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Enhancing Students' Performance in Biology through Blended Learning with Collaborative Tools and Interactive Online Activities

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The study focused on the assessment of the technological pedagogical and content knowledge (TPACK) of graduate students enrolled in the Master of Arts in Science Education (MASE) program and tested the effectiveness of a blended learning approach using online collaborative tools, a learning management system, and interactive resources in Biology. The specific objectives of the study included describing the profile of MASE students in terms of computer and internet resources and skills, measuring their confidence levels in the four TPACK constructs, finding significant differences in pretest and posttest scores, and obtaining student feedback on the use of Edmodo as a Learning Management System. The study employed a one-shot pretest-posttest experimental design using a combination of online resources and face-to-face interactions. Based on the results, there was an increase in the median values before and after the intervention, as shown by the difference between the pre-median and post-median. Pre-implementation, the TPACK confidence level of the students was rated fairly confident (FC), but it increased after to completely confident (CC). This suggests that the students' TPACK confidence level improved positively using the BL approach. Likewise, the t-stat value of 10.68 indicates a significant difference between the pretest and posttest scores after implementing the blended learning approach. This suggests that the blended learning approach had a positive and noteworthy impact on the student's performance, as seen in the improved test scores. The study's results highlighted the benefits of Edmodo as well as the use of interactive online activities in their performance and TPACK as reported by the students.

Keywords: TPACK, blended learning, Biology, Edmodo, graduate students

INTRODUCTION

Educators now face the task of instructing Generation Z learners, who excel at multitasking and are proficient in using various digital tools simultaneously. These students communicate primarily through visual means, expressing themselves through images. This elucidates why the incorporation of information and communication technology (ICT) and the extensive use of tablets, smartphones, interactive whiteboards, and other learning technologies have been the commonplaces in classrooms. A rising

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number of individuals are becoming acquainted with technology and gradually adopting the characteristics of digital natives. In this era dominated by technology, its application has significantly simplified various aspects of work, particularly within the field of education (Pazilah et al., 2019).

The primary focus of the country's educational system today is undeniably the enhancement of the quality of education across all levels. However, achieving this goal is a challenging task. In international evaluations of science literacy, Filipino students have consistently demonstrated subpar performance. This trend was reaffirmed in the PISA 2018 assessment, where Filipino students' average science literacy scores positioned them as the second lowest out of 78 participating countries. In Bernardo et al.'s 2023 study, the aim was to investigate factors that could be utilized to identify students at risk of very low performance in science and potentially pinpoint areas for improvement in science education within the Philippines. Their findings showed that the random forest classifier model was the most accurate and precise, with Shapley Additive Explanations highlighting 15 key variables for identifying students with low science proficiency. These variables included metacognitive awareness of reading strategies, social experiences at school, aspirations, pride in achievements, and family- or home-related factors such as parental characteristics and access to ICT with internet connectivity. In a similar vein, Yoon and Yun's research also discovered a variable linked to socioeconomic status (SES), specifically students' access to information and communication technologies (ICT) at home, particularly those with internet access. They found that the availability and use of ICT had a positive correlation with performance in various PISA assessments. Additionally, their study indicated that the amount of time students spent using smartphones was not necessarily associated with problematic behavior. This was exemplified by students in the learning group who primarily used their smartphones for academic purposes, which had a positive influence on their achievement goals and academic performance. (Yoon & Yun, 2021). Blended learning has been adopted in the Philippine basic education curriculum, but due to challenges such as lack of facilities and connectivity, the study of Tupas and Laguda (2020) suggests the need for experts to conduct studies to enhance blended learning and help the education system in the new normal.

With the widespread availability of Internet access, the potential for technology to boost learning is now greater than ever. As a result, teachers must offer students more engaging learning opportunities and experiences that can enhance their 21st-century skills. Li and Chu (2020) suggested that the deep engagement of students in a gamified e-learning platform can enhance their reading motivation and improve their reading skills. In addition to their entertaining feature, games offer an appealing and responsive setting that nurtures the development of problem-solving skills. Web technologies have become essential components of the learning process, with teachers, students, and parents utilizing various applications to foster a diverse learning environment and improve participation, feedback, and interactivity (Patel 2023).

To address the challenge of catering to the demands of 21st-century learners, teachers employ Blended Learning (BL) as a strategy to foster meaningful and authentic learning. Blended learning, as an instructional approach, combines the benefits of both traditional face-to-face learning and online e-learning methods (Saragih et al., 2020).

This approach is considered an active learning method that effectively addresses the demands of digital education 4.0. One article calls for more research to examine how the blended learning teaching approach will further impact academic work, post-pandemic (Hadjisolomou, et. al., 2021). Nijakowski et al., (2021) found in their study that students were very satisfied with the proposed blended learning model and would like to continue it even after the pandemic has ended.
According to Atwa et al., (2021), although face-to-face education in medicine is irreplaceable, the blended mode of learning remains an acceptable and practical solution for the post-COVID era. Likewise, Zheng and Lin's (2021) study shows that blended-learning students perform better than single-type-learning students in all aspects which proves the practicability and effectiveness of the proposed method.

