiences and views about the study, resulting in rich data for analysis. Also, the researchers submitted informed consent to the prospective participants, taped each session, and transcribed the whole interview. They stressed that the information collected from them remained confidential per Republic Act

10173, also known as the Data Privacy Act of 2012. Nonetheless, if the prospective participants declined the invitation or withdrew during the interview, the researchers respected their right to do so.

3. Results and Discussion

3.1 Struggles Experienced by Digital Immigrants in Educational Technology Integration

Presented in Table 1 is the set of emergent themes extracted from their cluster themes relevant to the struggles experienced by Digital Immigrants in Education Technology Integration.

Table 1: Struggles Experienced by Digital Immigrants in Educational Technology Integration

Emergent Themes	Cluster Themes	Formulated Meaning
Issues in Technological Tool Utilization	Manipulation of Equipment	• Teachers struggle to use basic presentation tools such as Microsoft PowerPoint. • The teacher lacks the necessary skills in using technological equipment in class. • Teachers encountered difficulties manipulating the equipment for the first time.
	Anxiety about Using Tools or Materials	• The teacher lacked confidence in her ability to use the new application correctly. • The teacher was concerned that he had used an incorrect tool, potentially misinforming his students. • The teacher worries about not finding materials relevant to his discussion.
Impediment in Technology Integration	Technical Issues	• Setting up equipment consumes too much time that is supposed to be intended for discussions. • Technical issues and troubleshooting result in less time for discussion. • Slow internet connection delayed the start and flow of the class.
	Difficulty in Technology Adaptation and Learning	• Teachers struggled to adapt to the sudden change in teaching modality. • Teachers face challenges in adapting new technologies due to the complex technical terms involved. • Teachers require time to learn and integrate new technologies effectively.
Engagement Issues in the Learning Environment	Distraction	• The teacher ended up discussing the video presentation due to students' excessive verbal engagement with one another. • Teachers are concerned about how students are easily distracted in class, even though technology is utilized. • The teacher's divided attention between managing the technology and delivering the lesson negatively impacted student engagement.

	Apathetic Learners	• The teacher's unfamiliarity with the tools used in class lessens the students' engagement and interest. • The teacher struggles to incorporate interactive digital tools to make students productive in class. • The teacher needs to adapt to using technology and improve teaching quality to stimulate the learner's interest in class.

A. Issues in Technological Tool Utilization

This emergent theme refers to the obstacles or difficulties when digital immigrants use technological tools in education. The cluster themes that create this emergent theme are Manipulation of Equipment and Anxiety in using Appropriate Tools or Materials. A teacher must have digital competence where technology is encouraged in education. Teachers' digital competence refers to their knowledge, skills, and attitude to ensure technology's critical and creative use in education (Babushko *et al.*, 2022).

However, Fernández-Batanero *et al.* (2021) implied that teachers experienced issues in technological tool utilization due to their lack of knowledge about technology and their fear of trying something new. Though teachers find technological tools helpful for students' daily instruction, their knowledge and skills when it comes to these tools are lacking (Babushko *et al.*, 2022).

B. Manipulation of Equipment

Teachers experience difficulties manipulating technological equipment, contributing to their struggle to integrate technology into education. Teachers use electronic devices such as projectors, mobile phones, PowerPoints, video presentations, and e-learning methods in the teaching-learning process (Haleem *et al.*, 2022). Additionally, digital tools allow teachers to create instructional materials and develop new teaching methods for students to learn and collaborate. However, Criollo-C. *et al.* (2021) stated that teachers are having difficulty manipulating tools since some of them are inexperienced when navigating technological tools. The problems experienced by teachers when manipulating equipment are observed in the following statements.

Teacher 4 implied that the sudden shift from traditional materials to digital tools challenged their adaptability.

> *"…we used manila paper, also called "Bitay Max", reporting all lessons should be done using those. Most of my colleagues, including myself, find it hard to manipulate equipment, such as basic PowerPoint, in a much more synchronized manner since we do not know how."* [Teacher 4]

Moreover, Teacher 7 insinuated they were unfamiliar with using the tool.

"…I am unfamiliar with the process of connecting an HDMI cable to the television, and it will take me too long to figure it out. I ended up asking a student from the other class for assistance to avoid significant delays." [Teacher 7]

Similarly, Teacher 17 also struggles with navigating the equipment to use in class.

"… I was having a problem using the projector because I did not know how it worked, and it was my first time using it. One of my colleagues told me I should at least know how to use a projector." [Teacher 17]

Technological tools enhance the classroom environment as they pique students' interest and increase engagement in the teaching and learning process. However, using that equipment without the skills and knowledge can result in difficulty when incorporating it into education. Salam *et al.* (2023) pointed out in their teaching study that teachers saw digital tools as a new tool to learn and integrate into their teaching practices rather than a natural teaching aid, and this challenged them to upgrade their technological skills and develop new strategies for adapting and adopting technologies in the classroom.

C. Anxiety in Using Appropriate Tools or Materials

This theme refers to the teachers' anxiety when they use a specific new tool or material in their teaching and worry about whether they use it appropriately and correctly. Using the right tools or materials in a technology-driven classroom is significant in learning. Moreover, teachers must consider which digital tools or materials are relevant and appropriate for the curriculum (Lindell, 2022). Still, teachers' lack of knowledge about technology makes them anxious, and they sometimes wonder if the tools and materials they will incorporate into the students' learning process are aligned, relevant, and appropriate for them. The anxiety and stress felt by the teachers when choosing tools affect their judgment on whether the tools that they are going to use are relevant, as observed in the following statements.

Teacher 8 expressed that integrating new digital tools and resources into teaching is more complex, resulting in uncertainties, leading to self-doubt about their proper application.

"…I cannot immediately apply the new tools because I doubt whether I know how to use them correctly." [Teacher 8]

Teacher 13 inferred that students can become misinformed when they cannot find aligned topics for their discussions and do not review them beforehand.

"*…without reviewing the content beforehand, I risk presenting inaccurate information to my students."* [Teacher 13]

Additionally, Teacher 15 worries about not finding proper materials that are relevant to the discussion.

> *"Sometimes, I worry about not finding materials that are relevant or aligned with my discussion."* [Teacher 15]

In this scenario, a person experiences anxiety when he or she is "ignorant of a particular situation" (Fernández-Batanero *et al.*, 2021), and in this case, teachers are anxious due to navigating unfamiliar tools and at the same time finding appropriate resources befitting the lesson. This technological anxiety can also significantly impact teaching effectiveness. Buhamad *et al.* (2024) note that due to the rapid pace of technological advancement, some teachers feel overwhelmed, resulting in weak performance when it comes to utilizing technology in their instructional practices.

D. Impediments in Technology Integration

This theme refers to hindrances that contribute to the struggles experienced by digital immigrants in integrating technology into education. The cluster themes that establish this theme are Technical Issues and Difficulty in Technology Adaptation and Learning. In Dinc's (2019) study, technology integration is the usage of technology to support the way of teaching. As much as they appreciate its significance, teachers encounter obstacles while integrating technology into teaching and learning (Moses *et al.*, 2022). These barriers are divided into first-order and second-order categories (Dinc, 2019; Ertmer, 1999). First-order barriers are external factors that include access to technology, time, support, and professional development training. On the other hand, second-order barriers are internal factors that include teachers' confidence in using technology and the usefulness of technology in education. These barriers are evident in the struggles of digital immigrants in technology integration.

E. Technical Issues

This theme refers to the technology-related issues that cause impediments to integrating technology. Technical problems are a significant barrier for teachers, including waiting for videos to load and failing to connect to the internet, which consumes too much time. Instead of having a full-hour smooth lesson delivery, the teachers are now busy attending to these issues (Ghavifekr *et al.*, 2016), which is evident, especially during the pandemic. During online learning, teachers experienced difficulties when navigating technology in particular areas. They find problems due to needing to be used to the new modality of learning (Haleem *et al.*, 2022). Thus, these technical issues experienced by digital immigrants are observed in the following statements.

Both Teacher 4 and Teacher 10 experienced unexpected equipment malfunctions and lengthy troubleshooting sessions, resulting in less discussion time.

"…there is little time left for discussions due to unexpected technical issues while setting up my equipment." [Teacher 4]

"…the time allotted for my discussion was lessened due to technical issues." [Teacher 10]

Moreover, Teacher 2 cited slow internet connectivity as another significant factor for having technical issues in teaching, causing delays and disrupting class flows.

