JOURNAL OF INTERDISCIPLINARY PERSPECTIVES

ISSN Print: 2984-8288, ISSN Online: 2984-8385
Vol. 3 No. 1, pp. 194-214, January 2025

Technological Leadership Behavior and Technological Formation as Predictors of Education 4.0 Competency Determination of Educators in Region XII: A Convergent Design

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Date received: November 25, 2024
Date revised: December 8, 2024
Date accepted: December 22, 2024

Originality: 99%
Grammarly Score: 99%
Similarity: 1%

Recommended citation:
Simpal, M., Pidor, S. (2024). Technological leadership behavior and technological formation as predictors of Education 4.0 competency determination of educators in Region XII: A convergent design. *Journal of Interdisciplinary Perspectives*, 3(1), 194-214. https://doi.org/10.69569/jip.2024.0634

Abstract. This study determined the influence of technological leadership behavior and technological formation on Education 4.0 competency determination of educators in Region XII, Philippines. This study utilized mixed methods research, mainly convergent design. In the quantitative phase, adapted and validated survey questionnaires were employed, while an interview guide was utilized in the qualitative phase during in-depth interview (IDI) and focus group discussion (FGD). The statistical tools used in analyzing the quantitative data included mean, standard deviation, and multiple linear regression analysis, while thematic analysis was used for the qualitative data. The results revealed that the status of technological leadership behavior, technological formation, and Education 4.0 competency determination of educators were rated high. Moreover, technological leadership behavior and technological formation significantly influenced Education 4.0 competency determination. Further, facing limitations in the pedagogical and conceptual competencies related to Education 4.0, encountering inadequacy of resources, engaging in ICT upskilling and technology capacity-building activities, and becoming a proactive teacher were the themes generated from the lived experiences of educators. Furthermore, the themes extracted from the role of experiences that shaped their beliefs included learning is a continuous process, teaching is a vocation and bearing accountability to students. Likewise, manifesting resiliency, keeping a spirit of positivity, and embodying appropriate values were the themes generated from the experiences that shaped their attitude. Along with this, the themes that surfaced from the experiences that shaped the commitment of teachers involved visioning for knowledgeable students and manifesting passion for teaching. Finally, the nature of data integration revealed merging-converging.

Keywords: Convergent design; Education 4.0 competency determination; Technological formation; Region XII, Technological leadership behavior.

1.0 Introduction

Education 4.0 competency determination focuses on determining the expected competency of teachers to develop their knowledge and skills related to digital technologies and their ability to apply these new technologies in the learning environment (Turan-Güntepe & Abdüsselam, 2022). It aspires to develop digitally competent teachers using fundamental digital education available to all students to meet society's needs in the inventive age (Hariharasudan & Kot, 2018). However, despite the advent of technology, educators are reluctant to incorporate technological tools into the pedagogical framework despite a notable willingness among students to acquire

proficiency in emerging technology (Qureshi et al., 2021). Primary problems in ICT infrastructure and technical and pedagogical content competencies have resonated in Africa and Sweden's Education 4.0 competency determination of teachers (Van Wyk & Waghid, 2023). This data is also congruent with the data obtained from 26 participating countries by PricewaterhouseCoopers (2016) survey, which suggests that Education 4.0 competency determination faces challenges related to a need for digital culture and training (50%) and support from school leaders (40%).

Furthermore, as noticed by Alda et al. (2020), the need for more proficiency in utilizing learning management, the limited availability of virtual laboratories, and digital infrastructure are significant barriers to determining the Education 4.0 competency of teachers in the Philippines. In fact, Ventayen et al. (2019) mentioned that educators in the Philippines need more skills in preparing online content and assessments due to the unfamiliar use of technological tools. Likewise, Almacen et al. (2023) noticed that lack of financial resources and inadequate infrastructure are among the barriers to technical skills acquisition by teachers. However, in Region XII, Education 4.0 has become the focal point of innovation in teaching, stressing the need for DepEd and other education agencies to provide Filipino students with technology and internet resources. However, Macaranas and Robles (2023) found that despite the high responsiveness of STEM programs to Education 4.0 today in secondary schools, educators still need help in coping with the required competencies of Education 4.0 in General Santos City. This finding is also noted by Gonzales et al. (2022), who mentioned that educators face challenges developing Education 4.0 competencies due to limited training resources, high costs, inadequate technologies, skills and knowledge gaps, and complex learning platforms.

In the same way, Alkrdem (2014) found a positive connection between the principal's technological leadership behavior and the development of teachers' competencies in Education 4.0. This highlights the importance of technological leadership skills for robust, technology-oriented curriculum instruction as they influence the formation of teachers' technical skills. This is supported by Mendoza and Catiis (2022), who pointed out that school heads' technological leadership behavior affects teachers' technology skills in navigating their Education 4.0 competency determination.

On the other hand, upon reviewing the current literature, the researchers have found that most articles discussed Education 4.0 competency as one primary variable in their studies through surveys. Some literature focuses only on the association between technological leadership behavior and Education 4.0 competency determination and technological leadership behavior to teachers' competence in Education 4.0 through correlational study. Others were done through the correlation between the technological formation of teachers and competency determination in Education 4.0. In addition, some studies were conducted on groups of pre-service and higher education teachers abroad, and most studies utilized descriptive, descriptive-correlational, and some employed qualitative research design. Thus, less has been done in the Philippine setting.

As a result, the researchers felt the urgency to delve into the combined influence of technological leadership behavior and technological formation on Education 4.0 competency determination of educators in the Philippines, focusing on Region XII. Compared to the current study, this study is unique as it employed mixed methods research, mainly convergent design.

2.0 Methodology

2.1 Research Design

This study utilized a mixed methods approach, particularly the convergent design. As Creswell and Creswell (2017) emphasized, mixed methods research involves combining quantitative and qualitative data, integrating them, and deriving interpretations based on the combined strengths of both sets to understand research problems. In this study, the two data sets from the quantitative and qualitative strands were gathered from the participants; the quantitative and qualitative findings were then combined through data integration utilizing the convergent design methods to see whether the two data sets corroborate, converge, or diverge in results.

2.2 Research Locale

This study was conducted in Region XII comprises eight school division offices. In particular, the schools were selected based on the following criteria: a.) The school is categorized as a large school with at least 100 regular

teachers based on DepEd Memo No. 68, 2015, who could serve as sources for information gathering; b). The school is implementing a science, technology, engineering, and mathematics (STEM) curriculum.

2.3 Research Participants

There were 352 respondents in the quantitative phase derived from a 4,061 total population computed using the Raosoft sample size calculator set to a five percent margin of error (MoE) and a 95 percent confidence interval. Also, a stratified random sampling technique was utilized to determine the sample size needed for each identified public secondary school in Region XII. Moreover, 19 educators from the different public secondary schools in Region XII participated in the qualitative phase. The study's participants were selected through a purposive sampling technique based on the inclusion criteria set by the researchers. In particular, 12 participants were invited to participate in the IDI, and 7 were invited to participate in the FGD.

2.4 Research Instrument

In the quantitative phase, the researchers used an adapted and validated research survey questionnaire that had undergone validity and reliability tests. The research instrument is adapted from Durnali (2022), which assessed the technological leadership behavior; Erdogmus et al. (2021), which assessed the teachers' technological formation; and Turan-Guntepe and Abdusselam (2022), which assessed the teachers' determination of their Education 4.0 competency, with an overall Cronbach's alpha of 0.814. Furthermore, a researcher-made interview guide was utilized in the qualitative phase, which a panel of experts validated. The validated research interview guide was utilized to extract the participants' lived experiences concerning their education 4.0 competency determination.

2.5 Data Gathering Procedure

The data collection of both the quantitative and qualitative data was conducted simultaneously. As part of the research protocol, the researcher secured an Ethical Clearance from the UIC - Research Ethics Committee (UIC-REC) to guarantee the ethical soundness of the study. Moreover, the researchers obtained the respondents' consent to partake voluntarily in the quantitative phase. The respondents were informed about the study's entire procedure. The informed consent form (ICF) was personally given to the respondents before administering the survey questionnaire. The respondents were asked to answer the survey questionnaires about their school heads' technological leadership behavior, teachers' technological formation, and Education 4.0 competency determination. The respondents' responses were combined and totaled, and the appropriate statistical tools were used to analyze the quantitative data.

Furthermore, in the qualitative phase of the study, the researchers conducted an IDI and FGD on the study participants. The execution of the qualitative strand adhered precisely to the established protocols. The ICF indicated that participation in the study was voluntary and was given to the participants for approval. The procedures, such as goals, potential hazards, and discomforts, were disclosed to the participants. More so, they were guaranteed to keep their responses private and allowed to protect their identities using pseudonyms. Further, they were also informed of their rights to decline to answer the questions and withdraw from the study.