With the foregoing studies, the researcher aims to enhance the performance of Biology graduate students in the MASE program, ensuring their conceptual and linguistic preparedness for teaching science while also increasing their confidence in Technological Pedagogical Content Knowledge (TPACK). Additionally, the researcher seeks to assess the efficacy of the blended learning approach utilizing a freely accessible online collaborative tool and interactive resources in Biology, as perceived by the MASE graduate students. Hence, this study was conducted to address these objectives.

Specifically, this study aims: to determine the profile of the MASE Students as to computer resources and accessibility, computer skills (Basic and Internet Operations), and their level of agreement on the perceived computer and internet usage; to determine the perceived confidence level of MASE Students associated to the four TPCK constructs before and after their blended learning experience; to test significant differences between the pretest and posttest scores; and to describe the feedbacks and experiences of the students on the use of Edmodo as a Learning Management System.

Context and Review of Literature

This study is based on various theories and principles related to blended learning, namely Connectivism, Constructivism, Social Development Theory, Collaborative Learning, and the K-12 curriculum.

Kilag et. al (2023) tested the effectiveness of incorporating connectivism theory in blended learning environments in refining student learning outcomes in the Philippine context. Connectivism Theory stresses the effect of technology on learning where this study is anchored as it explores appropriate collaborative tools in blended learning that facilitate connections and experience to diverse viewpoints

Constructivism Theory suggests that instructors should facilitate student discovery of principles and adapt instruction to match the learner's current understanding (Kurt, 2021). Blended learning can facilitate constructivist principles through online discussions and interactions that enable students to construct knowledge with others in the course.

The Social Development Theory, proposed by Lev Vygotsky, emphasizes the role of social interaction in learning. In this study, technology serves as a Mediated Knowledge Object (MKO) and facilitates collaboration between students, teachers, peers, parents,

and other sources. Research consistently demonstrates that media and interactive technology can have a beneficial impact on a child's learning in their zone of proximal development. They act as a helpful guide, assisting with the understanding of complex concepts (Beaudoin-Ryan, 2020).

Collaborative learning, a vital aspect of web-based education, has been found to enhance student understanding and engagement when tasks are done collaboratively (*Collaborative Learning | Center for Teaching Innovation*, n.d.).

Furthermore, the study aligns with the K–12 curriculum, which aims to develop students' scientific knowledge, skills, attitudes, and values through various approaches, such as multidisciplinary, science–technology society, contextual learning, problem-based learning, and inquiry-based learning *(K To 12 Basic Education Curriculum | Department of Education, n.d.)*

METHOD

Research design

The present study utilized a descriptive quantitative research method to evaluate and describe the technological, pedagogical, and Content Knowledge (TPACK) of MASE Students. It utilized a one-shot pretest-posttest experimental design, which focused on the implementation of a collaborative tool and online interactive resources as enrichment activities in the teaching of Advanced Topics in Biological Science for a group of 29 MASE Students. Only one group was assigned for the researcher to teach, and it is not possible to divide them into groups due to ethical considerations in the academic policies of the institution. The experimental design allowed for the investigation of the efficacy of the blended learning approach specifically the use of the blended learning models crafted by the researcher on the student's performance in Biology, as well as the extent of their compliance and their overall experiences with the approach.

Research Subjects

In this study, a total enumeration approach was employed, and all 29 MASE students enrolled in the Advanced Biological Science course were included as respondents. As to their profile, these teachers are employed in private and public schools in the region. Initially, they were asked about their specializations and subjects they were teaching. Unfortunately, most of them are physics and chemistry teachers and non-biology majors, but they are teaching the subject because of the spiral progression nature of the curriculum. Hence, they deemed biology a difficult subject for them to teach since it is not their major. The activities used in the blended learning approach consisted of selected online resources from a validated Blended Learning Course plan as well as other available resources compiled by the researcher. Edmodo, a free online collaborative tool was used as the Learning Management System (LMS) for the implementation of the blended learning activities. The application process and its sequence are summarized below:

The collaborative tool and students' orientation

Before implementing the blended learning approach, a pretest was administered to the class to assess their initial knowledge level on the topics. The students were then

provided with an orientation on the rationale and benefits of using blended learning. The students' profiles were assessed to determine the most suitable modality (synchronous or asynchronous) for implementing the majority of the enrichment activities.

The online activities:

The online resources used in this study were sourced from a validated course plan compiled by the researcher. The selection of these resources was based on the topics in the syllabus that were identified as challenging for both the researcher and the students. The basic components of the online activities included the topic, content standards, performance standards, learning competencies, blended learning collaboration (face-to-face and online, synchronous or asynchronous), instructional time, introduction, jumpstart activity, discussion, exercises and assessment, and assignment. The preparation of the components of the blended learning followed a blended recipe model proposed by the researcher.

Formative tests were conducted using a combination of paper and pencil tests, an online quiz tool, and a reflection log.

Lesson implementation:

For most lessons, students were encouraged to prepare for their classes by asynchronously reviewing subject summaries, related videos and animations, and other relevant links embedded in the collaborative tool. After exploring an interactive site, a forum environment was provided for students to discuss concepts they did not understand. Furthermore, students were encouraged to incorporate online activities into their teaching practices at their respective schools.