.

"…I played a video, and after how many minutes it stops playing, starts to buffer and will take a while to start playing again." [Teacher 2]

Technical issues in the classroom and poor internet connectivity significantly hinder teachers' ability to effectively integrate technology into their instructional practice (Olita & Orong, 2023). Additionally, Ilias *et al.* (2020) stated that these challenges not only affect teachers but also impede students' learning experience. Such difficulties were evident during online instruction, where teachers encountered technical difficulties that hindered their effective use of the medium (Sitzmann *et al.*, 2010).

F. Difficulty in Technology Adaptation and Learning

This theme refers to digital immigrants' difficulties adapting to and learning technology, which causes impediments in technological integration and contributes to their struggle. Babushko *et al.* (2022) implied that teaching is one profession that needs digital skills and the ability to apply new technologies; therefore, digital competence is a basic need for teachers. Additionally, teachers must be able to use technology to help students become collaborative, problem-solving, and creative learners; professional development and training are essential for teachers to achieve this purpose. However, teachers with inadequate training are neither prepared nor confident to integrate technology (Ghavifekr *et al.*, 2016). Difficulty in technology adaptation and learning has contributed to the struggles of digital immigrants in the integration of technology in education, as observed in the following statements.

Teacher 16 struggled during the abrupt shift in teaching modality and did not have adequate time to familiarize herself with online classroom technology.

"…it was hard to navigate the laptop, applications, and platforms used for online classes. The shift was sudden, and we could not prepare for the changes." [Teacher 16]

Additionally, Teacher 4 stated that even though schools conduct seminars and training about technology to help them, they find applying what they learn into practice difficult, as some seminars and training are fast-paced, and they cannot keep up.

"…lectures are fast-paced, and we have no time to learn immediately, especially with our age." [Teacher 4]

Similarly, Teacher 5 struggles to learn about technology and, at the same time, utilize it in the classroom due to their age.

> *"…we need more time to learn everything about technology, and with our age, it is hard to keep up."* [Teacher 5]

Additionally, the COVID-19 pandemic and school lockdown necessitated teachers to shift into online teaching. It was not an easy transition, and success depends on teachers having the skills, knowledge, and competence for online teaching (Winter *et al.*, 2021). Moreover, Ghavifekr *et al.* (2016) also stated that the age of teachers could be an objective factor in their difficulty in acquiring digital competence.

G. Engagement Issues in the Learning Environment

This theme concerns digital immigrants' difficulties keeping students engaged and focused during class. Despite the efforts of teachers to utilize technology in learning, there are still issues in maintaining students' focus. The cluster themes that establish this emergent theme are Distraction and Apathetic Learners. Students are digital natives and are more knowledgeable in using technology than digital immigrants; therefore, engaging more in learning technology is involved in their learning process. Engagement is a central aspect of effective teaching; however, if students are not fully engaged in the class, there is a possibility that they will not learn from the lesson (Grove, 2019). Teachers who are inexperienced in technology will find it challenging to think of ways to engage students in the classroom (Bergdahl, 2022).

E. Distraction

This theme refers to how teachers' lack of skills and inexperience when using technology affects students' attention and focus in class. Also, students using mobile phones during class without the teacher's permission can make them easily distracted. Students are now digitally dependent, and various forms of technology, such as laptops, tablets, mobile phones, etc., have invaded the classroom, and keeping them focused and interested for the whole class duration is a challenge for teachers (Attia *et al.*, 2017). Guerrero-Arias *et al.* (2021) emphasized that students may experience distraction if the teacher is inexperienced in using technology, and because teachers struggle to use technology, students tend to do irrelevant things during class hours, taking away their focus and attention and keeping them busy. Hence, distraction affects the engagement of students in the learning environment, as observed in the following statements.

Teacher 10 had to re-explain the video presentation to the students due to their off-topic conversations.

> *"…even though I used a video presentation for my discussion, I had to re-explain its content because they still do not listen and do some things unrelated to the class."* [Teacher 10]

Similarly, Teacher 8 also has the same problem: students cannot answer when asked about their previous discussion because they are busy using their phones.

> *"…students cannot answer when asked about the previous topic because they were busy using their phones without permission, and this behavior can affect their performance in class."* [Teacher 8]

Lastly, Teacher 4's concern was that the students' attention during class would be distracted because the teacher was busy figuring out what to do next with the tool they used in class.

> *"…the students' retention and attention are affected because I cannot entirely focus on discussing the topic because I am busy figuring out what to do next with the tool I used."* [Teacher 4]

Saroh and Htun (2020) revealed that some digital immigrant teachers lacked the confidence to integrate technology in teaching since they are aware that students are more proficient than they were, and this issue may unintentionally contribute to student distraction due to the challenges in integrating technology effectively. Furthermore, a teacher's inability to clearly deliver information with the use of modern educational tools can lead to students' disinterest in the discussion, and students who simultaneously talk during class create a distraction within the learning environment (Attia *et al.*, 2017).

F. Apathetic Learners

This theme refers to the difficulty of digital immigrants in integrating technology into education and keeping the students interested in class. Teachers have long faced the challenge of getting students excited about learning and keeping them engaged in the classroom, and this problem is not new to them (Long, 2023). However, in this era where technology integration is encouraged in education, it becomes challenging for digital immigrants to operate tools in class without enough knowledge and at the same time, it should not affect the students' interest, so they do not have a passive attitude towards learning. Moreover, digital immigrants have trouble keeping students' interest in class, and this contributes to their struggle with technology integration in education, as observed in the following statements.

Teacher 17 sensed that students are interested in something other than listening to the discussion despite utilizing digital tools, and they can feel that the teacher is not yet familiar with the tools.

> *"…students are not interested in listening to me during discussion or when I use technology, maybe because they can sense I do not know what I am doing with the tool."* [Teacher 17]

Furthermore, Teacher 9 struggles to incorporate interactive digital tools to make students more productive in class.

> *"…when I incorporate digital tools in my class, it seems they are not interested in participating, maybe because the tool I used was not that interactive."* [Teacher 9]

Lastly, Teacher 3 needs to adapt to using technology to stimulate the learner's interest in class.

> *"…if I do not adapt and learn technology this time, students might lose interest in my class because I cannot incorporate interactive tools."* [Teacher 3]

Digital immigrant educators find it difficult to integrate technology into their teaching and, at the same time, motivate apathetic learners (Oriji & Torunarigha, 2020). To address this challenge, when teachers integrate technological tools in class, they must be familiar with them, ensuring that they suit the students' needs (D'Angelo, 2018), and keep them interested throughout class.

3.2 How Teachers Cope with Their Struggles Along Their Experiences

Presented in Table 2 is the collection of emergent themes derived from their cluster themes concerning how teachers manage challenges throughout their experiences.

Table 2: How Teachers Cope with Their Struggles Along with Their Experiences

Emergent Themes	Cluster Themes	Formulated Meaning
Adaptive Practices	Notetaking as a Coping Mechanism	• The teacher takes notes on managing technology integration. • Recognizing memory challenges with age, note-taking aids in managing technology integration. • The teacher resorts to using the chalkboard if they encounter difficulty with technology.
	Alternative Strategy for Handling Technology	• Familiarizing with the details of using technology tools to effectively integrate technology into teaching. • The teacher utilizes shorter video clips in teaching to maintain student engagement. • The teacher applies their experiential learning to easily present the discussion.
Seeking Support	Technology Integration Assistance	• Students who are proficient in technology are chosen by the teachers as models for learning the technology. • Initial challenges in balancing technology use are lessened by the guidance of family members. • Expert teachers are consulted for guidance on utilizing specific technologies effectively.
	Collaborative Support in Technology Navigation	• Co-teachers are relied upon for assistance in using unfamiliar technologies. • The teacher sought assistance from colleagues in navigating technological challenges.

		• Daily interaction with colleagues at school proves beneficial in addressing technological challenges.
E-learning	Incorporating Online Tutorials for Technology Skill Acquisition	• The teacher utilizes YouTube tutorials as the chosen method. • YouTube serves as a primary resource for acquiring support and improving proficiency. • Following a recommendation, YouTube tutorials are sought for assistance.
	Accessing Websites and Applications for Educational Technology Purposes	• PowerPoint presentations and relevant video clips, along with information from Google, are utilized by the teacher. • Google and YouTube are relied upon to fulfill the teacher's learning needs. • Overcoming challenges involves seeking solutions through YouTube tutorials.
Self-Tailoring Strategies	Independent Learning Strategies in Educational Technology	• Self-teaching for comprehensive learning. • Self-directed learning for staying current in education. • The teacher's strategy for managing technology challenges involves understanding the technology and identifying specific obstacles.
	Progressive Learning in Technological Proficiency	• Adapting a gradual approach for navigating technology integration. • Enabling self-discovery and understanding of technology functionalities. • The teacher proficiently learns and explores technological tools.

