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Enhancing Collaboration and Creative Thinking Skills through Technology Preparedness in a Mixed Learning Environment

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Abstract

This study aimed to investigate the technology preparedness of Grade 10 students as to their collaborative and creative thinking skills. Specifically, it determined the extent of technology preparedness in mixed learning environment in terms of performance expectancy, effort expectancy, facilitating conditions, and social influence, the level of collaboration and creative thinking skills in learning science and the relationships of technology preparedness as to collaborative and creative thinking skills. The study employed descriptive correlational research through the utilization of self-made questionnaire to measure the students' technology preparedness. Meanwhile, the assessment of the collaboration and creative thinking skills, different activities with rubrics were used. The findings revealed that the students are were moderately prepared in technology but they were proficient in learning science. The study further showed significant relationship between the student's technology preparedness and some skills in collaboration and creative thinking skills. With this finding, it is recommended that collaborative and creative thinking skill activities as a teaching method be used in classes across levels and programs.

Keywords: *technology preparedness, mixed learning environment, collaboration skills, and creative thinking skills*

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1. Introduction

Even though the Philippines is progressively incorporating technology into classroom instruction, the country is still far from being ready to compete with developed nations in terms of technology application and usage in teaching and learning. Although mobile device penetration and social media usage are high, the country is behind in ICT infrastructure investment. The 2020 IMD Digital Competitiveness Ranking report listed the Philippines at 58 out of 63 countries surveyed (Ibanez, 2021). With the current situation and shift in education landscape, technology preparedness is indeed imperative. Preparedness ensures both teachers and students have sufficient knowledge and abilities in using tools for teaching and learning. The use of technology in education is not limited to the devices themselves, but also to the software that may assist teachers and students in teaching and learning.

Many schools around the Philippines use limited progressive expansion classes, where only a small number of students meet face-to-face for a shorter amount of time while the rest of the time is spent at home. In such circumstance, the students' learning readiness in using technology has a great role in mixed learning environment. Also known as blended learning or hybrid learning, mixed learning is an approach to education that combines online educational materials and opportunities for interaction online with traditional place-based classroom methods (Quigley, 2022).

With the current teaching modality in the country, there is a huge demand with the use of technology. Teachers are often in charge of providing appropriate learning tools where electronic versions of educational resources can be downloaded to a computer, tablet PC, or smartphone. This method is frequently employed in public schools and in remote regions. As a result, this requires educational learning technique that reaches learners in locations like their homes and provides learning resource materials with limited formal sessions in person (Enicola, 2021). However, this modality may open a gap or obstacles with learning opportunities and level of cognitive and non-cognitive skills (Yusuf & Al-Banawi, 2013). In addition, the lack of access to technology by most of the students in the country may hamper the learners' ability to study. These scenarios require students be technology prepared in a mixed learning modality. As such, this study surveyed the students in one public school in the province of Batangas, Philippines to assess whether technology preparedness affect their collaborative and creative skills in learning science subject. As the school has still limited progressive expanded face-to-face classes, there is

still a need for the students and teachers to have communication after class to evaluate the students' knowledge and skills.

2. Literature review

2.1. Mixed Learning

Several factors might have an impact on a students' ability to learn such as educational program, learning resources, teachers' communication with students, or even learners' exchange of ideas or communication with other learners (Alawamleh et al., 2020; Jia, 2015). However, different educational setting results to different factors. For instance, technology preparedness of students is critical in mixed learning (Rahman, 2014) but not so critical in a traditional classroom setting. A Mixed Learning (ML) or Blended learning (BL) is a learning approach that combines traditional face-to-face teaching method with online-based instructions. Addressing the growing belief that this is an entirely fresh approach, the Department of Education cleared that the country has been practicing distance learning for decades (CIIT, 2020). In general, ML/BL is characterized by: (1) some learning happens online in a format where the student has control over the path and pace at which they engage with content; (2) some learning happens in an instructor-led classroom; and (3) online and in-person learning is complementary, creating a truly integrated learning environment (Panopto, 2020). The ML/BL is widely adopted across higher education with some scholars referring to it as the "new traditional model" or the "new normal" in course delivery (Graham, 2013).