The implementation of the lessons used and followed a developed model called the FAS (Flexible-Alternation-Supplementary) Blended Learning Model (Figure 1).

Figure 1
The FAS blended learning approach model

This model was designed and intended to effectively accommodate the available resources of the school, promoting flexibility for teachers to shift between different resources to address facility and ICT equipment limitations, and fine-tune according to the availability of resources.

Post-implementation and assessment:

A posttest was administered to evaluate student learning outcomes after the lesson implementation. Likewise, a survey was administered which students were required to complete to evaluate the extent of compliance with the blended learning program.

Data-gathering procedures and instrumentation

Profile assessment instrument

A validated questionnaire was utilized to assess the profile of the students in terms of computer resources, accessibility, basic computer skills, and their perceived readiness for computer and internet usage. These data of the students played a vital role in the preparation of the blended learning method, mainly considering the availability of resources in their homes, their internet access, and their proficiency in using computers.

TPACK instrument

Another instrument used in the study was the TPACK in Science Survey (TPACKSS) to analyze and assess the student's confidence level in the four constructs of TPACK (Graham et al., 2009). The survey was given to the students both before and after the implementation of the blended learning approach, serving as pre-and post-tests to measure any changes in their confidence levels.

Extent of compliance instrument

The modified version of the Student Satisfaction Survey Form (SSSF) developed by Naaj, Nachouki, and Ajman (2012) was an additional instrument used in this study. The adapted survey assessed the extent of the student's compliance with the blended learning program. Several modifications were made to ensure that the survey captured the relevant information related to the operation of the blended learning method.

Pretest and posttest on biology concepts

A validated 100-item pretest/posttest on Biology concepts was utilized in this study. The test underwent evaluation by expert educators in the field of science. Based on the suggestions and comments of the evaluators, a few items of the test were revised.

To assess the reliability of the test, the Kuder-Richardson Formula 20 (K-R 20) was used and resulted in a rkr20 value of 0.79, indicating a high level of consistency in the responses and demonstrating the test's reliability.

Analysis of data

The data collected were tabulated, analyzed, and interpreted using various statistical tools, which are outlined below:

1. Frequency counts and percentages were employed to interpret the profile of the students.

2. The TPACKSS survey consisted of 31 items that covered areas. The scale for answering each item consisted of 5 points, indicating confidence. Descriptive statistics, including the median, were calculated for each survey item.

3. The median increase was computed by subtracting the pre-median from the post-median for each item. Pre- and post-medians were calculated for the four TPACK constructs.

4. To examine whether there were significant differences between the means of the pretest and posttest scores of the group, a t-test was employed at a significance level of 0.05.

5. The students' readiness and extent of compliance were analyzed using a median.

FINDINGS

Profile of teachers on computer resources, skills, and readiness based on TPACK

In this research, the teachers' profiles regarding available computer resources, fundamental computer and internet skills, and perceived readiness based on TPACK were evaluated using a validated survey questionnaire (Figure 2).

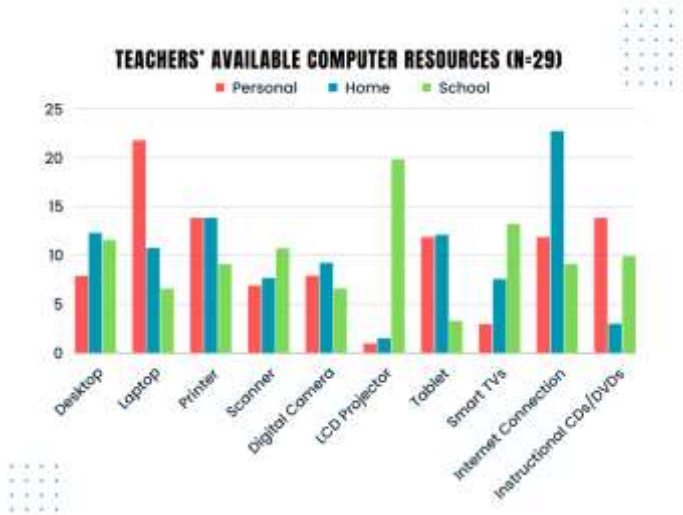


Figure 2
Teachers available computer resources

For the findings of this research, students have available laptops most are personally acquired. There is an internet access, printers, and tablets. There is a need for teachers to have the technological knowledge and skills since they are dealing with digital learners (Akram et al., 2022). According to a study conducted by the Department of Science and Technology-National Research Council of the Philippines (DOST-NRCP), teachers in public schools are personally investing in gadgets such as laptops and

mobile phones, in addition to internet connection services, to aid the teaching and learning process.

Table 1 displays the proficiency level of basic computer skills of the students. The information reveals that the respondents demonstrate a high level of skill, as indicated by the overall median score of 5.00. The results demonstrated that teachers' perceived technology skills played a significant role in their utilization of instructional and application software. It is suggested that improving the teachers' perceived skills and technological competencies by way of professional development programs can greatly enhance their use of instructional and application software. Additionally, the research findings indicate that teachers' self-confidence and ease in using technology directly and positively impact their embracing of instructional and application software (Doğan et al., 2020).