2.7 Ethical Considerations

This study adheres to ethical standards by submitting it to the UIC-REC guidelines and following the required procedures while interacting with participants. The ten ethical considerations were strictly observed, including social value, informed consent, participant vulnerability, risks, benefits, privacy, confidentiality, justice, transparency, researcher qualification, facility adequacy, and community involvement. Moreover, before the study's conduct, Ethical Clearance (Protocol Code: GS-0088-02-24) was secured from the UIC - Research Ethics Committee (UIC-REC) to guarantee the ethical soundness of the study. The participants were personally given the informed consent form (ICF), seeking their voluntary participation in the study before administering the surveys, IDIs, and FGDs. They were permitted to remain unknown in the entire process through a pseudonym, and their responses were guaranteed to be kept confidential. They were also informed of their rights to decline or withdraw at any given time without any legal sanction. Further, a full review of the ethics committee on the study's design, methods, and procedures was done, ensuring that the study met the ethical standards. All ethical guidelines were followed precisely during the study's implementation.

3.0 Results and Discussion

3.1 Status of Technological Leadership Behavior

The status of the technological leadership behavior of educators in Region XII was measured through its four indicators: motivation, orientation, precaution, and support (see Table 1). Computations yielded an overall mean of 3.84, which is described as high. This implies that technological leadership behavior is oftentimes evident among educators in public secondary schools in Region XII. Moreover, the overall standard deviation is .77, which is less than 1, indicative of a minimal range of dispersion.

This implies that school heads create expectations on the use of technology and are fully aware of its importance at school while supporting the emergence of technology, particularly the technological needs of teachers inside the classroom. The school heads recognize the vital role of technology in today's educational setting as an essential part of education today, which makes them active in providing essential tools for the teachers' effective integration of technology in the classroom.

Table 1. Descriptive statistics of the status of technological leadership behavior

Indicators/Items	Mean	SD	Description
A. Motivation			
1. trying to address concerns about the use of technology at school.	4.00	.82	High
2. guiding about the safety precautions should be taken when in use of technology at school.	3.96	.86	High
3. creating clear expectations about the use of technology at school.	4.01	.82	High
4. motivating to use technology at school.	4.22	.88	Very High
5. giving access to technology on an equal basis with other employees in the school.	4.01	.90	High
6. informing about the unnecessary use of technology at school.	3.93	.92	High
Category Mean	**4.00**	**.74**	**High**
B. Orientation			
1. enabling to internalize the importance of using technology at school.	4.13	.82	High
2. enabling to apply technology successfully to the teaching process at school.	4.19	.82	High
Category Mean	**4.10**	**.74**	**High**
C. Precaution			
1. ensuring that the information technology tools needed at school are ready for use.	3.89	.82	High
2. providing the software(s) needed in the teaching process at school.	3.64	.93	High
3. providing the equipment needed in the teaching process at school.	3.66	.95	High
4. providing the hardware upgrades needed in the teaching process at school.	3.50	.98	High
Category Mean	**3.67**	**.82**	**High**
D. Support			
1. showing awareness of the legal issues related to the use of technology.	3.87	.90	High
2. ensuring that the software(s) used at school are licensed.	3.80	1.00	High
3. taking measures to prevent illegal copying of the software(s) used at school.	3.77	.99	High
4. leading the use of computers in accordance with ethical values at school.	3.94	.90	High
5. leading to take measures to prevent possible IT-based crimes that may occur at school.	3.85	.93	High
Category Mean	**3.83**	**.88**	**High**
Overall Mean	**3.84**	**.77**	**High**

Motivation

This indicator obtained a category mean of 4.00 with a description of High and interpreted as oftentimes evident. Looking at the individual items, the mean rating of this category ranges from 3.93 to 4.22. In particular, the item motivating to use technology at school, received a mean rating of 4.22. Meanwhile, the item informing about the unnecessary use of technology at school registered a mean rating of 3.93. This indicates that the school heads support teachers' integration with technology, as they have a positive outlook on utilizing technology in school, giving teachers free access and equal opportunity to better facilitate their technological needs inside the school. This finding aligns with the study of Soy and Behcet (2021), who showed that a high level of motivation affects the instructional style and direction of teachers in the utilization of technology. Moreover, the study's results support the findings of Andriani et al. (2018), who pointed out that the high level of motivation and leadership skills shown to the teachers contributed to the increase in teachers' competence, particularly when embracing the new era of learning today. However, the study contradicts the study of Kou (2024), who found that the leader's behavior does not influence high motivation to do the work tasks.

Orientation

This indicator reveals a category mean of 4.10 with a description of high. By looking at the individual items, the mean rating of this category ranges from 4.13 to 4.19. The item enabling to apply technology successfully to the

teaching process at school, got a mean rating of 4.19. While the item enabling to internalize the importance of using technology at school, obtained a mean rating of 4.13. This means that the technological leadership behavior of school heads shows awareness of the importance of technology in school, which influences the successful application of technology among teachers. The school heads high orientation level further indicates that they have embraced the emergence of technologies, emphasizing the importance of applying them in school and allowing teachers to use these new technologies as part of classroom instructions. This finding supports the study of Mubarak and Petraite (2020), who found that a high orientation level of school leaders in technology use improved active learning environments. Moreover, the study is also congruent with the findings of Gurr and Drysdale (2020), whose paper underscores that guiding an educational organization to increase adaptability requires a high level of school leader orientation on the advent of technology to develop individual competence and enhance the adaptive competence of the teachers. In addition, Gyeltshen (2021) highlighted that a moderate level of leadership orientation influences teachers' use of technology in classroom teaching and learning, which can be effective in school practice in Bhutan.

Precaution

This indicator accumulated a category mean of 3.67, described as high. Looking at the individual items, the mean ratings ranged from 3.50 to 3.89. In particular, the item ensuring that the information technology tools I need at school are ready for use obtained a mean rating of 3.89. Likewise, the item providing the hardware upgrades needed in the teaching process at school also got a mean rating of 3.89. This suggests that school principals are supportive enough to provide for the technological needs of the teachers and ensure that the equipment needed is ready to facilitate the learning process of the students inside the classroom. The results support the finding of Kumar et al. (2019), whose paper highlighted the teacher use of technology tools that facilitate student learning, effective management of the classroom environment, and efficient carrying out of tasks can be attributed to a high level of precaution of the school principal on the use of technology at school. On the other hand, Karabatak and Karabatak (2018) emphasized that inadequate school leader support for technology tools and information for teachers may affect their technological literacy.

Support

This category obtained a mean of 3.83, which is described as high. Looking closely at the individual items, the mean rating of this category ranges from 3.77 to 3.94. The item leading the use of computers by ethical values at school got the mean rating of 3.94. The item taking measures to prevent illegal copying of the software(s) used at school has a mean rating of 3.77. The high support for teachers shows the grasp of school heads on the use of technology and the observance of ethical values for the use of technology. This may prevent teachers from committing a serious offense by exploiting this technology. The result agrees with the study of Pollock (2020), whose findings revealed that school leaders with a high level of support promote safe school practices and establish a framework for the use of technology to guide learning initiatives through the utilization of technology. As a matter of fact, Andriani et al. (2018) accentuated that technology integration in schools is influenced by technologically proficient principals who adhere to ethical principles.

3.2 Status of Technology Formation

The status of the technological formation of educators was measured in terms of content development, interactive object development, problem solving, and creativity (see Table 2). The computations yielded an overall mean of 3.49, which is described as high. This suggests that technological formation is oftentimes demonstrated among educators in public secondary schools in Region XII. More so, the overall standard deviation is .66, which is less than 1, indicative of a minimal range of dispersion on respondents' responses.

This implies that teachers can handle various aspects of online educational media, including mobile content and technology integration into lessons, despite a partially strenuous field of robotics education. Likewise, teachers can also utilize various ways to enhance lesson content using electronic circuits and educational technology tools while involving planning, collaborating with experts for successful results, and adapting to new technological tools. Choosing appropriate digital resources through problem-solving skills reciprocates to enhancing technological competence among teachers.