2.2. Technology Preparedness in Science

Computers, probeware, data collection and analysis software, digital microscopes, hypermedia/multimedia, student response systems, and interactive white boards are examples of educational technology tools that can assist students in actively participating in the acquisition of scientific knowledge and the development of the nature of science and inquiry. Apparently, Guyon and Cauthers (2018) assert that one advantage of using digital technologies in science classes is that it is easier to distribute data throughout the entire class (Guevarra & Panoy, 2022) and increases the likelihood that students will spot patterns, errors, and odd data.

Thomas (2017) found in a study that technology preparedness has a positive impact to the students' learning. Teachers believe that integrating technology into their classes and students being technologically prepared would help them equipped in 21st century learning. With these rationale, Callo and Yazon (2020) conclude that well-designed online education might be equally successful as face-to-face instruction, with an emphasis on the design of the learning experience, content quality, and student engagement. Thus, Manalo and Benavides (2021) found in their survey that it was vital for teachers to be technologically prepared in teaching. In addition, Setiyani et al. (2020), identified that an educational institution must be prepared to invest time and other resources to develop and maintain a successful blended learning environment and internet capacity.

2.3. Unified Theory of Acceptance and Use of Technology (UTAUT)

UTAUT examines the acceptance of technology, determined by the effects of performance expectancy, effort expectancy, social influence and facilitating conditions (Chao, 2019). This model was designed to have three direct effects from three determinants on the behavioral intention, which are: performance expectancy, effort expectancy, and social influence. In addition, the two direct determinants on usage behaviour are the intention of use and facilitating conditions. The performance expectation is the degree to which an individual believes that adopting the method would help them improve their performance while the effort expectancy is defined as the degree of ease with which the system may be used, built from perceived ease of use and complexity (Chauhan & Jaiswal, 2016).

According to Chao (2019), the UTAUT model includes a factor called effort expectation (EE), which is a key predictor of technological acceptance. EE is the degree of ease associated with the usage of the system, and the antecedents of EE include ease of use and complexity. EE represents university students' beliefs about the ease of use of e-learning. According to Cimperman et al. (2016), PE is the degree to which an individual believes that the system helps to improve performance. Meanwhile, the social influence is the degree to which an individual perceives the importance others believe he or she should use the new system. Social influence is similar to the subjective norms, social factors, and image constructs in the way that they denote that the behavior of people is adjusted to the perception of others about them. The effect of social influence is significant when the use of technology is mandated. In the mandatory context,

individuals might use technology due to compliance requirement, but not personal preferences (Chauhan & Jaiswal, 2016). Lastly, the facilitating conditions is the degree to which an individual believes that an organizations and technical infrastructure exists to support the use of the system. Facilitating conditions have a direct positive effect on intention to use, but after initial use, the effect becomes insignificant. Therefore, the model proposes that facilitating conditions have a direct significant effect on use behavior.

3. Methodology

3.1. Research Design

The study utilized a quantitative research design in determining the technology preparedness of the students in a mixed learning environment. This method is chosen because of its suitability to the investigated variables of the study. In particular, the descriptive and correlational research designs were used. Descriptive design measures the variables without influencing them while correlational design determines the extent of a relationship between two or more variables using statistical data.

3.2. Respondents

There were one hundred fifty (150) respondents of this study who were junior high school students from one school in Batangas province. Stratified random sampling technique was used to estimate the sampling size. They were stratified into 10 activities under collaboration and creative thinking skills. Each activity had thirty (30) random members.

3.3. Instrument

A researcher-made survey questionnaire and adopted activities with rubrics were the primary tools utilized in this research. The survey questionnaire assessed students' technology preparedness level in the current modality being used by the school. This focuses on the performance expectancy, effort expectancy, facilitating conditions, and social influence. The part two of the research instrument contained the collaboration and creative thinking skills of the students. The questionnaire was founded on UTAUT model for the students' level on technology preparedness. Meanwhile, the adopted activities include group discussion, completing shared

activities, group-based design journal, role play, and information exchange activity all under the collaboration skills. For creative thinking skills, the multimedia creation, designing a project, experimentation, problem-solving, and concept mapping were included. These activities and rubrics were all taken from Grade 10 Science modules and textbooks. These instruments were validated by the experts to confirm their alignment with the research objectives. Before the actual data gathering, pilot testing was conducted to the 50 Grade 9 students.