Table 1
Teachers' basic computer skills (Basic Operations) (N=30)

Basic Operations	M	DR
Turning on and shutting down	4.00	MS
Dragging	5.00	HS
Mouse clicking	4.00	MS
Entering text, numbers, symbols	4.00	MS
Highlighting texts	4.00	MS
Copying and pasting	4.00	MS
Saving Files in selected folders or destinations	5.00	HS
Printing Files and documents	5.00	HS
Creating, Copying, Deleting Folders	5.00	HS
Creating a New Document	5.00	HS
Opening an Existing Document	4.00	MS
Inserting Images	4.00	MS
Resizing Images	5.00	HS
Changing Fonts, Font Styles and Color	5.00	HS
Playing Music and Videos in a multimedia player	5.00	HS
Use a memory stick to transfer data	4.00	MS
Install new software on a computer	4.00	MS
Install a printer	5.00	HS
Basic Troubleshooting	5.00	HS
Overall Median	5.00	HS

Legend: 4.50 - 5.00 - Highly Skilled (HS) 3.50 – 4.49 - Moderately Skilled (MS)
2.50 – 3.49 – Skilled (S) 1.50 – 2.49 - Slightly Skilled (SS)
1.00 – 1.49 - Not Skilled (NS)

Table 2 illustrates the internet skills of the students. The overall median indicates that teachers possess a moderate level of proficiency in tasks associated with internet usage. These findings suggest that teachers have acquired the fundamental competencies required for effectively implementing technology-driven instruction in the classroom.

The DepEd Internet Connectivity Project (DICP) was launched in 2009 to deliver internet access to public high schools in line with Presidential Directives. Working in conjunction with the DepEd Computerization Program (DCP), the DICP equips schools

with appropriate technologies to enhance the teaching and learning process. In response to the COVID-19 pandemic, DM No. 080, s. 2023 outlines the use of DCP packages (desktop PCs, laptops, and tablets) for remote learning. These devices have played a crucial role in facilitating online classes and access to digital resources during the pandemic (*DepEd Computerization Program | Department of Education*, 2018).

Table 2
Teachers' basic computer skills (Internet Operations) (N=29)

Internet Operations	M	DR
Use different browsers	4.00	MS
Navigate to known websites	4.00	MS
Searching for information on the web	4.00	MS
Download files from the internet to your computer	4.00	MS
Upload files from your computer to the internet	4.00	MS
Save images and text from sources	4.00	MS
Play video and audio files	5.00	HS
Creating an email account	5.00	HS
Composing and sending emails	5.00	HS
Signing up for known websites	5.00	HS
Filling in usernames and passwords	4.00	MS
Signing out	4.00	MS
Chatting	5.00	HS
Sending other file types through email	5.00	HS
Log in to a network	5.00	HS
Add a shared folder on a network	5.00	HS
Make information on a network source	4.00	MS
Overall Median	4.00	MS

Table 3 displays the teachers' proficiency in basic computer skills for instructional usage. The results indicate that the teachers possess high proficiency in all the specified basic instructional tasks, especially for PowerPoint, where they demonstrate a high level of skill with a median score of 5.00. This recommends that teachers excel at utilizing PowerPoint for instructional purposes. Additionally, they exhibit proficient skills in utilizing the internet for lesson research and leveraging social networking platforms for communication and interaction with students.

This finding reinforces the idea that MASE students, who are teachers by profession, have the potential to effectively utilize the blended learning approach in their teaching, given they have access to sufficient resources. Both students and teachers benefit from integrating technology into education. Nowadays, teachers rarely use traditional methods like writing on chalkboards or using Manila paper as instructional materials. Instead, they leverage technology, such as slideshow presentations, which not only streamlines the preparation of visual aids but also makes classroom discussions more engaging and stimulating for students.

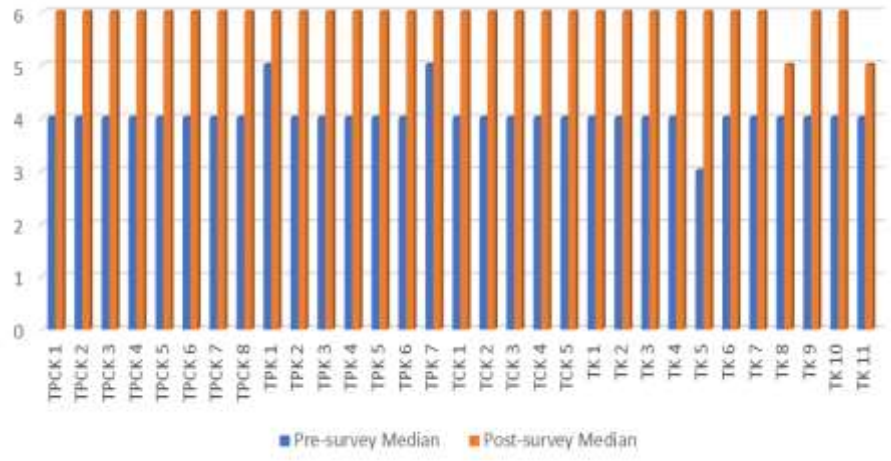
Table 3
Teachers' basic computer skills (Instructional Usage) (N=29)