Table 2. Descriptive statistics of status of technological formation

Indicators/Items	Mean	SD	Description
A. Content Development			
1. making online educational media (animation, video, educational game).	3.82	1.05	High
2. fictionalizing an educational media (animation, video, educational game) step by step.	3.56	1.02	High
3. making custom pages on the online platforms used.	3.56	1.02	High
4. customizing the software used based on my needs.	3.40	1.12	High
5. making a blog or blogs that students can use to discuss and submit ideas.	3.49	1.04	High
6. preparing creative lesson content with mobile devices (smartphone, tablet).	3.88	.97	High
7. writing unique scenario for educational media (animation, video, educational game).	3.54	1.01	High
8. preparing online interactive lesson presentation	3.80	1.05	High
9. preparing different concept maps and drawings online.	3.59	1.06	High
10. creating game with online game providers for both educational and fun.	3.26	1.10	Moderate
11. designing a unique character for educational media (animation, video, educational media).	3.22	1.08	Moderate
12. building an online platform to evaluate my students.	3.38	1.12	Moderate
13. deciding on specific online platforms or simulation development apps to use based on lesson content.	3.38	1.05	Moderate
14. designing a page/platform where students get lesson content with social networks.	3.33	1.07	Moderate
15. planning and process a mobile app development step by step.	3.12	1.10	Moderate
16. deciding which computer hardware will be used based on needs.	3.50	1.05	High
17. studying with different simulation, virtual reality or augmented reality apps.	3.42	1.03	High
18. designing simple simulations to use in my lessons.	3.41	1.03	High
19. developing websites about different departments.	3.11	1.16	Moderate
20. preparing online survey, quiz etc. for students to fill.	3.78	1.07	High
21. understanding which websites use technologies.	3.66	1.06	High
22. surviving the hardship in the process of mobile app development.	3.43	.99	High
23. developing virtual reality app or augmented reality to enrich my lessons.	3.17	1.03	Moderate
24. re-enriching a printed lesson material with virtual reality or augmented reality.	3.43	1.01	High
25. making brochure or poster with desktop publishing app (MS Publisher etc.).	3.57	1.13	High
26. preparing lesson content about mobile app development.	3.42	1.07	High
27. editing my images with photo editor app.	3.77	1.12	High
28. designing creative interface design for my mobile app.	3.40	1.14	High
29. installing different operating systems (Windows, Linux, MacOS).	3.35	1.21	Moderate
30. knowing what formats (apx, php, html etc.) on the address bar means.	3.35	1.20	Moderate
Category Mean	**3.49**	**.87**	**High**
B. Interactive Object Development			
1 enriching lesson content by using electronic circuit (Arduino, Raspberry Pi, Tinker Board, UDOO etc.).	2.77	1.17	Moderate
2 building a project with electronic circuit (Arduino, Raspberry Pi, Tinker Board, UDOO etc.).	2.65	1.13	Moderate
3 deciding components to be used in electronic circuit (Arduino, Raspberry Pi, Tinker Board, UDOO etc.).	2.61	1.14	Moderate
4 developing an app with electronic circuit (Arduino, Raspberry Pi, Tinker Board, UDOO etc.).	2.50	1.12	Low
5 developing the products which support lesson content by using electronic circuit (Arduino, Raspberry Pi, Tinker Board, UDOO etc.).	2.56	1.14	Low
6 enriching my lesson content by using block-based app (Scratch, Codu etc.)	2.55	1.13	Low
7 developing lesson content by using educational robot kits.	2.60	1.17	Moderate
Category Mean	**2.59**	**1.08**	**Low**
C. Problem Solving			
1 mathematically expressing the solution of the problems faced in daily life.	3.60	.98	High
2 thinking can learn better the instructions made with the help of mathematical symbols and concepts.	3.62	.97	High
3 thinking have a special interest in the mathematical processes.	3.62	1.02	High
4 having problems in the issue of where and how should use the variables such as X and Y in the solution of a problem.	3.14	1.11	Moderate
5 trying to solve the complex problems.	3.58	.10	High
6 preparing regular plans regarding the solution of the complex problems.	3.50	.94	High
7 making use of a systematic method while comparing the options at hand and while reaching a decision.	3.60	.95	High
8 applying the solution planned respectively and gradually.	3.69	.94	High
9 having no problems in the demonstration of the solution to a problem in mind.	3.60	.92	High
10 producing so many options while thinking of possible solutions to a problem.	3.62	.91	High
11 immediately establishing the equity that will give the solution of a problem.	3.57	.89	High
12 thinking will attain more successful results because of working in a group, in cooperative learning.	3.83	.93	High
Category Mean	**3.59**	**.80**	**High**
D. Creativity			
1 liking people who are sure of most of their decisions.	4.31	.83	Very High
2 liking fair and realist people.	4.41	.82	Very High
3 believing that dreaming is caused by my desire to showcase my important projects.	4.14	.83	High
4 trusting myself to conduct the plan while planning to solve problem.	4.12	.81	High
5 having faith in solving the problems when come across a new situation.	4.11	.81	High
6 adapting to a new technologies.	4.07	.90	High
Category Mean	**4.20**	**.72**	**Very High**
Overall Mean	**3.49**	**.66**	**High**

Content Development

This category has a mean of 3.49 with a description of high. Looking at the individual items, the mean ratings ranged from 3.11 to 3.88. In particular, the item, preparing creative lesson content with mobile devices (smartphone, tablet), and the item, building an online platform to evaluate my students, and the item deciding on specific online platforms or simulation development apps to use based on lesson content obtained a mean rating of 3.88. While the item, developing websites about different departments, got a mean rating of 3.11. This implies that teachers are using various technological platforms for educational drives in their classroom instruction. This result is congruent with the study of Emre (2019), who revealed that teachers with a high content development level are inclined to create an online platform, simulate development applications, and create a social media platform for their lesson content. Moreover, Unal and Uzun (2019) stressed that using technology is complicated and that teachers encounter strenuous technology platforms that infuse moderate content development skills. Thus, teachers should adapt technologies flexibly.

Interactive Object Development

This category garnered a mean of 2.59 with a description of low, which is seldom demonstrated. Looking at the individual items, the mean rating of this category ranges from 2.50 to 2.77. Specifically, the item enriching lesson content by using an electronic circuit obtained a mean rating of 2.77 with a description of moderate and is interpreted as sometimes demonstrated. Meanwhile, the mean rating of 2.50 was obtained by the item developing an app with an electronic circuit**.** The result demonstrates low interactive object development skills among teachers, suggesting they need to be more confident in handling electronics and robotics education. This can be a barrier to integrating robotics education into their lessons. The result of the study contradicts the study of Roemintoyo et al. (2022), whose paper found that senior high school teachers have very high interactive object development skills for learning in classroom activities in Indonesia. In connection, Schina et al. (2021) added that with the rapid spread of technology advancement and educational robotics, a low interactive object development level necessitates teachers to attend training and technological pedagogy programs.

Problem Solving

This indicator gained a category mean of 3.59 with a description of high and interpreted as oftentimes demonstrated. Looking at the individual items, the mean rating of this category ranges from 3.14 to 3.83. In particular, the item thinking will attain more successful results because of working in a group, in cooperative learning, acquired a mean rating of 3.83. While the item having problems in the issue of where and how I should use the variables such as X and Y in the solution of a problem, obtained a mean rating of 3.14. The result suggests that teachers can achieve more when working collaboratively to demonstrate a systematic solution to a problem. This result affirms the study of Treffinger et al. (2023), whose findings revealed a high level of problem-solving among individuals who can innovatively provide a problem-solving technique that utilizes mathematical skills to demonstrate the solution. Moreover, Nelson et al. (2019) underlined that teachers become adept at preparing regular plans and creating a systematic decision-making method when they have high problem-solving skills.

Creativity

This category has a mean of 4.20 with a very high description and is described as always demonstrated. Looking at the individual items, the mean rating of this category ranges from 4.07 to 4.41. The item liking fair and realist people, got a mean rating of 4.41. Meanwhile, the item adapting to a new technologies obtained a mean rating of 4.07. This implies that creativity is always evident among teachers; they work effectively with their peers and are committed enough to their decision-making process while solving particular problems when encountering new situations, necessitating careful planning. This finding is aligned with the study of Kettler et al. (2018), whose paper highlighted that teachers with very high creativity levels are more innovative in embracing technologies and tend to go along with individuals who are confident with most of their decisions. Furthermore, as Bereczki and Karpati (2018) noted, creative teachers have faith in solving problems when faced with new situations that strengthen their technological formation. Teachers' creativity has been observed to positively impact the acceptance of technological innovation among teachers in gaining their technological formation.

3.3 Status of Education 4.0 Competency Determination

The status of Education 4.0 competency determination of educators in Region XII was measured in terms of mastery of digital technology, information management, and active participation in the process (see Table 3).

Computations yielded an overall mean of 3.49, which is described as high. The results suggest that Education 4.0 competency determination is very satisfactory among educators in public secondary schools in Region XII. Moreover, the overall standard deviation is .73, which is less than 1, indicative of a minimal range of dispersion. This means that teachers have acquired the necessary skills to deal with digital technologies and have relevant knowledge of its various platforms.