3.4. Data Collection

The study administered an online survey encoded in Google Forms while the assessment of the activities was done through Zoom meeting. The online survey was sent through electronic mails to the participants with an informed consent form stating that their participation is voluntary, and their responses treated with high confidentiality. This method was used because its cost-effective and convenient. The study ensured high-response rate by checking weekly the number of responses and following up with the participants who have not yet responded through private and group messages.

3.5. Data Analysis

The study employed statistical measures to analyze and draw meaningful inferences from the gathered data. The answer sheets that were retrieved, presented in tabulated form, analyzed, and were interpreted using frequency and percentage to determine the collaborative and creative thinking skills of the respondents in group discussion, sharing activity, designing journal, role playing, creating multimedia, designing projects, problem solving, experimenting, and concept mapping. The mean and standard deviation was applied in technology preparedness of the respondents in mixed learning environment in terms of performance expectancy, effort expectancy, facilitating conditions, and social influence. Further, Pearson r was used to find out significant relationship between the technology preparedness as to collaboration and creative thinking skills of the respondents.

4. Findings and Discussion

Table 1 shows the extent of technology learning preparedness of students in mixed learning environment in terms of performance expectancy.

Table 1

Extent of Performance Expectancy Technology Learning Preparedness in Mixed Learning Environment

Performance Expectancy	Mean	SD	VI
As a student,			
1. Technology enables me to access scientific, technological, and environmental information relevant to my subject activities and tasks.	3.70	1.04	Prepared
2. I can learn efficiently in demonstrating an understanding in science concepts and apply inquiry skills in addressing real-world problems with the use of technology.	3.57	.99	Prepared
3. The use of technology improves my performance in my subject activities and tasks that result to my low and satisfactory ratings.	3.54	1.03	Prepared
4. Implementation of science related literature search and academic information retrieval are easy with technology when answering my activities and tasks.	3.63	.97	Prepared
5. There is advantage associated with the use of technology in learning Science in gaining knowledge and skills in the competencies I needed on the subject.	3.61	.98	Prepared
6. The electronic information resources in learning my subject that can be accessed and used motivate me to use technology.	3.43	1.02	Moderately Prepared
7. I am convinced that the technology use will add value in developing myself and in acquiring the standard and competencies I am needed as a student of the subject.	3.62	.98	Prepared
8. Using technology for learning Science enables me to follow the trend in learning globally acquiring the national standards and competencies included and stated in the DepEd Science Curriculum and Framework.	3.53	.95	Prepared
Overall	**3.58**	**.82**	**Prepared**

Legend: 4.51-5.00 -Highly Prepared; 1.51-2.50-Slightly Prepared; 3.51-4.50-Prepared; 1.00-1.50-Not Prepared; 2.51-3.50-Moderately Prepared

Among the eight (8) indicators, technology enabled students to access scientific, technological, and environmental information relevant to their subject activities and tasks with a mean score of 3.70. It can be interpreted that most of the students were prepared in accessing technology to do their subject activities and tasks. Meanwhile, the indicator with the lowest mean score of 3.43 is that the electronic information resources in learning their subject could be accessed and used to motivate them to use technology. This suggests that the respondents were somewhat prepared to use technology as motivation for them as they used it as a learning resource. As overall interpretation, students has technology preparedness in terms of performance expectancy. It can be inferred that respondents believed that adopting the technology would help them improve their learning engagement performance during mixed learning modality.

It is imperative for educational institution to invest time and other resources to develop and maintain a successful blended learning environment and internet capacity. Furthermore, a substantial time commitment is also needed at the start-up phase and continued maintenance throughout (Setiyani et al., 2020; Marikyan and Papagiannidis, 2021). As shown in the results, e-learning system increases lecture performance, create possibilities for lecturing advancement, and develop competence (Mahande & Malago, n.d.).