Instructional Usage	M	DR
Using application software to prepare lessons. e.g., Office suite programs	4.00	MS
Communicating with peers and lecturers (e.g., e-mail or instant messenger)	5.00	HS
Using the Internet to research lesson	5.00	HS
Using Social Networking platforms to communicate and interact. e.g., Facebook	5.00	HS
Producing projects/assignments. e.g., Office suite programs	4.00	MS
Planning lessons or projects that integrate ICT	4.00	MS
Constructing tests and other documents using MS Word	5.00	HS
Computing grades using spreadsheets (i.e., MS Excel)	5.00	HS
Using PowerPoint and other presentation software to discuss lessons	5.00	HS
Overall Median	5.00	HS

It is also proposed by Taşar (2010) and Niess (2005) that teachers display TPCK when they show and acknowledge 1) an all-encompassing concept of teaching a particular subject where technology is integrated into learning; 2) knowledge of instructional approaches and illustrations for teaching specific topics with the use of technology; 3) knowledge of students' comprehensions, rational, and skills on technology for a particular subject; and 4) curricula and curriculum resources that integrate technology with learning a particular topic (Niess, 2005).

The TPACK confidence level of the students

Figure 3 revealed the perceived confidence level of the students along the four TPCK constructs. The average mean values were calculated for each item and the overall mean values for the four constructs.



*FC-Fairly Confident; CC-Completely Confident
Figure 3
TPACK confidence level of the MASE students

According to the graph, there was an increase in the median values before and after each item, as shown by the difference between the pre-median and post-median. Before being taught using the approach, the TPACK confidence level of the students was rated fairly confident (FC), but it increased after its implementation to completely confident (CC). This suggests that the students' TPACK confidence level improved positively using the BL approach. TPACK refers to teachers' understanding of educational technologies, encompassing the complex interface between content, pedagogy, and technology.

The same increase in values is observed for the other three constructs. Previous studies also indicate that technological knowledge (TK) has increased, as it serves as the foundation of the TPACK framework (Graham et al., 2009). The eleven items related to TK represent basic computer operations, suggesting that the students possess knowledge of these fundamental skills. Among these items, creating a document with text and graphics in Word. (TK 5) showed the highest median increase, while taking and editing a digital photograph. (TK 8) had the lowest.

TK encompasses the capability to use technological tools along with the underlying knowledge. This finding strengthens the view that confidence in TK is crucial for developing confidence in the other three forms of knowledge (Mishra & Koehler, 2006). It is logical to believe that basic technical awareness and skills are prerequisites for meaningful technology integration in teaching. It emphasized the importance of Technological Knowledge (TK) as a foundational component of the TPACK framework. They found that teachers' value beliefs associated with using technology positively influenced their integration efforts. This highlights the significance of teachers' technological knowledge and attitudes in effectively incorporating technology into their pedagogy (Ottenbreit-Leftwich et al., 2010).

On the other hand, TCK also increased, indicating that after being taught using the BL Approach, the students improved in their ability to incorporate content and technology. It likewise the importance of Technological Content Knowledge (TCK) in the TPACK framework. They emphasized that TCK involves teachers' knowledge of how to incorporate technology in the context of specific content areas (Angeli & Valanides, 2009). This finding underscores the consequence of teachers' ability to integrate technology effectively with subject-specific content.

TPK on the other hand, showed enhancement, indicating that the students already knew integrating technology and pedagogy for Biology topics. One research finding with a study on K–12 online distance educators found that Technological Pedagogical Knowledge (TPK) was a significant factor in effective technology integration (Archambault, n.d.). The study also revealed that teachers with advanced levels of TPK demonstrated more effective use of technology in their web-based teaching practices.

Finally, TPACK also increased as the students acquired knowledge of the multifaceted interactions between content, pedagogy, and technology. This success mainly occurs when teachers recognize how technological tools change pedagogical approaches and content illustrations for teaching specific topics, as well as how these tools and representations affect students' understanding of the topic. The use of a blended learning

approach had a positive effect on preservice teachers' Technological Pedagogical Content Knowledge (TPACK) and their teaching knowledge in technology integration (Qasem & Viswanathappa, 2016). This recommends that integrating technology into teacher training is needed to follow up support and ensure appropriate use of technology in the classroom. This supports the idea that blended learning can contribute to the significant change in teachers' TPACK.

Performance of the students in biology

There was an increase in the average mean score of the students in the post-test after being taught using the collaborative tool and online resources. The post-test scores ranged from 47 to 70 points out of the 100-item Biology test. This shows that the performance of the students improved with the use of the blended approach. This coincides with the study which investigated the effects of a blended learning approach on student outcomes in a postgraduate health professional where it showed that students' performance improved significantly in the blended learning environment (Westerlaken et al., 2019). This study provides evidence that supports the notion that blended learning can lead to improved student performance, aligning with the findings mentioned.