Table 3. Descriptive statistics of the status of Education 4.0 competency determination

Indicators/Items	Mean	SD	Description
A. Mastery of Digital Technology			
1. knowing about cloud technologies.	3.24	1.13	Moderate
2. knowing about smart technologies such as wearable technologies and smart glasses.	3.40	1.18	High
3. knowing about robotic programming.	2.71	1.11	Moderate
4. knowing about mobile technologies.	3.58	1.11	High
5. knowing about Bitcoin and Blockchain technologies.	2.98	1.17	Moderate
6. knowing about three-dimensional (3D) technologies.	3.16	1.14	Moderate
7. knowing which software to use to do 3D printing.	2.93	1.18	Moderate
8. knowing about artificial intelligence.	3.49	1.17	High
9. writing program using code blocks.	2.63	1.14	Moderate
10. knowing the intended purposes of wearable technologies and smart glasses.	3.00	1.19	Moderate
Category Mean	**3.11**	**1.01**	**Moderate**
B. Information Management			
1. taking security measures while using information and communication technologies.	3.57	.97	High
2. paying attention to ethical principles when using information and communication technologies.	3.77	.90	High
3. knowing what to do when encountering a security incident while using information and communication technologies.	3.51	.93	High
4. questioning the accuracy of information in digital resources.	3.43	.95	High
5. choosing the correct information digital resources.	3.59	1.00	High
Category Mean	**3.59**	**.88**	**High**
C. Active Participation in the Process			
1. directing training depending on personal needs.	3.72	.90	High
2. participating in project-based studies.	3.75	.90	High
3. using time effectively in the learning process.	3.90	.86	High
4. easily solving the problems encountered in the learning process.	3.78	.84	High
5. knowing from whom to get help when faced with difficulties in the learning process.	3.90	.85	High
6. conducting interdisciplinary studies.	3.65	.90	High
Category Mean	**3.79**	**.75**	**High**
Overall Mean	**3.49**	**.73**	**High**

Mastery of Digital Technology

The mastery of digital technology of educators in Region XII generated a category mean of 3.11, which is described as moderate. Looking at the individual items, the mean rating of this category ranges from 2.63 to 3.58. The item knowing about mobile technologies obtained a mean rating of 3.58. Meanwhile, the item writing my program using code blocks got a mean rating of 2.63. This indicates that teachers in public secondary schools are satisfactorily knowledgeable about the technological tools and software needed in their Education 4.0 competency determination**.** However, some relatively difficult aspects of digital technologies require more skills for teachers to embrace them, particularly in classroom settings. The result of the study is congruent with the findings of Amhag et al. (2019), which revealed that teachers who used digital tools occasionally for pedagogical purposes are less acquainted with the use of technologies in Education 4.0 due to a moderate level of mastery of digital technology. On the other hand, Nasution et al. (2020) suggested that to improve the mastery of digital technology, schools should implement digital initiatives and socialize digital activities to motivate others to transform into digitally competent individuals.

Information Management

The information management reveals a category mean of 3.59 with a description of high. By looking at the individual items, the mean rating of this category ranges from 3.43 to 3.77. In particular, paying attention to ethical principles when using information and communication technologies obtained a mean rating of 3.77. Likewise, the item questioning the accuracy of the information in digital resources got a mean rating of 3.43. This implies that teachers have very satisfactory knowledge of information management principles and understand the accuracy of information from digital resources. The high level of information management further denotes that teachers are well-informed about the ethical principles of using technology. This result is consistent with the findings of

Licorish et al. (2018) that teachers with high information management levels embrace technology advancements as preventive measures to reduce workloads and secure the accuracy of information in digital resources based on this advancement. More so, Sánchez-Cruzado et al. (2021) reiterated that teachers often need a higher self-perception of their digital skills, especially with high information management skills, to better prepare for security incidents.

Active Participation in the Process

This category obtained a mean of 3.79, which is described as high. By looking at the individual items, it can be observed that the mean rating of this category ranges from 3.65 to 3.90. It can be noted that the two items have the same mean rating of 3.90: knowing from whom to get help when faced with difficulties in the learning process and using time effectively in the learning process. This indicates that educators who participate extensively in digital literacy activities can collaborate with their peers on project-based learning development activities that allow them to devise a plan to effectively address learning challenges efficiently. The result of the study is consistent with the study of Aslan (2021), which highlighted that teachers with high active participation in digital literacy show competence in embracing the trends of education today that require problem-solving, decision-making, and understanding of technological concepts. Furthermore, Joseph et al. (2021) underscore that even with less technology adoption, teachers with high active participation in the process could find ways to gain knowledge on digital literacy depending on their needs and the effective use of their time in the learning process in gaining their Education 4.0 competency determination.

3.4 Significance of the Influence of Technological Leadership Behavior and Technological Formation on Education 4.0 Competency Determination

The results of the multiple regression analysis which purpose is to determine the influence of technological leadership behavior and technology formation on Education 4.0 competency determination indicate that technological leadership behavior (β=.150, p<.05) and technology formation (β=.621, p<.05) significantly predict the education 4.0 competency determination of educators in Region XII (see Table 4). This means that the regression weights for technological leadership behavior and technological formation in the prediction of Education 4.0 competency determination are significantly different from zero at the 0.05 level (two-tailed). This suggests further that for every unit increase in technological leadership behavior, there is a corresponding increase in the Education 4.0 competency determination by .150. More so, for every unit increase in technological formation, there is a corresponding increase in the Education 4.0 competency determination by .621. In other words, a strengthened technological leadership behavior and technological formation would contribute to the enhancement in Education 4.0 competency determination of educators. Furthermore, the finding reveals in the results of the multiple regression analysis in which 49.2 percent of the variance of Education 4.0 competency determination can be explained by the model as indicated by R^2 = .492. This implies that 50.8 percent of the variance of Education 4.0 competency determination can be attributed to the other factors aside from technological leadership behavior and formation.

Table 4. Significance of the influence of technological leadership behavior and technological formation on education 4.0 competency determination

Model	Unstandardized Coefficients		Standardized Coefficients	t	p-value	Remarks
	B	Std. Error	Beta			
(Constant)	.513	.161		3.184	.002	
Technological Leadership Behavior	.144	.038	.150	3.770	.000	Significant
Technological Formation	.694	.045	.621	15.584	.000	Significant

Note: R=.702, R-squared=.492, F=193.405, p=.000

This implies that the more supportive the school heads are in the development and integration of technology by providing the necessary tools for teachers, the more enhancement in the Education 4.0 competency determination is manifested among teachers. Likewise, as teachers' technological skill sets in the utilization of technology increase, so does their Education 4.0 competency determination. The findings of the study affirm the claim of Thannimalai and Raman (2018), whose paper emphasized that the principal's technological leadership behavior had a positive influence on the Education 4.0 competency determination of teachers, making the leadership behavior a substantial effect on the advancement of teacher competence in overcoming the barriers of education 4.0. Moreover, the study confirms the study of Suharyatia et al. (2019), which noted that technological formation influences the development of education 4.0 competency determination of teachers, which plays a crucial role in

shaping their ability to foster creativity and innovation. In fact, the current findings validate the Transformational Leadership Theory of Bass and Riggio (2006), which posits that making teachers aware of the task value, prioritizing the organizational goals, and providing and supporting teachers with their needs can significantly transform their vision. More so, the findings also validate the Self-determination Theory of Deci and Ryan (2012), which states that teachers are motivated by their innate needs for autonomy, relatedness, and competence, which give them a sense of control over what to adapt to technological tools inside their classroom. In the same way, the findings also support the Self-efficacy Theory of Bandura (2000) that human competencies are cultivated and demonstrated in many ways, involving distinct sets of knowledge and skills across various domains of functioning like the cognitive, motivational, emotional, and selection processes. This particular set of domains embedded in the minds of teachers influences their belief in their abilities to succeed in the advent of technology today that rapidly develops their technological skills and competence towards attaining their Education 4.0 Competency Determination.

3.5 The Lived Experiences of Participants Concerning Education 4.0 Competency Determination

In the IDI and FGD (see Table 5), the essential themes generated from the participants' statements concerning their lived experiences in Education 4.0 competency determination are as follows: facing limitations in the pedagogical and conceptual competencies related to Education 4.0, encountering inadequacy of resources, engaging in ICT upskilling and technology capacity building activities, and becoming a proactive teacher.