Table 2

Extent of Effort Expectancy Technology Learning Preparedness in Mixed Learning Environment

Effort Expectancy	Mean	SD	VI
As a student,			
1. The use of technology in learning my subject is not characterized with stress therefore, I can manage myself and acquire enough knowledge and skills in the blended learning modalities.	3.42	.86	Moderately Prepared
2. I am required much technical expertise to effectively use technology for learning and acquiring knowledge and skills in the subject more especially in this blended learning setup.	3.40	.93	Moderately Prepared
3. I can access electronic information resources like scientific, technological, and environmental literatures anywhere and anytime through my gadgets to do my activities and tasks in my subject.	3.39	.98	Moderately Prepared
4. The use of technology for learning reduces cost, time and effort associated with conventional learning system.	3.48	.96	Moderately Prepared
5. Constraints of gadget terminals such as small screens, low battery life and inconvenient input make it difficult to use them for learning and doing my activities and tasks in my subject.	3.57	1.01	Prepared
6. The use of technology for learning in Science is not frustrating comparing to the face-to-face classes resulting to better performance and in doing my written and performance activities like experimentation, paper-pencil activities etc.	3.25	.94	Moderately Prepared
Overall	**3.42**	**.69**	**Moderately Prepared**

Legend: 4.51-5.00 Highly Prepared; 1.51-2.50 Slightly Prepared; 3.51-4.50 Prepared; 1.00-1.50 Not Prepared; 2.51-3.50 Moderately Prepared

Table 2 shows the extent of technology learning preparedness in terms of effort expectancy. Among the six (6) indicators, the highest rated indicator was constraints of gadget terminals such as small screens, low battery life and inconvenient input make it difficult to use them for learning and doing their activities and tasks in their subject with a mean score of 3.57. Most of the respondents wanted big screen gadgets, with lifelong battery, and easy to use or navigate if not they would find it difficult or inconvenient to use. Meanwhile, the indicator with the lowest mean score of 3.25 was that the use of technology for learning in science was not frustrating comparing to the face-to-face classes resulting to better performance and in doing their written and performance activities like experimentation, paper-pencil activities etc. Therefore, this can be interpreted that the respondents were moderately prepared only in the use of technology during distance learning since there was only a small portion who agreed that the use of technology for learning in science was not frustrating comparing to the face-to-face classes. Overall, the respondents were moderately prepared in terms of effort expectations for technology. The respondents' degree of technological readiness was modest. As a result, they are only somewhat equipped to employ technology during distant learning. Using technology

allowed students more comfort in their learning (Millar, 2013) and increased learners' levels of knowledge construction (Kintu et al., 2017).

Table 3

Extent of Performance Facilitating Conditions Technology Preparedness in Mixed Learning Environment

Facilitating Conditions	Mean	SD	VI
As a student,			
1. There is adequate training on the use of technology for learning in my school/home.	3.30	.97	Moderately Prepared
2. The use of technology for learning is encouraged by my science teacher every time and in most of my written and performance activities.	3.34	.87	Moderately Prepared
3. The presence of unstable power supply hinders the effective use of technology for learning and doing scientific, technological, and environmental activities and tasks in my school/home.	3.50	.91	Moderately Prepared
4. Internet connection and adequate bandwidth in my school/home motivates me to use my smart phone for mobile learning.	3.35	.96	Moderately Prepared
5. I have the skills and abilities to use technology for learning more especially in my subject that requires challenging competencies and tasks.	3.57	.92	Prepared
6. I need to improve my ICT skills to effectively use of technology for learning.	3.67	1.03	Prepared
7. I find it easy and convenient to use the technology for learning Science related activities because it is not complex resulting to my good grade in both written and performance-based tasks.	3.37	.99	Moderately Prepared
Overall	**3.44**	**.71**	**Moderately Prepared**

Legend: 4.51-5.00 Highly Prepared; 1.51-2.50 Slightly Prepared; 3.51-4.50 Prepared; 1.00-1.50 Not Prepared; 2.51-3.50 Moderately Prepared

Table 3 shows the extent of technology learning preparedness of students in mixed learning environment in terms of facilitating conditions. Among the seven (7) indicators, first on the list was the need to improve ICT skills to effectively use technology for learning with a mean score of 3.67. Most of the respondents wanted to improve more their ICT skills so they could be technology prepared in distance learning towards to better learning engagement. The indicator with the lowest mean score of 3.20 was the respondents' adequate training on the use of technology for learning in school/home. Respondents were only moderately knowledgeable on technology and desired further ICT training. Overall, the respondents were moderately prepared in terms of facilitating conditions for technology.