A. Adaptive Practices

This theme refers to the adaptive approaches teachers employ to learn technology. It is shaped by two cluster themes: Notetaking as a Coping Mechanism and Alternative Strategy for Handling Technology. Teachers often encounter challenges when integrating technology into their teaching practices. As they navigate this learning process, they develop adaptive strategies to cope with these challenges effectively. Being adaptable in academic settings is linked to enhancing learning outcomes. Teachers who can adjust well to different situations often have skills and abilities that can improve gradually, as stated by Mardiana (2020). Adaptive strategies reflect teachers' resilience and determination to overcome obstacles in their journey toward mastering technology integration in education. It underscores the importance of flexibility, creativity, and perseverance in overcoming the hurdles associated with technology integration in education. Adapting technology into the learning process improves the learning environment, as it is seen as a valuable educational tool, albeit requiring extensive preparation and training to be effectively integrated into learning strategies (Ajaj, 2021).

B. Notetaking as a Coping Mechanism

This theme refers to teachers who engage in note-taking as they learn about technology. *Note-taking* is a strategy used by teachers to enhance their understanding and retention of technological concepts. As Hüseyin (2019) mentioned, Note-taking is a highly efficient method for improving comprehension. By jotting down important information, teachers

can organize their thoughts, clarify complex ideas, and refer to their notes for review. Teachers find note-taking to be a useful coping strategy, as evidenced by the following statements.

Teacher 4 stated that taking notes is the starting point for learning the technology.

"It is as if one person teaches you, you will take down notes, and that becomes the process." [Teacher 4]

Teacher 3 highlights the challenges of being a senior, noting that memory lapses become more common and note-taking greatly helps.

"… I am already a senior and quickly forget things, and taking notes indeed helps a lot." [Teacher 3]

Meanwhile, Teacher 12 utilizes a distinct method, selecting visual illustrations to better grasp received information or instructions.

"To cope, we have a chalkboard; just illustrate on the chalkboard if you cannot handle it." [Teacher 12]

Recording information through note-taking is valuable for enhancing information retention (Hüseyin, 2019). Teachers can better encode and store information in their memory by documenting key information from their mentors. This aligns with cognitive theories suggesting that actively engaging with information through writing can aid in consolidating memory traces. Furthermore, note-taking allows teachers to organize and structure information in a personalized format, facilitating easier retrieval and review of content later. Teachers empower themselves to adapt more effectively to the demands of technology integration.

C. Alternative Strategy in Handling Technology

This theme refers to teachers' various alternative strategies for integrating technology into their teaching practices. It serves as a coping mechanism for them to effectively navigate and become proficient in technology use. Bulus (2020) asserts a structured approach to learning that harnesses the power of computers and electronic devices, representing a modern way to accomplish educational objectives through innovative learning methodologies. By embracing flexibility and resourcefulness, teachers demonstrate their commitment to mastering technology integration and ensuring its effective implementation in their teaching practices. The use of alternative strategies has emerged as a practical coping mechanism for teachers, as indicated in the following statements.

Teacher 13 ensures familiarity with technology tools to be well-prepared when students inquire.

> *"…you must be very familiar with the materials you introduced to the students. It is not good when students ask, and you are not familiar with the materials you will use inside the classroom."* [Teacher 13]

In addition, Teacher 13 devised a method of incorporating online videos into their teaching, editing them for seamless presentation in class. It is a method to leverage the technological tool for a specific purpose.

> *"…one of my tactics is to put the video into smaller clips and put it in a PowerPoint presentation, and in between are slides explaining every clip, and the video will now be chopped into smaller clips."* [Teacher 13]

Moreover, Teacher 4 emphasized the concept of "learning by doing" in coping with the challenge of navigating tools.

> *"Learning by doing. I apply what I recently learned, just like PowerPoint, by putting images in the slides to make it easier for me to present the concepts of my discussion."* [Teacher 4]

Teachers engage in deliberate reflection and experimentation to determine the most effective ways to integrate technology into their instructional approaches. Educators must understand technology's appropriate usage and timing, as it is a valuable classroom resource when employed effectively (Winter *et al.*, 2021). This effectiveness manifests when technology is a valuable classroom resource, facilitating learning experiences and achieving educational objectives.

D. Seeking Support

This theme refers to the support received by the teachers in handling technology. The emergent themes from the cluster are Technology Integration Assistance and Collaborative Support in Navigating Technology. Information seeking refers to a deliberate attempt to obtain information in response to a specific need or to fill a gap in one's knowledge (Gunasekera & Balasubramani, 2020). Whether it involves learning new tools, troubleshooting technical issues, or brainstorming innovative ways to incorporate technology into lessons, teachers recognize the importance of seeking guidance to ensure the effective use of technology in education. Typically, teachers engage in active or intentional information-seeking to fulfil various responsibilities, such as imparting knowledge to students and preparing for class sessions, seminars, workshops, and conferences. For example, when teachers require information to complete their lessons or teaching notes (Gunasekera & Balasubramani, 2020), they are motivated to seek the necessary information to meet that need.

E. Technology Integration Assistance

This theme refers to teachers who received assistance from individuals while learning with technology. Teachers might need technological and administrative assistance while incorporating technological devices and platforms into their teaching practices. Top *et al.* (2021) highlight that teachers often invest significant time in troubleshooting technological issues and may lack the necessary expertise to resolve them independently. In such cases, they may require the assistance of technicians or other support staff to address fundamental technological problems in the classroom. Persistent technical challenges that disrupt classroom activities could result in teachers postponing or discontinuing the use of ICT in their teaching environment. However, showing willingness, teachers proactively seek assistance to overcome challenges and master technology. The assistance provided to the teachers during their learning journey is evident in the statements that follow.

Teacher 10 chooses tech-proficient students to assist in managing classroom technology, fostering a two-way process. Two-way learning is frequently linked with classroom dynamics, and his educational approach enables the exchange of skills and ideas between the teacher and the student.

> *"…we will select students who are good at using technology, and at the same time, we can also learn from them"* [Teacher 10]

Conversely, Teacher 6 received guidance from a family member in navigating technology. This support from a family member demonstrates the importance of interpersonal relationships in facilitating technological proficiency.

> *"…fortunately, I have my children guiding me in using technology, so I manage to carry it out."* [Teacher 6]

Teacher 8 stated about seeking guidance from expert colleagues when it comes to effectively utilizing the technology. This highlights the value of collaboration and mentorship within the teaching profession.

> *"We ask questions on how to use specific technology to teachers who are already technology experts."* [Teacher 8]

Teachers may benefit from ongoing assistance opportunities focused on technology integration. As a result, consulting with experienced educators ensures that teachers have access to valuable insights and strategies for integrating technology into their instructional practices.

F. Collaborative Support in Technology Navigation

This theme refers to teachers collaborating to handle technology as a means of coping. Teacher collaboration has been consistently portrayed as a beneficial professional endeavor. It enables educators to exchange ideas, offer emotional support, collaborate on materials, and participate in co-teaching experiences (Carpenter *et al.*, 2022). Teachers engage in collaborative learning by sharing their expertise in integrating technology into teaching practices, recognizing it as a vital coping mechanism amidst our increasingly high-tech world. Teachers can leverage each other's strengths and expertise through collaboration to develop more effective teaching strategies. The following statements will present their collaborative efforts in managing technology.

Each participant shares similar statements, as they depend on one another for support in navigating the complexities of technology in education.

> *"…if we do not know how to use technology, we ask for help from our co-teachers."* [Teacher 14]

> *"It is fortunate that some of my colleagues at school are proficient in technology, and I often ask them for help."* [Teacher 2]

> *"…colleagues are a big help. It is beneficial that you are together at school every day."* [Teacher 2]

This presents an advantage as teachers encounter technological challenges daily, facilitating easy consultation with one another regarding the intricacies of technology in their teaching practices. This reliance on collaborative problem-solving and knowledge-sharing underscores the importance of fostering a culture of teamwork and mutual assistance within educational settings. Through their collective efforts, teachers enhance their technological competencies and contribute to a culture of continuous improvement and innovation. Ultimately, educators' shared experiences and collaborative endeavors exemplify the power of teamwork and collective learning in effectively integrating technology into teaching practices.