Table 5. Lived experiences of participants as regards Education 4.0 competency determination

Essential Themes	Core Ideas
Limitations in the Pedagogical and Conceptual Competencies related to Education 4.0	Having insufficient knowledge about some areas of Education 4.0 although computer literate.
	Lacking some skills to access varied applications of technological platforms for classroom instruction.
	Some teachers are unfamiliar with the technological processes of Education 4.0
	Integrating ICT in the learning process but not well-acquainted with Education 4.0 processes.
	Understanding Education 4.0 as an era of computers and utilizing technology such as Zoom, Google meet, PowerPoint presentations in the lessons.
Inadequacy of Resources	Lacking computer units in the laboratory for the students
	Experiencing poor internet connection in some school campuses.
	Receiving insufficient funds during competitions particularly in Robotics
	Having most students with no personal gadgets like laptop or cellphone
Engaging in ICT Upskilling and Technology Capacity Building Activities	Being able to attend seminars and trainings for ICT upskilling
	Having school administrators providing and, or, sending teachers to computer literacy and ICT seminars
	Maximizing LAC sessions to share knowledge among teachers about e-learning, Education 4.0, and other fields.
	Being allowed to join Robotics competitions in various levels
	Having school heads ensuring the availability of necessary technological resources no matter how mean are they in quantity
	Collaborating with experts and other stakeholders for guidance related to ICT and other technological fields
Becoming a Proactive Teacher	Taking initiatives to self-learn about technology and its application in instruction as well as appropriate teaching strategies.
	Utilizing innovative and interactive tools for an enriched classroom teaching
	Doing lots of readings and research about Education 4.0 and motivated for its employment to the teaching and learning processes

Limitations in the Pedagogical and Conceptual Competencies related to Education 4.0

When asked about the experience of teachers regarding Education 4.0 competency, the participants revealed that they lack the knowledge and skills on Education 4.0. Despite being computer-literate, the participants were not proficient at employing technological platforms for classroom instruction. Their lack of exposure to ICT integration and familiarity with Education 4.0 procedures led to their inability to use technological tools effectively and integrate them into classroom instruction. With this, the participants felt that Education 4.0 could be embraced as an era of computers and that technology applications could be employed to improve the technological skills of the teachers. This implies that participants need to be exposed to and acquainted with some technological applications in the classroom, particularly in the technological process of Education 4.0. Although they use

computers as part of their daily school tasks, when it comes to applying new technologies in classroom instruction, they still need to gain skills in utilizing technological applications to enhance the learning process in their respective classes. This finding aligns with the idea of Sousa and Roucha (2019), who highlighted that minimal teacher exposure to technological advancements limits their acquisition of the skills essential for digital transformation and adapting to the technical framework of Education 4.0. In connection, the finding confirms the study of Artacho et al. (2020), which revealed that there is still a perceived deficit in digital teaching and problem-solving skills and competence among teachers today, particularly in digital content creation

Inadequacy of Resources

It was found that school laboratories lack computer units and have poor internet connections. Sometimes, financial resources are also limited. These inadequacies confronted the teaching and learning process to utilize technology effectively. The limited resources hinder the teachers from maximizing learning, including school participation in out-of-campus competitions like robotics and other competitions, where the schools need gadgets like laptops and cellphones, making it challenging for teachers to enhance Education 4.0 competency determination and improve access to personal gadgets. This implies that the need for more equipment and facilities confronted teachers to facilitate learning, which is essential in Education 4.0. With the advent of technological tools in the era of Education 4.0, the technical support needed seemed insufficient to cope with the advent of technologies. The school has a limited supply of technological equipment like laptops and internet connection since schools need more funds to provide these technological needs. The result corroborates with the study of Awang et al. (2020), which emphasized that IT infrastructure, like the availability of computers and technological facilities, is among the main challenges of Education 4.0 today. Moreover, the results support the claim of Costan et al. (2021), who pointed out that financial support in operationalizing IT infrastructure, such as internet connectivity, was among the barriers to Education 4.0.

Engaging in ICT Upskilling and Technology Capacity Building Activities

The participants pointed out that to capacitate teachers in the emergence of technology, they must attend seminars and training relative to computer literacy and ICT upskilling to acquire the skills needed for Education 4.0. They also highlighted that sharing knowledge about e-learning and Education 4.0 could greatly enhance the skills of teachers in technology integration. More particularly, venturing into other fields of technological advancement, like participating in robotics and other technology-related competitions, would capacitate teachers to acquire the skills. The results indicate that attending seminars and upskilling activities for ICT enhances the Education 4.0 Competency Determination of the participants; this can be strengthened by sending them to seminars and maximizing school-based activity training to share knowledge on facilitating e-learning and the Education 4.0 learning process among teachers. This finding affirms the study of Wilk et al. (2020) that professional training of teachers must focus on enhancing Education 4.0 competency determination to adapt to the trends and changing landscape of education today. Thus, school administrators should provide facilities and programs that support the enhancement of the technological competence of the teachers at school and send their teachers to seminars and training (Agustini et al., 2020).

Becoming a Proactive Teacher

Teachers emphasized the importance of looking at the needs in the trends in education and working with experts and stakeholders to improve further their skills in coping with the advancement of technology. It is also imperative for teachers to continuously explore the possibilities of learning the new era of technology by self-learning about technological tools and using these innovative tools to enrich classroom teaching, learning experiences, and skills in Education 4.0. More so, the teachers engage in extensive readings and research about Education 4.0 and are motivated to apply it to the teaching and learning process to elevate Education 4.0 competency. The result emphasized that becoming proactive in learning various technological applications enhances Education 4.0 Competency Determination. They emphasized the critical role of working together with ICT specialists for guidance while taking the initiative to acquire and discover innovative tools for teaching instruction enhancement. This finding confirms Emre's (2019) claim that teachers with positive perceptions of Education 4.0 collaborate more with experts to enhance their skills in technology manipulation. Further, Kochan (2022) added that teachers who proactively use digital technologies motivate students to embrace technological developments and are willing to collaborate with other teachers to acquire the technical skills needed.

3.6 The Role of the Experiences in Shaping the Beliefs of the Participants

The roles of experiences in shaping the participants' beliefs on Education 4.0 competency determination generated essential themes from the participants' statements that underlined the following ideas: learning is a continuous process, teaching is a vocation, and bearing accountability to the students (see Table 6). This implies that participants recognized the significant role of experiences that led to a change in beliefs and perspectives as to how to gain their Education 4.0 Competency Determination in the teaching-learning process of the Education 4.0 era. By realizing these themes, educators in Region XII can further enhance their technological skills and contribute to their professional growth.

Table 6. Role of the experiences in shaping the beliefs of the participants

Essential Themes	Core Ideas
Learning is a Continuous Process	Open to any advancement in the educational landscape. Must learn to adapt and apply the changes in the educational processes. Determined to learn new things. Upgrading oneself is a necessity in strengthening one's capability. Demonstrating effectiveness at work while applying the new knowledge learned.
Teaching is a Vocation	Teachers are molders of students. Delivery of instruction to students with passion and dedication. Looking at difficulties as a source of inspiration to strive more and become better. Learning from experiences for self-enhancement.
Accountability to Students	Having profound responsibilities to the students and the school. Provision of proper educational foundation to students Feeling accountable to the future of the student. Preparing students to become digital citizens. Development of the students in applying the latest trends in education.

Learning is a Continuous Process

The study results show that continuous learning is essential for teachers in enhancing technological skills in the Education 4.0 era. This means that to gain their Education 4.0 Competency Determination, teachers were adaptive and open to any advancement in today's educational processes, particularly 21st-century skills. More so, they believed that continuous learning strengthens their competencies and improves effectiveness at work by applying the new knowledge gained. This finding is aligned with the study of Caena and Redecker (2019), which underlined that teachers' continuous learning is necessary for improving their digital skills in the education 4.0 era and significantly impacts students' learning process. Furthermore, Billiot (2023) highlighted that teachers must acquire and apply new knowledge, develop new attitudes, and change learning behavior to help the school undergo endless changes shaped by technological advancements by continuously learning about the advent of technology today to engage students in today's educational landscape.

Teaching is a Vocation

As the interview continued, the participants accentuated that teaching is not just conveying knowledge but a commitment to assist students in capitalizing on learning experiences to drive them toward their goals. It is essential to be internalized by the teachers that they are the molders of tomorrow's future, the students. With this idea, teachers also strive to deliver instruction with passion and dedication to the students, which could cultivate their potential to strive more for learning and succeed in time. With this, teachers consider difficulties as their inspiration to improve themselves professionally and personally, emphasizing the importance of learning from experiences for personal growth. Based on the study's results, teachers considered teaching a vocation driven by passion and dedication to education. This implies that teachers mold students by carrying out instruction with passion and dedication while looking at the challenges as a motivation to grow and continually improve from learning experiences. The challenges brought about by Education 4.0 due to rapidly increasing technological tools motivate teachers to persevere in maximizing their knowledge and staying attuned to technology. This result confirms the findings of Alfalah (2018) that dedication is essential in making the learning process more engaging and motivating for students. In the same way, Daskan (2023) pointed out that passionate teacher possesses enthusiasm, desire, effort, dedication, and commitment to deliver compelling learning experiences for the students despite the challenges of the emergence of technologies, which are significant contributors to the success of education.