To ensure student success in the combination of face-to-face and asynchronous learning environments, the researcher crafted a blended learning model that was based on existing models, and several considerations were taken into account in the organization of the learning management system components. The researcher was guided by a design and development stages model shown in an infographic in Figure 4. The blended learning environment was organized by clearly explaining the project and theme, the importance of having a plan, the required resources, the timelines, the usage of various technologies, and the evaluation criteria.

Figure 4
Blended learning stages model

Blending is not an easy task. It is not just merely mixing what one wants. A lot of factors have to be considered. This model was conceptualized by the researcher for the following reasons and concerns: 1) Students' learning styles and technological skills vary; 2) Students have different needs. Such needs may arise suddenly within a certain lesson task; 3) To ensure deeper learning, a right blend between online and face-to-face, synchronous and asynchronous activities must be established; 4) Students learn best through varied and enjoyable activities; and 5) Students love to play and are fond of online games.

Paired sample t-test results for the pretest and posttest mean scores.

At a significance level of.05, the t-stat value of 10.68 indicates a significant difference between the pretest and posttest scores after implementing the blended learning approach (Table 4). Therefore, it can be concluded that the performance of the students improved significantly after being exposed to the blended learning approach. The mean posttest score of 55.97 was significantly higher than the mean pretest score of 33.72. This suggests that the blended learning approach had a positive and noteworthy impact on the student's performance, as seen in the improved test scores.

Table 4
Paired sample t-test

	Mean Difference	Test Statistic	p-value
Pretest-Posttest	22.25	10.68*	<.01

*significant at .05

It also infers that the use of a blended approach to augment their performance was effective. This not only leads to higher scores but also indicates that students enjoyed and appreciated the experience. In one meta-analysis study that examined the effect of online learning, blended learning, and flipped classrooms on student achievement, the results revealed positive significant differences in the three measures. (Schmid et al., 2023). The study supports the concept that the implementation of blended learning approaches, combining traditional and online learning, enhances student performance. These findings strengthen the conclusion that the performance of students can improve after being exposed to a blended learning approach.

Students' extent of compliance with the blended learning program

To assess the extent of compliance, the researcher utilized the Student Satisfaction Survey Form (SSSF), selecting relevant items for the study. The results demonstrated a very high level of compliance with the blended learning program, as evidenced by an overall median score of 5.

The selected Student Satisfaction Survey Form (SSSF) has been validated as a reliable measure of student satisfaction, as highlighted in the study conducted by Naaj et al., (2012). Similarly, Wu and Wen-Yu (2013) conducted a study on EFL (English as a Foreign Language) blended learning and found that the students exhibited a positive attitude towards this learning model. They expressed satisfaction and enthusiasm for studying in an EFL blended learning environment.

Similarly, in another research, the main objective was to examine the level of student satisfaction following the implementation of a blended course in a university setting, specifically in a management course. The study specifically explored the factors related to the Learning Management System (LMS) that influenced students' self-efficacy and the subsequent impact on their overall satisfaction. The findings revealed a positive correlation between LMS self-efficacy and students' satisfaction with their educational experience (Prifti, 2020). Indeed, technology has the potential to intensify instruction as well as student commitment and learning. Blended learning has become a permanent fixture in the educational landscape. This hybrid approach offers a versatile and all-encompassing learning environment, allowing students to acquire knowledge at their speed and in alignment with their unique preferences. (Michael Patrao & Michael Patrao, 2023)

The challenges, strengths, hindrances, and overall impression of blended learning

In addition to the abovementioned findings, the researcher included the students' perceived challenges in using the LMS, the strengths and hindrances in the use of the Blended Learning Approach, and their overall impressions of their blended learning experience. They were asked to fill in a Padlet on their experiences in the use of Edmodo. From these responses, challenges, hindrances, and strengths were identified.

As to the challenges in using Edmodo as a learning management system, some respondents mentioned some connectivity issues and difficulties, which affected their experience with Edmodo. As per technical limitations, the reliance on technology and the need for maintenance were seen as factors influencing Edmodo's efficiency. Likewise, some students were affected by slow internet connection in their locations, affecting the usability and enjoyment of Edmodo. In this study, the challenges of using Edmodo as a learning management system were examined from the students' standpoints. One student mentioned, "It's helpful in ways that it connects the whole classroom even at home. only that, on my part, it should have been more helpful and enjoyable if not with my net connection problems in my location". The study emphasized the need for a high-speed internet connection (Irawan et al., 2020). Connectivity issues are considered a major challenge, with some respondents who responded experiencing difficulties due to variable internet connections (İnel-Ekici, 2017).

In terms of the hindrances and factors that affected their blended learning experience, the teachers expressed that a reliable internet connection is essential to fully benefit from Edmodo and engage in blended learning. One of the responses includes, "In every website or online application, its maintenance and connectivity are factors to its efficiency ". Challenges related to net connection problems in certain locations also impacted the overall blended learning experience. According to one research, Edmodo and the flipped classroom approaches are effective in developing student teachers' digital literacy, fostering collaborative work, and empowering them to take control of their learning process. The study also highlighted that student teachers stated their intention to apply these tools in their future teaching careers, despite it being their first experience with them (Erdemir & Ekşi, 2019). It is therefore recommended that teacher

educators prioritize enhancing student teachers' digital literacy by incorporating multimedia tools into teacher education programs.