G. E-learning

This theme refers to learning technology through direct engagement with the technology itself. The emergent theme arose from the convergence of two cluster themes: Incorporating Online Tutorials for Technology Skill Acquisition and Accessing Websites and Applications for Educational Technology Purposes. As internet access becomes more pervasive, Khandelwal and Augustine (2019) stated that e-learning is experiencing significant expansion, with numerous educational applications and websites being developed to cater to this growing demand.

E-learning offers diverse multimedia resources and interactive tools that can enhance teaching effectiveness. Salloum *et al.* (2019) emphasized that e-learning utilizes

diverse technologies and media for instructional purposes. A crucial aspect of e-learning involves using electronic media, which encompasses learning facilitated through various computational devices, including computers, mobile phones, tablets, and virtual environments.

Teachers acquire technological proficiency through online tutorials and websites or applications, integrating these newfound skills into their teaching methodologies. This approach enables educators to engage in self-directed learning, exploring tutorials and resources at their own pace to build competence in technology integration.

H. Incorporating Online Tutorials for Technology Skill Acquisition

This theme refers to the approach employed by teachers to incorporate technology into their teaching practices. Seeing how continuous professional growth in technology integration is necessary, many teachers use online lessons as a strategy. YouTube is a prominent online platform where educators seek information and resources to support their learning. Ray *et al.* (2021) explore the integration of YouTube-style tools into the evolving pedagogical framework. YouTube has persisted as the leading video-sharing website since the widespread adoption of the internet in the 1990s. With its vast repository of videos spanning various topics and subjects, YouTube is a valuable resource hub for teachers seeking instructional materials, tutorials, and educational content. The following statements demonstrate how helpful online tutorials are for teachers as a coping strategy.

The statements provided by the participants indicate that watching YouTube tutorials is among their effective strategies for learning technology.

"For me, the method I use is watching tutorials on YouTube." [Teacher 4]

"…I rely on YouTube whenever I need to learn how to use a tool." [Teacher 11]

"…someone recommended that there are tutorials on YouTube" [Teacher 5]

Online tutorials' user-friendly interface and accessibility allow educators to access relevant information anytime and anywhere. This approach allows educators to access a wealth of instructional content tailored to their needs and preferences. The findings indicated that the pause and rewind functionalities on YouTube platforms function as practical and efficient aids for learners, enabling them to access specific details within videos as needed (Ray *et al.*, 2021). YouTube tutorials offer step-by-step guidance, practical demonstrations, and valuable insights from experts, enabling teachers to enhance their technological proficiency at their own pace.

I. Accessing Websites and Applications for Educational Technology Purposes

This theme refers to the dependence of teachers on search engines and applications as they endeavor to acquire information about technology. Khandelwal and Augustine

(2019) asserted that educational applications and websites serve as platforms for learning that offer flexibility, allowing education to be accessed anytime and anywhere, based on individual convenience. These platforms utilize visuals and animations to teach and illustrate concepts, enhancing comprehension and making learning more engaging and memorable. Teachers accessing websites and applications for educational technology purposes signifies a proactive approach to integrating technology into their teaching practices, as evidenced by the statements provided below.

Teacher 12 uses a variety of digital tools such as PowerPoint presentations, videos, and online resources like Google Search to create engaging and informative lessons.

> *"…it is by using PowerPoint presentations or video presentations concerning the topic and getting information from Google."* [Teacher 12]

Similarly, Teacher 17 adopts a proactive approach to address challenges by harnessing the power of digital tools such as YouTube and Google.

> *"I am so thankful to Google and YouTube because they can meet my needs."* [Teacher 17]

When faced with obstacles or uncertainties, Teacher 17 turns to YouTube tutorials to gain insights into various technologies' functions.

> *"…I must look for a way to overcome it, and through YouTube, I can search for how to use it."* [Teacher 17]

Accessing websites and applications enables teachers to stay updated on the latest updates and developments in educational technology, allowing them to continually adapt their teaching methods to meet the evolving needs of students. This underscores teachers' strategies as they navigate the ever-evolving technology landscape in education.

J. Self-Tailoring Strategies

This theme refers to teachers' self-reliance in acquiring technological proficiency. The emergent theme stemmed from these two cluster themes: Independent Learning Strategies in Educational Technology and Progressive Learning in Technological Proficiency. By embracing self-directed learning, individuals can delve into course content extensively and tailor their educational pace to suit their unique requirements (Safapour *et al.*, 2019). This approach lays the groundwork for lifelong learning. Despite initial challenges and uncertainties, teachers persevere and self-teach, motivated by a deep commitment to their students' learning and success. They dedicate time outside regular classroom hours to explore online tutorials and experiment with new technologies.

K. Independent Learning Strategies in Educational Technology

This theme refers to the individualized approaches employed by teachers to address challenges related to technology. The idea of independence or autonomy gained prominence in education during the 1990s, sparking the development of a new approach (Shobeiry, 2023). Teachers inherently possess a drive for continuous learning and improvement, which extends to their endeavors to overcome technology challenges. They seek resources and tutorials tailored to their specific needs and preferences, gradually allowing them to familiarize themselves with new tools and applications. Hence, teachers' efforts to self-teach and overcome technology challenges reflect their dedication to providing high-quality education and adapting to the demands of the digital age. This approach is evident in the following statements.

Teacher 4 demonstrates strong enthusiasm for acquiring technological proficiency through self-directed learning and problem-solving and exhibits a proactive approach to mastering the intricacies of technology.

> *"…aside from watching tutorials, I also teach myself."* [Teacher 4]

Moreover, Teacher 14 and Teacher 17 recognized the necessity of self-teaching as their primary recourse for navigating the complexities of technology within their teaching methodologies.

> *"I cope through self-learning and self-study."* [Teacher 17]

> *"…handling technology challenges in teaching is to focus, dig deeper and identify the challenges themselves."* [Teacher 14]

Through self-guided learning and reflection, teachers cultivate an environment of ongoing enhancement and creativity within their educational settings. This reflective approach allows them to identify areas for improvement, refine their strategies, and continuously iterate on their teaching practices. As they confront the challenges posed by technological advancements, their proactive approach to self-directed learning is a testament to their resilience and determination.

L. Progressive Learning in Technological Proficiency

This theme refers to the progress made by teachers in grasping technology. Fayek *et al.* (2020) argue that progressive learning denotes a comprehensive learning model characterized by ongoing learning, where tasks are acquired sequentially, leveraging prior knowledge from earlier tasks to aid learning and executing new ones. Teachers are progressively acquiring technology as an integral component of their teaching practices. Through self-directed learning and exploration, educators equip themselves with the necessary skills and knowledge to effectively integrate technology into their classrooms. This gradual learning process allows teachers to familiarize themselves with various

technological tools and platforms, empowering them to adapt their instructional strategies to meet the needs of modern learners. The manifestation of self-learning with technology is evident in the following statements.

Teacher 8 articulates an approach to technology integration, one step at a time, towards mastering its use before incorporating it into their teaching methods.

> *"My coping mechanism is baby steps or one step at a time. If I can only apply what I can in using ICT, that is the only thing I can do. If someone teaches us new things about ICT and it can be easily applied, I will also apply it. It is just a matter of adjusting."* [Teacher 8]

Teacher 17 highlighted how online searches significantly impact their understanding of complex concepts, clarifying areas of confusion.

> *"…I searched how to manipulate [tools] until slowly I realized "Oh, so this is how it works" and that is thanks to YouTube."* [Teacher 17]

Teacher 14 expounds on the iterative learning process, emphasizing the importance of effectively studying and mastering concepts to impart them to students.

> *"Learning and studying technology are also important because you cannot give it to your students if you do not know how to use the application or the technology itself."* [Teacher 14]

As educators strive for continuous improvement, they view learning technology as professional development, actively seeking resources and training opportunities to enhance their skills. Teachers' gradual acquisition of technological proficiency in their teaching practices reflects a transformative repertoire of digital tools and strategies. As a result, gradually learning technology in teaching is dynamic and enables teachers to thrive in an increasingly digital educational landscape.

3.3. Insights of the Non-digital Educators Towards Evolving Technology

Table 3 presents a set of emerging themes taken from their cluster theme that are relevant to participants' insights into evolving technology.