Accountability to Students

The participants emphasized the realization of the responsibilities of teachers bearing accountability to their students. Teachers shed light on providing a solid educational foundation for students, especially in this era of Education 4.0. Teachers must prepare students to be effectively adept with the technological world and the emergence of digital applications to actively and responsibly engage in these platforms. This would promote the development of their ability to apply current educational trends to effective learning. Thus, it is a significant responsibility for teachers to help students navigate in the era of Education 4.0. This emphasized the substantial roles of teachers in providing strong educational groundwork for the student's future by nurturing digital citizenship and integrating the modern educational trends in Education 4.0 for their growth and development. The finding corroborates with the statement of Thibaut et al. (2018) that teachers' accountability in a technology-driven society offers opportunities for students to succeed; it is then the responsibility of teachers to be equipped with technological skills to ensure that students have the necessary competencies to face a digitally information-driven education landscape in preparing them in the future. Moreover, Aslan (2021) stressed that dedicated engagement of teachers in digital literacy can provide effective learning acquisition and maximize students' preparedness for Education 4.0.

3.7 Role of the Experiences in Shaping the Attitudes of the Participants

In the interview (see Table 7), the roles of experiences in shaping the participants' attitude generated three essential themes from their statements: manifesting resiliency, keeping a spirit of positivity, and embodying appropriate values.

Table 7. Role of the experiences in shaping the attitude of the participants

Essential Themes	Core Ideas
Manifestation of Resiliency	Willingness to accept latest trends in education.
	Enthusiasm in handling challenges due to advancement in Education 4.0.
	Becoming innovative in teaching approaches.
	Strong determination to learn, accept and adapt new landscape of education.
	Embracing the challenges at work.
Keeping a Spirit of Positivity	Always searching for solutions when unexpected scenarios come.
	Building self-confidence in the midst of being unskilled about Education 4.0.
	Emphasizing self-reflect to continue self-learning.
	Practicing a not settling for less character.
Embodiment of Appropriate Values	Emanating patience and perseverance.
	Striving more to perform effectively being a responsible educator.
	Demonstration of humility especially when collaborating with colleagues and stakeholders for assistance and guidance.

Manifestation of Resiliency

The manifestation of participants unveiled the idea of their resilience in the era of Education 4.0. This shows that teachers are willing to embrace modern trends in the new education landscape, particularly in technology. The need for teachers to be determined and passionate in dealing with the challenges brought about by the advancement in Education 4.0 is essential in elevating teachers' interest in exploring new digital tools available for teaching-learning. The determination to adjust to situations leads to innovative teaching methods by learning, accepting, and adapting to the new landscapes of education. This can be an excellent pathway for enhancing teachers' capabilities and accepting the challenges of today's educational trends. This finding underscores that resiliency plays a critical role in Education 4.0 competency determination of teachers. More so, embracing the challenges of Education 4.0 is necessary to develop the necessary skills to face the advent of technology today. This finding affirms the study of Borah (2021), who stressed the essence of teachers' resiliency in enhancing the necessary skills in technology-based instruction geared toward adapting to the Education 4.0 landscape. Moreover, Subedi and Subedi (2020) reiterated that teachers' resiliency amidst the emergence of technological developments is about how someone can successfully adapt to the changing environment.

Keeping a Spirit of Positivity

The participants revealed that keeping a spirit of positivity is vital in improving their Education 4.0 competency determination. They underlined that teachers feel encouraged to explore and search for solutions when unexpected scenarios come despite their limited skills in Education 4.0; this optimistic viewpoint benefits teachers in evolving their skills in several technological applications. Thus, internalizing the importance of self-learning

and not settling for less character can significantly develop teachers' positive attitudes toward acquiring new skills related to Education 4.0. The results of this study manifested the spirit of positivity to self-reflect and continuously learn things to build self-confidence in overcoming the challenges of Education 4.0 despite having little knowledge about it. This shows that teachers must be good problem solvers in searching for solutions to develop their skills by not just settling for less but continuing to explore the advent of technology to enhance their Education 4.0 Competency Determination. These findings aligned with the study of Vongkulluksn et al. (2018), which highlighted that a positive attitude toward Education 4.0 coupled with good problem-solving skills, the teachers are most likely to manifest better outcomes despite limited knowledge. Further, Lu et al. (2024) asserted that teachers with a high degree of optimism, resilience, and emotional regulation are more likely to have a better attitude toward embracing technology-enhanced teaching.

Embodiment of Appropriate Values

When asked about embodying appropriate values, the participants highlighted exhibiting patience and perseverance to gain the necessary skills in Education 4.0. They also emphasized the importance of fostering ethical values, particularly in collaborating with colleagues and other experts to seek guidance toward acquiring the digital skills necessary to become an effective teacher in the recent educational landscape and making a greater effort to perform effectively as responsible educators foster good values that teachers should possess. This finding proved that part of the Education 4.0 Competency Determination of the teachers is the ability to demonstrate ideal values, which implies that teachers should be responsible enough to strive to perform effectively and embody the core values of patience and perseverance. The teachers should collaborate with their colleagues to seek their support and guidance with humility to ensure a positive and effective working environment. Parallel with this finding, Miranda et al. (2019) magnified the ideal values of collaborating with others that plays a crucial role in surmounting the challenges associated with Education 4.0. The result supports the study of McCulloch et al. (2018), which revealed the core values of perseverance when teachers strive to use technology effectively.

3.8 Role of the Experiences in Shaping the Commitments of the Participants

The role of experiences in shaping the participants' commitments generated two themes from their narratives (see Table 8): vision for knowledgeable students and manifesting passion for teaching.

Table 8. Role of the experiences in shaping the commitments of the participants

Essential Themes	Core Ideas
Vision for Knowledgeable Students	Providing the students with the needed competencies of the new trends in education. Developing students for life-long learning. Improving the desirable skills or potentials of the students aligned with the Education 4.0. Realizing that students deserve to receive quality education from teachers. Strengthening teacher-student engagement through the utilization of student-centered teaching approaches.
Manifestation of Passion for Teaching	Being a dedicated educator to practice the technological advancement of Education 4.0 for the development of students. Having the necessity as teachers to be equipped with the skills, expertise, and competencies aligned with Education 4.0 for the benefit of students especially. Becoming technologically skillful and competent to become an effective teacher. Keeping a mission to teach students appropriately despite difficulties Undergoing ICT upskilling to share one's knowledge and expertise to others.

Vision for Knowledgeable Students

The participants revealed the idea of a vision for knowledgeable students. Students have to be provided with the skills needed for this new era of education. In developing students with life-long learning, teachers strive to impart knowledge focusing on enhancing the desirable skills or potentials of the students, which can be directly aligned with the necessary skills needed in Education 4.0. This is an essential aspect of producing a well-rounded student. When the teacher is committed to realizing that students deserve to receive quality education, it could strengthen the learning engagement through the student-centered teaching approach essential for developing a knowledgeable and skillful student. This suggests that teachers should prepare students with the necessary knowledge aligned with the new trends of Education 4.0, which supplements their skills and potential in digital technology tools, nurturing lifelong learning by providing a quality education that reinforces engagement through the student-centered teaching approach. The contribution of these findings to the study of Kumar et al. (2019) informs teachers that equipping students with desirable knowledge in digital technology tools facilitates effective

learning acquisition, enabling students to be knowledgeable enough to cope with Education 4.0. Moreover, Vongkulluksn et al. (2018) emphasized that the commitment of teachers to acquiring technical skills in the emergence of technologies is an essential factor in understanding the use of technology in the classroom, their vision of how technologies can be utilized for effective classroom instruction helps maximize their resources to immerse students in a technology-driven instruction that promote lifelong learning.

Manifestation of Passion for Teaching

The teachers' dedication to optimizing the development of the students is necessary. Students are motivated by demonstrating enthusiasm and welcoming new ideas in Education 4.0. Upskilling activities and sharing one's expertise can provide competitive skills and expertise aligned with Education 4.0 among teachers to benefit their students, essential in manifesting passion for teaching. More so, becoming technologically skillful teachers who are competent in utilizing technology could help students succeed by providing effective learning experiences despite difficulties encountered in implementing Education 4.0. This implies that staying equipped with the relevant knowledge, skills, and expertise through ongoing ICT upskilling can foster the commitment to effective teaching for the benefit of students. Moreover, the result confirms the study of Mannila et al. (2018), who highlighted that more than just training, the teachers must be passionate enough to actively participate in the learning process of technology, particularly in knowing what is relevant and how to incorporate digital skills into classroom instruction effectively. Likewise, ElSayary (2023) magnified that the development of teachers' digital competence is greatly influenced by the upskilling training program, which directly enhances the knowledge and skills of the teachers to acquire positive attitudes toward utilizing technology in the classroom.