Similar to Mahande and Malago (n.d.), the facility condition directly affects the use or e-learning acceptance, and it affects students' performance. As recommended in previous studies, to successfully integrate technology in the classroom, instructors and students needed additional

training (Carsten et al., 2020) so they can easily navigate electronic applications and systems (Rahman, 2014).

Table 4

Extent of Social Influence Technology Learning Preparedness in Mixed Learning Environment

Social Influence	Mean	SD	VI
As a student,			
1. It is important to use the technology in learning Science since it is the best way to gain the required standard and competencies in this blended learning.	3.49	.99	Moderately Prepared
2. My peers and relatives affect my learning behavior that I should use technology in learning my subject.	3.19	.91	Moderately Prepared
3. I think that using technology is fashionable.	3.19	.95	Moderately Prepared
4. My science teachers are supportive of the use of technology in learning and in teaching using current trends in educational blended learning.	3.59	1.02	Prepared
5. Using technology helps me connect with my peers/classmates in learning and acquiring the most essential competencies in my subject.	3.72	1.08	Prepared
6. I use technology in learning my subject since my family members and classmates use it.	3.56	1.08	Prepared
Overall	**3.46**	**.77**	**Moderately Prepared**

Legend: 4.51-5.00 Highly Prepared; 1.51-2.50 Slightly Prepared; 3.51-4.50 Prepared; 1.00-1.50 Not Prepared; 2.51-3.50 Moderately Prepared

Table 4 shows the extent of technology learning preparedness of students in mixed learning environment in terms of social influence. Among the six (6) indicators, respondents believed that using technology helped them connect with their peers/classmates in learning and acquiring the most essential competencies in my subject with a mean score of 3.67. Most of the respondents were prepared when it comes to the use of technology in sharing information and collaborating to their peers or classmates. However, they did not find technology as fashion statement in social world and their peers and relatives did affect their learning behavior when it came to technology use in learning their subject. Both indicators have a mean score of 3.19. Overall, the respondents were moderately prepared in terms of social influence for technology.

The results somehow reflect concerns raised in previous studies that students helping each other adjusted easily in blended learning (Han & Ellis, 2021) and technology promotes higher self-regulation (Topping et al., 2022). Lastly, social influence had a positive effect on the use of learning management. As such, the school management system and the attitudes of the teachers and students were among the factors that shape the social and cultural atmosphere of a certain school (Ain et al., 2016).

Table 5

Level of Learning in Terms of Collaboration and Creative Thinking Skills

Activities/Skills	Mean	SD	Remarks
Collaboration Skills	89.57	4.05	Proficient
Creative Thinking Skills	89.47	4.29	Proficient
Composite Mean	**89.52**	**4.17**	**Proficient**

Legend:74 below Beginning; 85-89 Proficient; 75-79 Developing; 90-100 Advanced; 80-84 Approaching Proficiency

Table 5 presents the level of students learning in science in terms of collaboration and creative thinking skills. The respondents' collaboration skill was proficient with 89.57 mean score giving them high collaboration skills despite the distance learning modality. Similarly, creative thinking skill was proficient as well with 89.47 mean score giving them high creative thinking skills.

Results proved that no difficulty was experiences in blended learning that hampers the development of the skills; similar to the conclusion of Harris (2016) that technology application is not a challenge in distance learning, It is a catalyst for change as schools were using it to engage students. Although collaboration is not always successful (Watsons, 2021), the collaboration skills of the students are not being affected too much by the application of distance learning. Similarly, the mixed learning environment was successful in improving student's creative thinking skill (Roqobih et al., 2019). While Nurdiana et al. (2020) found various efforts needed to improve students' creative thinking skills during distance learning, students training can hone higher-order thinking skills (Malanog & Aliazas, 2021). Teachers should think more ways on improving creative thinking skills (Orozco & Pasia, 2021) such as effective training that enhances students' creative thoughts on strategies related to problem definitions, conceptual combinations, implementation plans, and ideas construction (Mumford et al., 2012).