Table 3: Insights by non-digital educators towards evolving technology

Emergent Themes	**Cluster Themes**	**Formulated Meaning**
Rapid Emerging Technology	Continuous Technological Progress	• Technology's evolution unfolds rapidly with greater advancements in teaching. • Technological innovation will come one after the other with better features, leaving the old technology behind. • Continuous technological advancement has made it hard for non-digital educators to integrate amidst the challenges of age.
	Imperative Technological Practices through Technology	• Non-digital educators are constantly challenged by the continuous advancement of technology. • Teachers' endless pursuit of technological advancements never stops. • Teachers in today's world embrace technology not just because it's an option, but because it's a necessity to keep up with or be more advanced with digital native students.
Work Efficiency	Streamlining Teaching Practices through Technology	• Technological advancement reduces the time and effort required for paperwork, especially in computing grades. • Teachers have more time for teaching because of technology than for material preparation. • Teaches integrating technology in teaching alleviates the tedious tasks, heavy workload and simplifies preparation.
	Technology-Assisted Change in Teaching Methods	• Teacher's instructional materials shift into much more dynamic and interactive methods of instruction with technology. • Teachers' pedagogical methods and strategies shift and improve with the impact of technology. • Teachers utilize the help of technology in lesson delivery, aiding students in comprehending complex concepts.
Technological Adaptability in Learning	Embracing Technology in Education	• Teachers should actively engage in the process of acquiring new knowledge and skills in adapting technology, which can help in practical contexts. • As new technological advancements emerge, adapting helps to recognize the potential to enhance teaching methods while maintaining a positive outlook on technology's role in education. • Teachers are slowly embracing and adapting to technology, even to applying it in teaching, while at the same time learning.
	Tailoring Technological Adaptation	• Adapting to technology is not a one-size-fits-all attempt. It requires the adaptation of multifaceted approaches to address the diverse needs and intelligence of tech-savvy students. • Learning technology becomes not just an option but a necessity with constant technological advancements. • Most non-digital educators came from different generations where tools, such as technology, were not integral to education, and they earnestly try to adapt to recent

		technological advancements, so they cannot be blamed for not adapting quickly.

A. Rapid Emerging Technology

This theme relates to the teacher's insights towards the continuous pursuit of innovation and technological advancement. The cluster themes that build this emergent theme are Continuous Technological Process and Imperative Technological Integration in Education. Tiwari (2022) explained that rapid emerging technologies refer to those technological innovations that are in the development process and have the potential to fundamentally change how we interact with the world around us. In addition, education in the modern world is aimed at technological learning and increasing the usability of new learning tools; hence, technological changes are constant (Shvardak, 2024).

B. Continuous Technological Progress

This theme refers to how teachers view the ongoing development, advancement, and refinement of technologies in education as a constant. Eckhaus and Davidovitch (2019) and Corben (1986) asserted that new technology is not implemented with the understanding that teachers are the most efficient means of learning, and a new technology may try to circumvent teachers. The insights of the participants into the continuous technological progress are observed in the following statements.

Teacher 11 expressed that integrating technology with its advancements is difficult because of their age.

> *"It is hard for me to integrate technology with its advancements, much more so with my age. I am not so techy. I am not techy when it comes to technology."* [Teacher 11]

Meanwhile, Teacher 3 stated that technology continues to evolve faster, even though it is already at its prime. They recognize the current technological advancements but emphasize the ongoing nature of technological evolution.

> *"Technology is at its peak, but there is more to come as technology evolves quickly."* [Teacher 3]

In addition, Teacher 3 highlights a critical aspect of technological education's evolution: the accelerating pace of technological innovation. Each development cycle brings a significant increase in new technological innovation integrated into education. Teacher 3's statement illustrates that current advanced features, such as those in televisions, will eventually be replaced by newer innovations.

> *"If you think this is the best technology, there is more to come. If you notice now, you might think that the features of TVs are already high-tech, but they will eventually phase out, and there will be something new again."* [Teacher 3]

Technology's continuous progress shows that the insights of non-digital educators toward evolving technology affect their integration process and their perspectives on technology. Sedov and Kashfrazyeva (2022) support the idea that the rapid progress of technology requires attention, especially in education and society.

C. Imperative Technological Integration in Education

This theme refers to teachers' constant challenges and endless pursuit of technological excellence for education. Technological advancements in all spheres of human existence have resulted in studies investigating the close connection between technology (e.g., robotics) and people's relationships extending beyond physical interaction to cognitive relations. However, there is little contention that technology has significantly improved the quality of life of people over time and that it continues to have enormous potential to change the conditions in which people live, especially in the academe (Grange *et al.*, 2022). The insights of the participants into the imperative technological integration in education are observed in the following statements.

Teacher 11 inferred that learning technology for non-digital educators is a need, especially since most students are digital natives.

> *"…the children in this generation are so into technology that they want you to be more advanced than them."* [Teacher 11]

On the other hand, Teacher 5 and Teacher 2 implied that with the constant advancements of technology, such as software, technological excellence is far from being reachable for non-digital educators.

> *"We have not mastered one software yet, and there is already a new one."* [Teacher 5]

> *"No matter how much you chase technology, you will not catch up."* [Teacher 2]

In the 21st century, the integration of material and pedagogical expertise alone has proven insufficient for teachers, prompting the addition of another component: technology. Hence, learning technology became non-negotiable, which led to the creation of the TPACK framework (Bilgiç, 2022). Given the rapid pace at which new technologies arise, it is challenging for educators to keep up while demanding that teachers learn how to use these technologies in their teaching (Raja & Nagasumbramani, 2018).

D. Work Efficiency

This theme refers to the ability of participants to maximize the effectiveness of their time, resources, and efforts in achieving educational goals with the use of technology. The cluster themes that build this emergent theme are Streamlining Teaching Practices through Technology and Technology-Assisted Change in Teaching Methods. The proliferation of online learning resources, remote training options, and e-learning

platforms has revolutionized the professional development landscape for educators. These tools enable teachers to enhance their competencies and expertise without the constraints of physical location, allowing them to continue their learning journey while remaining within their school environment.

E. Streamlining Teaching Practices through Technology

This theme refers to strategically integrating technological tools and resources to improve teaching and optimize the teaching and learning process. As technology in teaching improves overall educational quality (Livingstone, 2012), it is also an essential form of assistance in improving the teacher's performance of their tasks while streamlining the teaching-learning process, helping educators have an easier job (Özdemir, 2017). The effectiveness of technology in work efficiency is observed in the following statements.

Teacher 7, Teacher 9, and Teacher 16 infer that teaching is considerably more manageable with the help of technology, reducing the stress of their workload, allowing for easier coding with grades, and more time spent on preparation and educating their students.

> *"Paperwork is so much easier to do now, such as making grades. Before, we encoded grades manually, but now we can use laptops to make grades for the students."* [Teacher 7]

> *"It requires less time for preparation, and I can focus on my teaching."* [Teacher 9]

> "*…our work is much lighter, and with televisions and laptops, preparation is more accessible."* [Teacher 17]

Work efficiency is evident in the academe when technology is used to its advantage. Moreover, because of the positive effects of technology on educators' work efficiency, it also promotes the development of virtual academic mobility, enhances the expansion of educational choices for students, reduces the cost of educational services, and improves the accessibility of education (Landa *et al.*, 2023).

F. Technology-Assisted Change in Teaching Methods

This theme refers to teachers using technological tools and resources to transform and enhance traditional teaching approaches. Holm *et al.* (2019) emphasize that digital technology empowers the creation of personalized learning experiences tailored to individual learners' unique needs, interests, and abilities. With this, educators can enhance their teaching strategies and delivery of lessons, as observed in the following statements.

Teacher 8, Teacher 11, and Teacher 16 stated that technology significantly changed their teaching strategies and delivery and improved their abilities as educators.

"Before, we prepared traditional materials that needed to be hung or pasted on the board, but now we can prepare presentations through PowerPoint or present videos and then have a follow-up discussion. It is less chalk today because technology exists." [Teacher 8]

"It taught me to improve my strategies and helped me compared to before, when I only did lecture type. Technology helps the teacher improve his or her teaching strategies." [Teacher 11]

"Technology is a helpful tool for delivering the lesson well, helping the students understand what you want them to understand, and because technology is a language for them— a common language for them, so it is helpful." [Teacher 16]

Knowledge transfer becomes very easy, convenient, and effective as technology continues to flourish in the educational sector. This means that our minds now tend to work faster when assisted with modern technology (Raja & Nagasumbramani, 2018).