3.9 Joint Display of the Salient Qualitative and Quantitative Findings

The salient points of the quantitative and qualitative strands of the research study focusing on technological leadership behavior, technological formation, and Education 4.0 competency determination of educators in Region XII has four major parts (see Table 9): shown in the first column the aspect of focal point, the second column pertains to the quantitative findings, the third column refers to the qualitative findings, and the fourth column pertains to the quantitative and qualitative findings nature of integration. In connection, the two data sets were compared for similarities and differences and integrated to draw a complete result related to converging ideas generated from the two strands. As Fetters et al. (2013) emphasize, merging two databases for analysis involves integrating data collection and analysis at multiple points. Integration at the interpretation and reporting level involves narrative, data transformation, and joint display, with the fit of integration determining the coherence of qualitative and quantitative findings. To see if the quantitative data corroborates with the qualitative data, the two data sets are compared; thus, similarities were found, making the nature of integration merging-converging.

Table 9. Joint display of the salient qualitative and quantitative findings

Aspect or Focal Point	Quantitative Findings	Qualitative Findings	Nature of Integration
Technological Leadership Behavior	Table 1 on technological leadership behavior, under indicator motivation, the item motivating to use technology at school, is rated High, M= 4.00, SD=.737	Table 5 on Lived Experiences, has core ideas, doing lots of readings and research about Education 4.0 and motivated me for its employment to the teaching and learning processes, with theme, becoming a proactive teacher.	**Merging-Converging**
	Table 1 on technological leadership behavior, under indicator, orientation, on item, enabling to apply technology successfully to the teaching process at school, is rated High, M= 4.10, SD= .744	Table 5 on Lived Experiences, has core ideas, utilizing innovative and interactive tools for an enriched classroom teaching, has a theme, becoming a proactive teacher	**Merging-Converging**
	Table 1 on technological leadership behavior, under indicator, precaution, on item, ensuring that the information technology tools needed at school are ready for use, is rated High, M= 3.67, SD= .820	Table 5 on Lived Experiences, has a theme, engaging in ICT upskilling and technology capacity building activities, has core ideas, having school heads ensuring the availability of necessary technological resources no matter how mean are they in quantity.	**Merging-Converging**
	Table 1 on technological leadership behavior, under indicator, support, on item, leading the use of computers in accordance with ethical values at school, is rated High, M= 3.83, SD= .883	Table 5 on Lived Experiences, has a theme, engaging in ICT upskilling and technology capacity building activities, has core ideas, collaborating with experts and other stakeholders for guidance related to ICT and other technological fields.	**Merging-Converging**
Technological Formation	Table 2 on technological formation, under indicator, content development, on item, preparing creative lesson content with mobile devices, is rated High, M=3.49, SD= .868	Table 5 on Lived Experiences, has a theme, becoming a proactive teacher, has core ideas, taking initiatives to self-learn about technology and its application in instruction as well as appropriate teaching strategies.	**Merging-Converging**
	Table 2 on technological formation, under indicator, interactive object development, on item, enriching lesson content by using electronic circuit, is rated Low, M= 2.59, SD= 1.079	Table 5 on Lived Experiences, has a theme, facing limitations in the pedagogical and conceptual competencies related to Education 4.0, has core ideas, having insufficient knowledge about some areas of Education 4.0 although computer literate.	**Merging-Converging**

	Table 2 on technological formation, under indicator, problem solving, on item, thinking will attain more successful results because of working in a group, in a cooperative learning, is rated High, M= 3.59, SD= .795	Table 5 on Lived Experiences, has a theme, becoming a proactive teacher, has core ideas, collaborating with experts and other stakeholders for guidance related to ICT and other technological fields.	**Merging-Converging**
	Table 2 on technological formation, under indicator, creativity, on item, liking fair and realist people, is rated Very High, M= 4.20, SD= .720	Table 7 on Role of Experiences, has a theme, embodying appropriate values, has core ideas, demonstrating humility especially when collaborating with colleagues and stakeholders for assistance and guidance	**Merging-Converging**
Educ 4.0 Competency Determination	Table 3 on Educ 4.0 competency determination, under indicator, mastery of digital technology, on item, knowing about mobile technologies, is rated Moderate, M= 3.11, SD= .1.01	Table 5 on Lived Experiences, has a theme, becoming a proactive teacher, has core ideas, doing lots of readings and research about Education 4.0 and motivated for its employment to the teaching and learning processes.	**Merging-Converging**
	Table 3 on Educ 4.0 competency determination under indicator, information management, on item, paying attention to ethical principles when using ICT is rated High, M= 3.59, SD= .881	Table 7 on Role of Experiences, has a theme, embodying appropriate values, has core ideas, demonstrating humility especially when collaborating with colleagues and stakeholders for assistance and guidance.	**Merging-Converging**
	Table 3 on Education 4.0 competency determination, under indicator, active participation in the process, on item, knowing from whom to get help when faced with difficulties in the learning process, is rated High, M= 3.79, SD= .751	Table 5 on Lived Experiences, has a theme, becoming a proactive teacher, has core ideas, collaborating with experts and other stakeholders for guidance related to ICT and other technological fields	**Merging-Converging**
Influence of Technological Leadership Behavior and Technological Formation on Education 4.0 Competency Determination	The standardized coefficients and p-values indicate that Technological Leadership Behavior and Technological Formation significantly influenced Educ 4.0 Competency Determination (R-squared=.492, p<.05	Strengthened technological leadership behavior and technological formation would contribute to the enhancement in Education 4.0 competency determination of educators.	**Merging-Converging**

Merging-Converging. The salient findings across quantitative and qualitative data in the aspect of technological leadership behavior is under the motivation indicator, which includes the item of motivating to use technology at school, supporting the theme of becoming a proactive teacher with a core idea of doing lots of readings and research about Education 4.0 and motivated for its employment to the teaching and learning processes. The results of the two data sets are converging since they point out the idea of motivation among the teachers. This implies that teachers' proactive engagement and motivation with new educational trends are key to effectively utilizing technology in teaching and learning. Himmetoglu et al. (2020) mentioned that in the teaching of Education 4.0, teachers' motivation to remain committed to integrating various technological applications effectively in the teaching and learning process is needed to make it more appealing to the learners. The school heads' empowerment to adapt to the innovative trends in the teaching and learning process is essential (Soraya et al., 2019). Added on, on the focal point of technological leadership behavior under the indicator orientation, the quantitative data, which talks about the idea of enabling the application of technology successfully to the teaching process at school when seen through the lens of qualitative data, converges directly on the idea about utilizing technology and interactive tools for an enriched classroom teaching. These two data sets, when merged, resulted in a merging-converging nature. The converging results of the two data sets are evident in quantitative and qualitative data, highlighting the idea of applying innovative technology for better classroom teaching and learning processes and outcomes. Qureshi et al. (2021) underscore that the ability of teachers to utilize digital and interactive technologies in classroom instruction as part of Education 4.0 brings massive changes to the educational process that strengthen the value of educational growth and the development of high-tech skills in improving the classroom learning process.

Moreover, the nature of the integration of the focal point technological leadership behavior under the indicator precaution is merging-converging. By merging, the quantitative data, which focuses on the idea of ensuring that the information technology tools needed at school are ready for use, which is done using a survey questionnaire, converges directly with the qualitative data about the idea of having school heads ensuring the availability of necessary technological resources no matter how mean are they in quantity which is done through an interview. The results of the two data sets converge because they highlighted the idea of ensuring the availability of technology tools at school. This means that regardless of limited resources, school heads must ensure the availability of technological means for teachers to receive the necessary upskilling activities in ICT, enabling them to develop their digital proficiency. The contribution of this finding to the study of Alemdag et al. (2020) informs school heads that providing teachers with necessary technology materials despite its limited resources contributes to the enhancement of digital proficiency among teachers in utilizing technologies. Likewise, on the indicator support, the nature of integration is merging-converging. In particular, the quantitative data, which talks about leading the use of computers by ethical values at school, when seen through the lens of qualitative data by

merging, directly converges with the idea that talks about collaborating with experts and other stakeholders for guidance related to ICT and other technological fields. The results of the two data sets are converging since they emphasize promoting the ethical and responsible use of technology at school among teachers. This implies that school heads should promote the ethical use of computers while supporting upskilling and capacity-building by collaborating with experts to ensure that teachers receive proper guidance on the use of ICT. As Hatlevik and Hatlevik (2018) emphasized, the school heads' support for collegial collaboration among teachers contributes to effectively utilizing ICT tools in their classroom instruction while promoting ethical and responsible use of technology.