Net connection problems in specific locations were also identified as challenges that affected their overall blended learning experience. However, despite these hindrances, participants still acknowledged the effectiveness and enjoyment of using Edmodo for blended learning.

As to the strengths of the Blended Learning approach, Edmodo was perceived to provide a helpful means of effective communication, especially for students and teachers who only met once a week. Some of the participants perceived Edmodo as "a tool in this present generation that engaged learners to become adaptive to what technology is offering to us right now," and one of them mentioned, "Surely, I will introduce this application to my students next semester since it is easy to manage and is similar to Facebook". For convenience and updates, Edmodo was praised for its ability to inform and update users effectively, making the teaching-learning process more seamless. The platform was also said to offer an avenue for collaborative understanding, clarification, and sharing of ideas and information between teachers and students. The findings of the study highlighted the advantages of Edmodo as reported by the students. One study shows that when higher-education students used Edmodo, it significantly boosted their learning skills and that students actually like using Edmodo in their courses (Hoesny et al., 2020)

CONCLUSION

Based on the findings of the study, the following conclusions were drawn:

1. The graduate students in the MASE program have proficient computer skills and are ready for technology-mediated learning.

2. The blended learning approach positively influenced the students' confidence levels in TPACK integration.

3. There was a significant improvement in the students' performance in Biology after trying out blended learning.

4. The students were satisfied with the use of the blended learning approach and found Edmodo as an effective learning management system.

Based on these conclusions, it is recommended that further research be conducted to explore the effectiveness of blended learning in different science disciplines to enhance TPACK. Longitudinal studies should be conducted to assess the long-term effects of blended learning on student performance and TPACK development. Moreover, TPACK and the findings of this research should be incorporated as a core component in teacher training programs to equip educators with the necessary skills for effective blended learning implementation. Other Learning Management Systems may also be adapted to support blended learning approaches and provide a platform for collaborative and engaging learning experiences.

REFERENCES

Akram, H., Abdelrady, A. H., Al-Adwan, A. S., & Ramzan, M. (2022). Teachers' Perceptions of Technology Integration in Teaching-Learning Practices: A Systematic review. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.920317

Angeli, C., & Valanides, N. (2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT–TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers & Education*, *52*(1), 154–168. https://doi.org/10.1016/j.compedu.2008.07.006

Archambault, L. (n.d.). *Examining TPACK among K-12 Online Distance Educators in the United States*. https://eric.ed.gov/?id=EJ904584

Atwa, H., Shehata, M., Al-Ansari, A., Kumar, A., Jaradat, A., Ahmed, J., & Deifalla, A. (2021). Online, Face-to-Face, or Blended Learning? Faculty and Medical Students' Perceptions During the COVID-19 Pandemic: A Mixed-Method Study. Frontiers in Medicine, 9. https://doi.org/10.3389/fmed.2022.791352.

Beaudoin-Ryan, L. (2020). Social Development Theory in Media Research. *The International Encyclopedia of Media Psychology*, 1–5. https://doi.org/10.1002/9781119011071.iemp0163

Collaborative Learning | Center for Teaching Innovation. (n.d.-b). https://teaching.cornell.edu/teaching-resources/active-collaborative-learning/collaborative-learning

Doğan, S., Dogan, N., & Çelik, İ. (2020). Teachers' skills to integrate technology in education: Two path models explaining instructional and application software use. *Education and Information Technologies*, *26*(1), 1311–1332. https://doi.org/10.1007/s10639-020-10310-4

DEPED Computerization Program| Department of Education. (2018, April 6). https://www.deped.gov.ph/2018/04/06/deped-computerization-program/

Erdemir, N., & Ekşi, G. Y. (2019). The perceptions of student teachers about using an online learning environment 'Edmodo' in a 'Flipped classroom.' *SDU International Journal of Educational Studies*, *6*(2), 174–186. https://doi.org/10.33710/sduijes.638795

Graham, C. R., Burgoyne, N., Cantrell, P., Smith, L. M., & Harris, R. (2009). TPACK Development in Science Teaching: Measuring the TPACK confidence of in-service science teachers. *TechTrends*, *53*(5), 70–79. https://doi.org/10.1007/s11528-009-0328-0

Hadjisolomou, A., Mitsakis, F., & Gary, S. (2021). Too Scared to Go Sick: Precarious Academic Work and 'Presenteeism Culture' in the UK Higher Education Sector During the Covid-19 Pandemic. *Work, Employment and Society*, *36*, 569 - 579. https://doi.org/10.1177/09500170211050501.