G. Technological Adaptability in Teaching

This theme refers to the participants adapting to effectively integrate and utilize various technologies in their instructional practices to meet the evolving needs of students, curriculum requirements, and educational goals. The cluster themes that build this emergent theme are Embracing technology in Education and Tailoring technological adaptation. Granziera *et al.* (2016) asserted that adapting to new and changing events in these ever-changing environments, especially with technology, is critical for thriving and effective instructors.

H. Embracing Technology in Education

This theme refers to the willingness of participants to adapt and integrate technological tools, resources, and methodologies into their teaching and learning practices. Zakrzewski and Newton (2022) argued that integrating technology into the classroom is no longer an option since being technologically literate is a requirement of the 21st century. As digital immigrant educators adapt and embrace technology, the participants' willingness to improve their teaching with technology is evident, as observed in the following statements.

Teacher 10, Teacher 11, and Teacher 12 expressed that they are open to adapting and integrating technology into their teaching, and they have positive attitudes toward implementing technology.

"Learn, practice, and integrate. It is important to adapt to technology." [Teacher 10]

"Just adapt, and when there are new things in technology, you can apply them." [Teacher 11]

"I need to adapt because at the same time, we learn something from it, and we are not ignorant in applying it." [Teacher 12]

Educators believe that when provided with appropriate training on professional digital competencies, they can use technological tools in the classroom to enhance the learning process for students (D'Angelo, 2018).

I. Tailoring Technological Adaptation

This theme refers to participants aligning technology integration with the academe's specific needs, goals, and contexts. Adov and Mäeots (2021) asserted that teachers' attitudes towards technology in teaching shape how they want to utilize technology depending on the contexts, which in turn predicts its use and results in the long run, as observed by the following statements below.

Teacher 13 and Teacher 15 emphasized the importance of adapting teaching methods to keep pace with technological advancements.

"You cannot just adapt one or two technologies; it should be multiple. Your students have multiple needs and different intelligences. You cannot say and assume that this is what they need as a class. As a strategic teacher, never stop exploring technology." [Teacher 13]

"We must learn. We do not have a choice but to learn and cope with the changes." [Teacher 15]

Moreover, Teacher 16 stated that most non-digital educators are still coping.

"We cannot blame non-digital educators because they live in a different generation. Also, a lot of them are still coping; they are not close to their end, and it is difficult to cope. I think we cannot judge that they are not good educators. They just have a way of teaching." [Teacher 16]

In conclusion, teachers will continue to adapt to technology, as one of the abilities required in the twenty-first century is the capacity to adapt quickly to the rapid technological transitions that are continuously taking place (Tami, 2017).

4. Recommendations

This study offers personal insights into the various struggles and coping mechanisms that digital immigrant educators face when navigating and integrating technology into education. The influence of technology has been both a challenge and an opportunity, especially for digital immigrant educators. The study's findings revealed that digital immigrant educators faced challenges such as unfamiliarity with new technologies,

which caused issues in tool utilization, difficulty integrating them into teaching practices, and the persistent challenge of engaging students in a tech-driven learning environment. Regardless of the issues observed, digital immigrant educators remain open and willing to adapt to technology to improve the teaching and learning processes of teachers and students. Furthermore, ongoing support and professional development opportunities should be provided to ensure educators remain updated with the latest advancements in educational technology. Sharing experiences, tips, and strategies with fellow educators has been beneficial, providing a sense of community and collective growth.

Reflecting on their experiences, the researchers encourage educational institutions to prioritize investment in resources, seminars, and support systems to enable digital immigrant educators in the Philippines. Access to dependable technology, technical support personnel, and platforms for exchanging best practices for teachers can significantly empower them to fully utilize the advantages of technology, especially in education. It is also vital for administrators to encourage experimentation and innovation in teaching approaches, fostering an environment in which educators can comfortably investigate and use new technologies without fear of failure.

Lastly, for future researchers who will study the lived experiences of digital immigrant educators trying to utilize technology in education, it is important to acknowledge that every educator has different struggles and perceptions of the use of technology in education. Research should look at other struggles and coping mechanisms of digital immigrant educators facing technology, depending on whether they teach in a public or private school. This can pique scholars to investigate. Understanding these nuances can provide richer insights and guide more targeted support and interventions.

5. Conclusion

In exploring the experiences of digital immigrant educators in navigating modern technology, results revealed that technological challenges experienced by Digital Immigrants have significantly contributed to their Struggles in Educational Technology Integration. Digital Immigrant educators expressed feelings of disorientation when confronted with unfamiliar digital tools, uncertainty about the pedagogical relevance of technology, and encountered practical implementation, especially in their environment. This shows that the struggles of integrating technology into education have been caused by digital immigrants' lack of digital competence, highlighting the need for more knowledge and training tailored to their needs to alleviate these technological struggles.

In examining the experiences of digital immigrant educators in navigating modern technology, findings suggest a relationship between the technological challenges faced by digital immigrant educators and their struggles with technology integration. The struggles when encountering unfamiliar tools, uncertainty, and practical implementation hurdles indicate a lack of digital competence among digital immigrants due to age, environment, and accessibility. Consequently, these struggles emphasize the importance of tailored knowledge and training programs to alleviate barriers to technology

integration in education, highlighting the pivotal role of comprehensive support in enhancing digital proficiency among digital immigrant educators.

The study's results affirm a connection between the hurdles immigrant teachers face and their difficulties in integrating technology. Factors such as age, surroundings, and accessibility contribute to the proficiency gap among immigrants, aligning with the theory that digital immigrants adapt to technology later in life and encounter unique obstacles. Moreover, highlighting customized knowledge and training programs as remedies supports the idea that comprehensive assistance is crucial for improving skills among digital immigrant educators. Hence, the study's findings uphold the basis for exploring digital immigrant educators' encounters with modern technology.

Reflecting on this journey, the researchers recognized that, while it was not straightforward, the challenges were worthwhile. Engaging in this study has brought us several realizations. Initially, the complexity of the subject matter might have been overwhelming, yet with the support of those around them, the researchers have steadily grasped every aspect. Second, this experience has fostered resilience within the researchers, fueling their anticipation for the outcomes. Lastly, the researchers have gained a deeper understanding of the significance and intent behind conducting research. As they finished this research, the researchers realized there are more problems for teachers when applying technology to learning than we see in our eyes. It has been an eye-opening experience to conduct this research, as well as to know the experiences of the teachers who face struggles with technology as they try to cope with the demands of their careers.

Acknowledgements

The researchers would like to extend sincere gratitude to the following individuals who have contributed to the completion of this research.

To begin with, we would like to thank our research advisors, Maribel Abalos, MAEd and Dr. Jocelyn Bacasmot, for their unwavering support, insightful guidance, and encouragement throughout the research process.

We would also like to extend our heartfelt appreciation to our esteemed panelists, Dr. Melissa C. Napil and Dr. Cristy Grace A. Ngo, for their invaluable feedback, constructive criticisms, and scholarly insights. Their thorough evaluation and comments have significantly improved the quality of our thesis. We are deeply grateful for their time, expertise, and dedication to academic excellence.

We also like to humbly acknowledge and give our deepest appreciation to our Almighty God for his guidance throughout our thesis journey. His grace and blessings have been our constant source of strength and inspiration to finish our thesis.

Finally, we would like to express our deepest appreciation to our families and friends, who have been a constant source of love, encouragement, and understanding. Their support and belief in us have kept us motivated and inspired, even during the most challenging times of our research journey. This thesis stands as evidence of our commitment to academic excellence and dedication to academic success. This would not

have been possible without the collective contributions and efforts of all those mentioned above. We are deeply thankful to each one who has played a part in this academic journey. Thank you for your contributions and support.

Conflict of Interest Statement
The authors declare no conflicts of interest.