Furthermore, for the focal point technological formation under the indicator content development, the quantitative data that points out the idea of preparing creative lesson content with mobile devices; when merged with the qualitative data, it directly converges with the idea of taking initiatives to self-learn about technology and its application in instruction as well as appropriate teaching strategies, thus, the nature of integration is merging-converging. The converging result of the two data sets is that they emphasized the same idea about using technological tools to enhance classroom instruction and the learning process. This suggests teachers should be more committed to continuous learning to adapt to new skills and effectively utilize technology to create innovative lesson content. This finding supports the study of Goh and Abdul-Wahab (2020), which emphasized that in facing the intricacy of Education 4.0 in utilizing new technologies today, teachers should be committed to developing their skills in adapting several technologies to the teaching-learning process. More so, as an indicator of interactive object development, the nature of integration is merging-converging. By virtue of merging, the quantitative data that talks about the idea of enriching lesson content by using electronics directly converge with the qualitative data, which points out the idea of having insufficient knowledge about some areas of Education 4.0 although computer literate. Thus, the two data sets are converging since they highlighted the idea of teachers' engagement in technology education while recognizing the gaps in their skills on advanced technology tools and concepts. This implies that despite the literacy on the use of computers, teachers must develop their pedagogical and conceptual skills related to Education 4.0, particularly in areas where advanced technologies like electronic circuits are being used to enrich lesson content. This finding corroborates the study of Ismail et al. (2020), who stated that teachers in the era of Education 4.0 must overcome the drawbacks of pedagogical skills and conceptual understanding in confronting the impact of technological advancement in the teaching and learning process due to the rapid progress of technologies in the Era of Education 4.0.

In addition, the indicator of problem-solving, when the quantitative data that pertains to thinking will attain more successful results because of working in a group, in cooperative learning when seen through the lens of qualitative data by process of merging, it directly converges with the idea of collaborating with experts and other stakeholders for guidance related to ICT and other technological fields. Thus, by virtue of integration, it resulted in merging-converging. The converging result of the two data sets revealed the same idea of teacher collaboration. This means that teachers must have a proactive teaching strategy, collaborate with experts, and seek guidance in effectively integrating ICT and other technological fields to achieve more successful learning outcomes. This finding aligns with the study by Tondeur et al. (2019), which emphasized that learning from other experts and peer collaboration are productive strategies for proactive teaching, in which the teachers have to obtain more knowledge and skills by seeking guidance from experts for the effective integration of ICT and other fields of technology, particularly in applying and integrating into a classroom teaching instruction to make it more effective. In connection, the quantitative data that points out liking fair and realistic people, when merged with qualitative data, directly converges on demonstrating humility, especially when collaborating with colleagues and stakeholders for assistance and guidance under the indicator of creativity. When combined by virtue of integration, the two data sets resulted in merging-converging. The converging result of the two data sets is due to the reason that they shed light on the same idea about the role of fairness and humility when collaborating with others. This implies that beyond technical skills, part of the Education 4.0 competency determination of teachers is their ability to demonstrate ingenuity, particularly in valuing fair and realistic individuals by showing humility, respectfulness, and inclusive environment when collaborating with colleagues and stakeholders in seeking assistance and guidance. The findings align with the study by Kettler et al. (2018), which informs individuals that beyond technological proficiency in Education 4.0, the interpersonal skills of teachers are essential for those with realistic and unbiased views who are confident in most of their decisions; these values are embodied in individuals who can work collaboratively and innovatively valuing humility and respect when seeking the experts' guidance.

In the same way, for the focal point of Education 4.0 competency determination under the indicator of mastery of digital technology, the nature of integration is merging-converging. When the qualitative data points out the idea of knowing about technology and is seen through the lens of qualitative data by merging, it converges with the idea of doing lots of readings and research about Education 4.0 and motivated for its employment to the teaching and learning process. The result is converging since the two data sets pointed out the same idea about exploring mobile technology applications in enhancing classroom instruction. These findings suggest that teachers should be committed to mastering their skills in digital technologies through continuous learning and exploration of new technologies in Education 4.0, particularly mobile technologies. Widana (2020) made a point that in today's technological progress, teachers must be committed to immersing themselves and exploring new technologies to master digital technology skills, particularly in the use of mobile technologies in teaching, which are essential aspects of Education 4.0. Adding on, the indicator of information management is that the nature of integration is merging-converging. In particular, the quantitative data about paying attention to ethical principles when using ICT converges directly with the statement, which points out the idea of demonstrating humility, especially when collaborating with colleagues and stakeholders for assistance and guidance. This makes the results of the two data sets converge since they emphasize ethical and professional behavior when collaborating. This means that teachers must go beyond the technical skills to comprise the ethical principles and collaborative dimension of information management, emphasizing the critical role of humility and appropriate values when utilizing ICT, mainly when collaborating with colleagues and stakeholders to seek assistance and guidance. The result confirms the statement of Ing et al. (2019) that teachers should acknowledge the value of collaborative relationships, which demonstrate humility while recognizing the critical role of continuous improvement when working with colleagues; this is vital in establishing a positive and supportive collaboration among other field experts.

Subsequently, the nature of the integration of the active participation in the process indicator is merging-converging. Notably, by merging, the quantitative data that talks about knowing from whom to get help when faced with difficulties in the learning process when seen through the lens of qualitative data converges directly with the data that pertains to collaborating with experts and other stakeholders for guidance related to ICT and other technological fields. These two data sets are converging since they magnified the importance of collaboration among teachers, particularly when seeking experts' guidance. The findings emphasize that teachers must be proactive collaborators and learners in participating in the learning process of ICT, particularly in seeking help when challenges come their way. This finding is parallel with the study of Nguyen and Ng (2022), which highlighted that in overcoming the challenges of Education 4.0, social reinforcement and commitment to learning improvement, such as peer collaboration and seeking assistance from experts in the use of ICT, are essential for teachers to enhance their understanding of the effective use of technologies in the teaching-learning process.

Finally, the salient quantitative and qualitative findings support the idea that strengthened technological leadership behavior, and technological formation would contribute to the enhancement of Education 4.0 competency determination of educators. In the aspect of the influence of technological leadership behavior and technological formation on Education 4.0 competency determination, the salient quantitative and qualitative finding is that technological leadership behavior and technological formation are significant predictors of Education 4.0 competency determination. This indicates that positive technological leadership behavior and technological formation of educators in Region XII contribute to the determination of Education 4.0 competency. It promotes collaboration, accountability for continuous learning, appropriate values, and support. The strong support of school heads in utilizing technology at school and teachers' technological inclination to handle new technological tools would then influence the determination of teachers' Education 4.0 competency. Similarly, the finding supports the study by Oberer and Erkollar (2018) that pointed out that the development of competence in Education 4.0 is significantly influenced by the leadership behavior of school heads, which plays a critical role in maximizing the ability of teachers to utilize technological tools in developing technological formation which can also be a contributory factor for the enhancement of Education 4.0 competency of the teachers. In fact, management and policy decision-making in industry revolution 4.0 trends (Ramírez-Montoya et al., 2021) and the technological skills of school administrators to remain abreast of educational trends significantly influenced the increase in teachers' competence in Education 4.0 (Kadiyono et al., 2020).

4.0 Conclusion

The status of technological leadership behavior was rated high, which shows that school heads support the use of technology in school, particularly motivating teachers to utilize technology and enabling them to apply it effectively by providing the facilities and necessary tools. Likewise, the technological formation of teachers was rated high, indicating that teachers can handle the advent of technology today and have acquired the necessary technical skills. However, teachers are confronted by the emergence of robotics and electronics, making them less competent in this area. More so, teachers' Education 4.0 competency determination status was rated high, indicating that ethical principles in using technology are observed among teachers. However, teachers still need more training in knowledge and background in programming and writing codes. Moreover, the technological leadership behavior and technological formation significantly influenced the Education 4.0 competency determination of educators in Region XII. The positive leadership behavior of the school principal on the use of technology and the formation of technological skills of the teachers provide an opportunity to gain mastery of the technology, increase information management, and inspire teachers to collaborate and participate actively in the learning process of improving their Education 4.0 competency determination.

In the same way, facing limitations in the pedagogical and conceptual competencies related to Education 4.0, encountering inadequacy of resources, engaging in ICT upskilling and technology capacity-building activities, and becoming a proactive teacher were the themes generated in the participants' lived experiences regarding Education 4.0 competency determination. In connection, the role of lived experiences of the educators shaped their beliefs, attitudes, and commitments toward Education 4.0 competency determination. They believed that learning is a continuous process, teaching is a vocation, and bearing accountability to students. Likewise, the participants have shaped attitudes on manifesting resiliency, keeping a spirit of positivity, and embodying appropriate values. Added on, participants have shaped their commitments to visioning for knowledgeable students and manifesting passion for teaching, leading to corroborated findings by data integration between the quantitative and qualitative data, which resulted in merging-converging.

5.0 Contributions of Authors

The principal author contributes to the study's writing, encoding, and implementation. The co-author edits, supervises, and analyzes the data.

6.0 Funding

This research paper received no funding or financial allotment from any funding agency.

7.0 Conflict of Interests

The authors declare that there is no conflict of interest concerning the publication of this paper.

8.0 Acknowledgment

This research paper acknowledges all who have contributed to its accomplishment, especially Dr. Pidor, Dr. Amoguis, Dr. Baradillo, Dr. Alderite, Dr. Solomon, Dr. Chavez, Dr. Dayaganon, Dr. Ortega, and Dr. Laya.

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