Table 6 shows the significant relationship between students' technology preparedness and their collaboration skills in a mixed learning environment. It can be inferred from the computed value that there were only significant relationships in the respondents' collaboration skills between effort expectancy and informative exchange activities (.34), facilitating conditions and completing shared activities (.37), and facilitating conditions and role play (.21). Based on the statistical result using the two-tailed test, the rest of the collaborative activities do not have any relationship with the two compared variables.

Table 6

Relationship Between Technology Learning Preparedness and Collaboration Skills

Collaborative Skills in Learning Science	Students' Technology Preparedness			
	Performance Expectancy	Effort Expectancy	Social Influence	Facilitating Conditions
Group Discussion	.02	.02	.03	.01
Completing Shared Activity	.08	.10	.14	. 37**
Competitive Element Game	.010	.10	.03	.10
Role Play	.07	.03	.01	.21**
Informative Exchange Activity	-.07	.34**	.07	.13

***Correlation is significant at the 0.01 level (2-tailed).*
**Correlation is significant at the 0.05 level (2-tailed).*

The results uphold Tarun (2019) that technical infrastructure, under facilitating conditions, had a big role in collaboration skills during blended learning. Similarly, the ease of use of technology contributed as well to the success of collaboration (Tarun, 2019) through informative exchange activity and effort expectancy.

In the terms of EE particularly in ease of use of technology, it was found that there was no relationship between perceived usefulness and social media-based collaborative learning (Al-Rahmi et al., 2020; Khan et al., 2021). Since most of the technology being use in the Philippine distance learning are the social media, it is an imperative point to be mentioned. Furthermore, perceived usefulness found a negative association with the use of information technology (Pitafi et al., 2018).

It can be inferred that performance expectancy and social influence do not have significant relationship with any of the collaboration activities. This is supported by the claims of Blasco-Arcas et al. (2013) that interaction using social media, a technology-based platform, students' level of learning and understanding is very high in group learning. Therefore, it is worth noting that the performance and social influence of others do not totally affect the learning of the students during distance learning. However, all these results were studies in developed countries which are equipped with learning technology facilities.

Table 7 presents the significant relationship between students' technology preparedness and the creative thinking skills. In the respondents creative thinking skills, it can be inferred that there were significant relationship between performance expectancy and multimedia creation (.73), performance expectancy and problem solving (.30), effort expectancy and multimedia

creation (.50), effort expectancy and problem solving (.31), social influence and multimedia creation, social influence and experimentation (.50), social influence and problem solving (.48), facilitating conditions and multimedia creation (.34), facilitating conditions and experimentation (.29) and facilitating conditions and problem solving (.30). The rest of the activities do not have a significant relationship with any of the respondents' technology preparedness.

Table 7

Relationship Between Technology Learning Preparedness and Creative Thinking Skills

Creative Thinking Skills	**Technology Preparedness**			
	Performance Expectancy	Effort Expectancy	Social Influence	Facilitating Conditions
Multimedia Creation	.73**	.5**	.33**	.34**
Designing Projects	.05	.00	.01	.06
Experimentation	.10	.03	.50**	.29**
Concept Mapping	.10	.07	.12	.05
Problem Solving	.30**	.31**	.48**	.30**

***Correlation is significant at the 0.01 level (2-tailed).*
**Correlation is significant at the 0.05 level (2-tailed).*

These are congruent with Auliyah et al. (2020) on the creative thinking skills of student in distance learning that are still in the sufficient category and the strategy of Kaye (2022) on the use of concept mapping without the use technology. However, Tituva el al. (2021) believe that ICT influence goals, learning content, teaching forms and methods as well as cooperation of teachers and students providing development of students' information literacy, skills of processing information, creation and joining ideas into new combinations and transferring them to different situations to provide students' preparedness for the activity.

5. Conclusions

This study found technology preparedness significantly related to completing shared activity and facilitating conditions, role play and facilitating conditions, and information exchange activity and effort expectancy. Similarly, technology preparedness significantly related to multimedia creation and problem solving and technology preparedness variables, and social influence and facilitating conditions and experimentation.

Developing programs particularly in science department in the preparedness on technology should be conducted. Additionally, teachers employ and encourage activities that foster collaborative learning and creative thinking abilities. Future research consider other factors that affecting students' technology preparedness.

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