About the Author(s)
Danielle Denise P. Amigo earned her Bachelor of Secondary Education, major in English, from the University of Mindanao. Her study was presented at the Seirei International Research Conference held in March 2025, which aimed to describe the struggles made by digital immigrant educators in navigating modern technology. Her research interests include technological tool utilization in education, impediments to technology integration, and engagement issues in the learning environment.
Jackie B. Cagutom holds a Bachelor of Secondary Education, major in English from the University of Mindanao. Her study was presented at the Seirei International Research Conference held in March 2025, which explored the struggles of digital immigrant educators in navigating modern technological advancements. Her research interests revolve around how educational tools are utilized in classrooms, the challenges educators face in integrating technology, and issues that affect student engagement in today's learning environments.
Joanna Christine B. Gervacio obtained a Bachelor of Secondary Education, major in English from the University of Mindanao. Her study was presented at the Seirei International Research Conference held in March 2025, which focused on the challenges faced by digital immigrant educators in adapting to modern technology. Her research interests include the use of technological tools in education, barriers to technology integration, and learner engagement, specifically in secondary education classrooms.
Jocelyn B. Bacasmot (PhD) is a professor and dean of the teacher education program at the University of Mindanao—main campus. She has been a research adviser for consecutive years and has published several studies through physical and digital platforms, including this research study. She has been to various research conferences—national and even international research conferences. Her niche and interest in research revolve around the development and improvement of teaching, along with the emergence and the utilization of digital tools and platforms integrated into the institutional curriculum.

References

Adov, Li., Mäeots, M. (2021). *What can we learn about science teachers' technology use during the COVID-19 pandemic?* https://doi.org/10.3390/educsci11060255

Ajaj, I. E. (2021). *Adapting technology to meet 21st-century language learning difficulties.* https://jls.tu.edu.iq/index.php/JLS

Aluko, R., & Ooko, M. A. (2022). Enhancing the Digital Literacy Experience of Teachers to Bolster Learning in the 21st Century. *Journal of Learning for Development, 9*(3), 420–435. https://doi.org/10.56059/jl4d.v9i3.662

Anzari, P. P., Shiddiq, I. H. A., Pratiwi, S. S., Fatanti, M. N., & Silvallana, D. F. (2021). Teachers' Technological Capability as Digital Immigrants in Learning from Home Activities. *International Journal of Emerging Technologies in Learning/International Journal: Emerging Technologies in Learning*, *16*(07), 146. https://doi.org/10.3991/ijet.v16i07.21229

Attia N.A., Baig, L., Marzouk, Y.I, & Khan, A. (2017). The potential effect of technology and distractions on undergraduate students' concentration. *Pakistan Journal of Medical Sciences*, *33*(4):860-865. https://doi.org/10.12669/pjms.334.12560

B2B International. (2022). *What are the benefits of focus groups?* - B2B International. https://www.b2binternational.com/research/methods/faq/benefits-of-focus-groups/

Babushko, S., Solovei, M., & Solovei, L. (2022). Digitalization of education: Challenges for teachers. *Grail of Science*. 460-464. https://doi.org/10.36074/grail-of-science.27.05.2022.082

Bergdahl, N. (2022). Engagement and disengagement in online learning. *Computers & Education*, *Volume 188*, https://doi.org/10.1016/j.compedu.2022.104561.

Bïlgïç, E. N. Ü. (2022). The relationship between technological pedagogical content knowledge of mathematics teacher candidates and teaching mathematics anxiety. *Journal of Educational Technology and Online Learning*, *5*(3), 619–635. https://doi.org/10.31681/jetol.1115994

Buhamad, A. M., Almisad, B. M., & Alsaffar, R. (2024). Poor performance of teachers in public education schools in Kuwait using educational technology. *International Journal of Learning and Development*, *14*(1), 63. https://doi.org/10.5296/ijld.v14i1.21653

Bulus, P. (2020). Significant of smartphone: An Educational technology tool for teaching and learning. *International Journal of Innovative Science and Research Technology 5*(5) Retrieved from https://www.ijisrt.com/assets/upload/files/IJISRT20MAY410.pdf

Carpenter, J. P., Kerkhoff, S. N., & Wang, X. (2022). Teachers using technology for co-teaching and crowdsourcing: The case of Global Read Aloud collaboration. *Teaching and Teacher Education*, *114*, 103719. https://doi.org/10.1016/j.tate.2022.103719

Corben, S. (1986). La Monarchie nucléaire [The nuclear monarchy]. Paris, France: Hachette

Crawford, J., Butler-Henderson, K., Rudolph, J., Malkawi, B., Glowatz, M., Burton, R., Magni, P. A., & Lam, S. (2020). COVID-19: 20 countries' higher education intra-period digital pedagogy responses. *Journal of Applied Learning and Teaching*, *3*(1). https://doi.org/10.37074/jalt.2020.3.1.7

Creswell, J. W. (1998). *Qualitative inquiry and research design: choosing among five traditions*. https://ci.nii.ac.jp/ncid/BA33299731

Creswell, J. W. (2013). *Qualitative inquiry & research design: Choosing among five approaches*. http://ci.nii.ac.jp/ncid/BB09168370

Criollo-C, S., Guerrero-Arias, A., Jaramillo-Alcázar, Á., & Luján-Mora, S. (2021). Mobile learning technologies for education: Benefits and pending issues. *Applied Sciences*, *11*(9), 4111. https://doi.org/10.3390/app11094111

D'Angelo, C. (2018). *The Impact of Technology: Student engagement and success*. Pressbooks. https://pressbooks.pub/techandcurriculum/chapter/engagement-and-success/

DepEd. (2020). *Official Statement Department of Education*. https://www.deped.gov.ph/2020/05/06/official-statement-2

Dinc, E. (2019). Prospective teachers' perceptions of barriers to technology integration in education. *Contemporary Educational Technology*, *10*(4), 381–398. https://doi.org/10.30935/cet.634187

Eckhaus, E., & Davidovitch, N. (2019). Technology-supported teaching: Technological progress or a sham? *European Journal of Educational Research*, *8*(3), 697–702. https://doi.org/10.12973/eu-jer.8.3.697

Ertmer, P. A. (1999b). Addressing first- and second-order barriers to change: Strategies for technology integration. *Educational Technology Research and Development*, *47*(4), 47–61. https://doi.org/10.1007/bf02299597

Fayek, H. M., Cavedon, L., & Wu, H. R. (2020). Progressive learning: A Deep learning framework for continual learning. *Neural Networks*, *128*, 345–357. https://doi.org/10.1016/j.neunet.2020.05.011

Fernández-Batanero, J. M., Román-Graván, P., Reyes-Rebollo, M. M., & Montenegro-Rueda, M. (2021). Impact of educational technology on teacher stress and anxiety: A Literature review. *International Journal of Environmental Research and Public Health/International Journal of Environmental Research and Public Health*, *18*(2), 548. https://doi.org/10.3390/ijerph18020548

Fullan, M. (2006). *The new meaning of educational change*. 4th Ed. Columbia University: Teachers College Press.

Geverola, I. J. R., Mutya, R. C., Bañados-Siason, L. M., & Bonotan, A. M. (2022). Challenges and struggles of public senior high school science teachers during the new normal. *Journal of Research, Policy & Practice of Teachers & Teacher Education*, *12*(1), 49–68. https://doi.org/10.37134/jrpptte.vol12.1.4.2022

Ghavifekr, S., Kunjappan, T., Ramasamy, L., & Anthony, A. (2016). *Teaching and learning with ICT tools: Issues and challenges from teachers' perceptions.* https://eric.ed.gov/?id=EJ1096028

Grange, L. L., Maistry, S., Simmonds, S., Visser, A., & Ramrathan, L. (2022). Education in a 'neoliberalised' online teaching and learning space: Towards an affirmative ethics. *Transformation in Higher Education*, *46*(1). https://doi.org/10.4102/the.v7i0.205

Granziera, H., Collie, R. J., & Martin, A. J. (2019). Adaptability: An Important capacity to cultivate among pre-service teachers in teacher education programmes. *Psychology Teaching Review*, *25*(1), 60–66. https://doi.org/10.53841/bpsptr.2019.25.1.60

Grove, A. (2019). *The teacher's role in student engagement*. Digital Commons @ Gardner-Webb University. https://digitalcommons.gardner-webb.edu/education_etd/352

Gunasekera, C., & Dr, R. B. (2020). *Challenges faced by school teachers when seeking information: How barriers be addressed*. Digital Commons, University of Nebraska - Lincoln. https://digitalcommons.unl.edu/libphilprac/4415

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A Review. *Sustainable Operations and Computers*, *3*, 275–285. https://doi.org/10.1016/j.susoc.2022.05.004

Holm, K., Yeung, J., Yu, M., Ho, R., Loong, Y., & Chao, F. (2019). Online learning of reflective journal writing in tertiary education. *ECEL 2019 18th European Conference on e-Learning* (p. 207). Academic Conferences and Publishing Limited.