Hoesny, M. U., Cahyani, H., & Aziz, I. N. (2020). The Use of Edmodo in Esp Classroom: A Study on Students' Perception and Classroom Activities. *Journal of Languages and Language Teaching*, *8*(3), 237. https://doi.org/10.33394/jollt.v8i3.2602

Irawan, R., Endahati, N., Nurizka, R., Rianto, & Kurniawan, D. E. (2020). Barriers to using LMS-Edmodo on speaking tasks: Students' perception. *Universal Journal of Educational Research*. https://doi.org.10.13189/ujer.2020.081131

İnel-Ekici, D. (2017). The use of Edmodo in creating an online learning community of practice for learning to teach science. *Malaysian Online Journal of Educational Sciences, 5*(2), 91–106. http://files.eric.ed.gov/fulltext/EJ1142512.pdf

Kilag, O. K. T., Abalo, S. J. R., Retes, G. P., & Dalogdog, L. G. (2023). Enhancing Student Learning through the Integration of Connectivism Theory in Blended Learning Environments. *ResearchGate.* https://www.researchgate/publication/371632262_Enhancing_Student_Learning_through_the_Integration_of_Connectivism_Theory_in_Blended_Learning_Environments

Kurt, S. (2021, February 21). *Constructivist Learning Theory - Educational technology*. Educational Technology. https://educationaltechnology.net/constructivist-learning-theory/

Li, X., & Chu, S. K. W. (2020). Exploring the effects of gamification pedagogy on children's reading: A mixed-method study on academic performance, reading-related mentality and behaviors, and sustainability. *British Journal of Educational Technology*, *52*(1), 160–178. https://doi.org/10.1111/bjet.13057

Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: a framework for teacher knowledge. *Teachers College Record*, 108(6), 1017–1054. https://doi.org.10.1111/j.1467-9620.2006.00684.x

Naaj, M. A., Nachouki, M., & Ankit, A. (2012). Evaluating Student Satisfaction with Blended Learning in a Gender-Segregated Environment. *Journal of Information Technology Education, 11*, 185–200. https://doi.org.10.28945/1692

Niess, M. L. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teaching and Teacher Education,* 21(5), 509–523. https://doi.org/10.1016/j.tate.2005.03.006

Nijakowski, K., Lehmann, A., Zdrojewski, J., Nowak, M., & Surdacka, A. (2021). The Effectiveness of the Blended Learning in Conservative Dentistry with Endodontics based on the Survey among 4th-Year Students during the COVID-19 Pandemic. *International Journal of Environmental Research and Public Health*, *18*(9), 4555. https://doi.org/10.3390/ijerph18094555

Ottenbreit-Leftwich, A., Glazewski, K., Newby, T. J., & Ertmer, P. A. (2010). Teacher value beliefs associated with using technology: Addressing professional and student needs. *Computers & Education, 55*(3), 1321–1335. https://doi.org/10.1016/j.compedu.2010.06.002

Patel, K. V. (2023). A constructive innovative tool for teachers: Edmodo to promote 21st-century skill visualized in NEP 2020. GAP GYAN: *A Global Journal of Social Sciences*, 6(1), 1.

Pazilah, F. N., Hashim, H., & Yunus, M. M. (2019). Using Technology in ESL Classroom: Highlights and challenges. *Creative Education*, *10*(12), 3205–3212. https://doi.org/10.4236/ce.2019.1012244

Prifti, R. (2020). Self–efficacy and student satisfaction in the context of blended learning courses. *Open Learning: The Journal of Open and Distance Learning*, *37*(2), 111–125. https://doi.org.10.1080/02680513.2020.1755642

Qasem, A. A. A., & Viswanathappa, G. (2016). Blended learning approach to develop the Teachers' TPACK. *Contemporary Educational Technology*, *7*(3). https://doi.org.10.30935/cedtech/6176

Saragih, M. J., Cristanto, R. M. R. Y., Effendi, Y., & Zamzami, E. M. (2020). Application of blended Learning supporting digital education 4.0. *Journal of Physics*, 1566(1), 012044. https://doi.org.10.1088/1742-6596/1566/1/012044

Schmid, R., Borokhovski, E., Bernard, R., Pickup, D., & Abrami, P. C. (2023). A meta-analysis of online learning, blended learning, the flipped classroom, and classroom instruction for pre-service and in-service teachers. *Computers and Education Open, 5*, 100142. https://doi.org.10.1016/j.caeo.2023.100142

Tupas, F., & Linas-Laguda, M. (2020). Blended Learning – An Approach in Philippine Basic Education Curriculum in New Normal: A Review of Current Literature. *Universal Journal of Educational Research, 8,* 5505-5512. https://doi.org/10.13189/ujer.2020.081154.

Yoon, M., & Yun, H. (2021). Relationships between adolescent smartphone usage patterns, achievement goals, and academic achievement. *Asia Pacific Education Review*, *24*(1), 13–23. https://doi.org/10.1007/s12564-021-09718-5

Westerlaken, M., Christiaans-Dingelhoff, I., Filius, R. M., Vries, B., De Bruijne, M., & Van Dam, M. (2019). Blended learning for postgraduates; an interactive experience. *BMC Medical Education*, *19*(1). https://doi.org.10.1186/s12909-019-1717-5

Wu, J., & Wen-Yu, L. (2013). An empirical investigation of the critical factors affecting students' satisfaction in EFL blended learning. *Journal of Language Teaching and Research*, *4*(1). https://doi.org.10.4304/jltr.4.1.176-185

Zheng, W., Ma, Y., & Lin, H. (2021). Research on Blended Learning in Physical Education During the COVID-19 Pandemic: A Case Study of Chinese Students. *SAGE Open, 11*. https://doi.org/10.1177/21582440211058196