Hüseyin, Ö. (2019c). Impact of note-taking during reading and during listening on comprehension. *Educational Research and Reviews*, *14*(16), 580–589. https://doi.org/10.5897/err2019.3812

Ilias, A., Baidi, N., Ghani, E. K., & Razali, F. M. (2020). Issues on the use of online Learning: An exploratory study among university students during the COVID-19 pandemic. *Universal Journal of Educational Research*, *8*(11), 5092–5105. https://doi.org/10.13189/ujer.2020.081109

Khandelwal, V. & Augustine, R. (2019). Effectiveness of educational applications and websites on students. *International Journal of Scientific Research and Review, 7*(3).

Landa, E., Zhu, C., Sesabo, J., & Machumu, H. (2023). Leader support and the integration of innovative teaching-learning technologies: The mediating role of technological level of knowledge. *Education and Information Technologies*, *28*(12), 15523–15541. https://doi.org/10.1007/s10639-023-11776-8

Lindell T. (2022). *Teachers' challenges and school digitalization: Exploring how teachers learn about technology integration to meet local teaching needs*. DIVA. https://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1690709&dswid=-9535

Lipsett, A. (2008). A third of teachers "struggle with technology." *The Guardian*. http://www.guardian.co.uk/education/2008/jan/28/schools.uk

Livingstone, S. (2012). Critical reflections on the benefits of ICT in education. *Oxford Review of Education*, *38*(1), 9–24. https://doi.org/10.1080/03054985.2011.577938

Long, C. (2023). *Leveraging technology to tackle student apathy and attendance in the post-pandemic era*. https://tinyurl.com/y2fwk36p

Mardiana, H. (2020). Lecturers' adaptability to technological change and its impact on the teaching process. *Jurnal Pendidikan Indonesia/Jurnal Pendidikan Indonesia*, *9*(2), 275. https://doi.org/10.23887/jpi-undiksha.v9i2.24595

Matua, G. A., & Van Der Wal, D. M. (2015). Differentiating between descriptive and interpretive phenomenological research approaches. *Nurse Researcher*, *22*(6), 22–27. https://doi.org/10.7748/nr.22.6.22.e1344

Mikusa, M. E. (2015). *The effect of technology self-efficacy and personal engagement on students' and teachers' attitudes toward technology use in education*. http://libres.uncg.edu/ir/listing.aspx?styp=ti&id=18800

Mishra, L. (2016). Focus Group Discussion in Qualitative Research. *Techno Learn: An International Journal of Educational Technology, 6*(1), 1. https://doi.org/10.5958/2249-5223.2016.00001.2

Morrow, R., Rodriguez, A., & King, N. (2015). Colaizzi's Descriptive Phenomenological Method. *The Psychologist, 28*, 643-644. https://doi.org/10.1016/j.jcin.2015.03.004

Moses, C., Nghipandulwa, L. L., & Shikusho, S. P. (2022). Investigating the challenges faced by teachers in the implementation of digital technology in secondary schools in Rundu Circuit, Kavango East Region, Namibia. *Open Journal of Social Sciences*, *10*(09), 286–301. https://doi.org/10.4236/jss.2022.109018

Olita, A. & Orong, M. (2023). Challenges experienced by teachers in the utilization of information and communication technology in the classroom. *United International Journal for Research & Technology, 4*(6), pp. 67-76. Retrieved from https://uijrt.com/articles/v4/i6/UIJRTV4I60007.pdf

Oriji, A., & Torunarigha, Y. D. (2020, January 27). *Digitized Education: Examining the challenges of digital immigrant educators in the face of net generation learners*. https://ijhumas.com/ojs/index.php/niujoss/article/view/717

Özdemir, S. (2017). Teacher views on barriers to the integration of information and communication technologies (ICT) in Turkish teaching. *International Journal of Environmental and Science Education, 12(3)*, 505–521. https://doi.org/10.12973/ijese.2017.1244p

Prensky, M. (2001). Digital Natives, Digital Immigrants Part 1. *On The Horizon*, *9*(5), 1–6. https://doi.org/10.1108/10748120110424816

Raja, R., & Nagasubramani, P. C. (2018). Impact of modern technology in education. *Journal of Applied and Advanced Research*, S33–S35. https://doi.org/10.21839/jaar.2018.v3is1.165

Ray, L. M., Satri, R., Uswatunisa, S., & Harahap, S. A. (2021). How does Youtube assist teachers in developing material? *ETDC: Indonesian Journal of Research and Educational Review, 1(1)*, 82-92. https://doi.org/10.51574/ijrer.v1i1.56

Salam, U., Wahdini, W., Surmiyati, S., Rezeki, Y. S., Riyanti, D., & Suthathothon, P. (2023). Teachers' challenges and strategies in using digital media in teaching English. *Journal of English Language Teaching Innovations and Materials*, *5*(1), 49. https://doi.org/10.26418/jeltim.v5i1.63204

Safapour, E., Kermanshachi, S., & Taneja, P. (2019). A Review of nontraditional teaching methods: Flipped classroom, gamification, case study, Self-Learning, and social media. *Education Sciences*, *9*(4), 273. https://doi.org/10.3390/educsci9040273

Salloum, S. A., Alhamad, A. Q. M., Al-Emran, M., Monem, A. A., & Shaalan, K. (2019). Exploring students' acceptance of E-Learning through the development of a

comprehensive technology acceptance model. *IEEE Access*, *7*, 128445–128462. https://doi.org/10.1109/access.2019.2939467

Saroh, Y., & Htun, K. W. W. (2020). Narrative Study: Diary of digital Immigrant EFL teacher in Myanmar. *IJEE (Indonesian Journal of English Education)*, *7*(2), 216–237. https://doi.org/10.15408/ijee.v7i2.17690

Sedov, S., & Kashfrazyeva, G. (2022). Trends in the development of technological education and advanced vocational training of students in the context of technological education. *World Journal on Educational Technology*, *14*(1), 200–216. https://doi.org/10.18844/wjet.v14i1.6718

Shobeiry, L. (2023). The study of difference between self-taught and non-self-taught learners in terms of the use of cognitive and metacognitive strategies. *Tarbiat Modares University Journals System - Language Related Research*. https://doi.org/10.29252/LRR.14.2.4

Shvardak, M., Ostrovska, M., Bryzhak, N., Predyk, A., & Moskovchuk, L. (2024). *The use of digital technologies in professional training of primary school teachers*. https://www.iejee.com/index.php/IEJEE/article/view/2163

Sitzmann, T., Ely, K., Bell, B. S., & Bauer, K. N. (2010). The effects of technical difficulties on learning and attrition during online training. *Journal of Experimental Psychology Applied*, *16*(3), 281–292. https://doi.org/10.1037/a0019968

Sooleen, A. (2024). *Different types of sampling techniques in qualitative research*. Sago. https://tinyurl.com/y4wv6euw

Tami, S. (2017). Training the teachers of tomorrow in an era of rapid technological advancement. *I-Manager's Journal of Education Technology*, *14*(1), 35. https://doi.org/10.26634/jet.14.1.13585

Tiwari, S. P. (2022). Emerging technologies: Factors influencing knowledge sharing. *World Journal of Educational Research (Los Angeles. Online)/World Journal of Educational Research*, *9*(2), p68. https://doi.org/10.22158/wjer.v9n2p68

Top, E., Baser, D., Akkus, R., Akayoglu, S., & Gurer, M. D. (2021). Secondary school teachers' preferences in the process of individual technology mentoring. *Computers and Education/Computers & Education*, *160*, 104030. https://doi.org/10.1016/j.compedu.2020.104030

Winter, E., Costello, A., O'Brien, M., & Hickey, G. (2021). Teachers' use of technology and the impact of Covid-19. *Irish Educational Studies*, *40*(2), 235–246. https://doi.org/10.1080/03323315.2021.1916559

Wirihana, L., Welch, A., Williamson, M., Christensen, M., Bakon, S., & Craft, J. (2018). Using Colaizzi's method of data analysis to explore the experiences of nurse academics teaching on satellite campuses. *Nurse Researcher*, *25*(4), 30–34. https://doi.org/10.7748/nr.2018.e1516

Zakrzewski, J., & BriAnne Newton, M. L. I. S. (2022). Technology in Teacher Education. *Journal on Empowering Teaching Excellence, Spring 2022*. Retrieved from https://digitalcommons.usu.edu/jete/vol6/iss1/4/