The Adoption of Blended Learning in Indonesian Science Classrooms

Herliani[1*], Lambang Subagiyo[2], Sukemi[3]

[1] Biological Education Program, Faculty of Teacher Training and Education, Mulawarman University, Samarinda, Indonesia.
[2] Physics Education Program, Faculty of Teacher Training and Education, Mulawarman University, Samarinda, Indonesia.
[3] Chemical Education Program, Faculty of Teacher Training and Education, Mulawarman University, Samarinda, Indonesia.

Abstract: Anchored by the interview analysis, the present study explored students' perceptions of blended learning enactment in Indonesian science classrooms. Data were garnered through questionnaires and semi-structured interviews focusing on students' perceptions of the benefits and challenges of adopting Blended Learning in science classes. Findings suggest that the benefits geared by blended learning in science classes include training students' learning independence, increasing students' understanding of science and technology, increasing students' learning effectiveness, and providing students with a variety of learning experiences. Meanwhile, the challenges depicted in blended learning include practicum activities, internet problems, and economic condition. This study pictured blended learning as an alternative learning method for teachers and students.

Keywords: Blended learning; Science class

Introduction

Technological developments have altered the enactment of teaching and learning both inside and outside the classroom. In the last ten years, blended learning (BL) has been widely adopted in universities worldwide, including in America (Cutri & Whiting, 2018), Pakistan (Siddiqui et al., 2020), Bangladesh (Chowdhury, 2020), India (Yashwant et al., 2020), China (Perera et al., 2020), and Australia (Han & Ellis, 2020). Myriad studies report that blended learning increases the effectiveness of learning and impact positively on academic achievement. Yusoff et al. (2017) conveyed that blended learning can be used as a teaching approach. It provides opportunities for students to socialize academically through discussion and significantly increases their inhibition and individuality. Wong (2019) observed that blended learning provides diverse learning opportunities both as a group and a self-regulating learning platform. Blended learning can

cater to competency needs and improved identity formation. Extensive evaluations have been carried out to measure the effectiveness of blended learning. As reported by Bo Tso (2015), blended learning can be applied to teach students' presentation skills. Furthermore, Dziuban et al. (2018) shows that blended learning provides a successful and effective learning environment.

Blended learning is a teaching and learning strategy that aims to achieve learning objectives by combining classroom-based learning and face-to-face learning with information and technology-based assistance carried out online. Blended learning leads students to have learning experiences in the forms of interactions between individuals and their environment and students are also actively involved in classroom discussions. Blended learning improves students' learning outcomes and is the most effective way to support teaching and learning activities (Dziuban et al., 2018). As a result of technological advancement and pedagogical

transformation related to delivering contents and engaging students in collaborative learning, adoption of blended learning has increasingly gained currency. Blended learning has been found more effective than traditional e-learning in terms of keeping contact with the students and making classes interactive (Islam et al., 2022).

Implementating a blended learning solution entails selecting from an ever-expanding variety of modalities and tools. It involves combining different forms of delivery while concentrating on optimizing the achievement of learning objectives and the cost of learning programs during a specific timeframe (Laifa et al., 2023). Blended learning is a continuum of educational delivery which combined with face-to-face learning and online learning. However, it is not just a simple technology mix, but it produces a highly participatory and personalized learning experience for students (Liu & Wang, 2022).

Blended learning is a combination of face-to-face teaching and online teaching. Practically, it is implemented with 75% face-to-face and 25% online, using discussion, presentation, and question and answer methods. Online learning is mostly carried out via the internet. The learning takes place entirely via the internet, where all instructions regarding content and results are conveyed via the internet, including downloading references and submitting assignments. Online learning can also be carried out inside and outside the classrooms, using technologies such as audio/video streaming, the Internet, podcasting, chat, simulations, video conferencing (Means et al., 2013). Blended learning could be defined differently as follows, a learning strategy that makes use of multiple implementation modes to provide significant gains in student learning while reducing instructional expenses and any combination of classroom teaching methods that includes a mix of traditional and innovative teaching techniques (Ali et al., 2023). The most important reasons for the adoption of a blended approach are its value for learning and its cost effectiveness, as well as increased access and learner satisfaction (Campagnaro et al., 2022).

In blended learning set ups, face-to-face experiences form part of the blend and learner positive attitudes to such sessions could mean blended learning effectiveness. Learners expressing their preference for face-to-face due to its facilitation of social interaction and communication skills acquired from classroom environment (Kintu et al., 2017). Blended learning in particular, helps students increase their interactions, communication skills, self-confidence, self-awareness, as well as encourage discussion and collaboration not only with their lecturers but also with their peer

classmates and course materials leading to an overall positive experience reported by the students (Bouilheres et al., 2020).

It is recognitions that this type of assessment increase students and teacher rapport at the same time provide opportunities for socialization and connectivity (Ibrahim et al., 2022). Blended learning models included the supplement model, the replacement model, the emporium model, the buffet model, the HyFlex model, and the time-based blended model that combines various synchoronous (Su et al., 2023). Blended learning arrangements is a settings that bring together online learning activities with synchronous, co-located settings show potential for addressing these requirements (Mayr & Oppl, 2023).

In science education, blended learning has been enacted and documented empirically. For instance, previous research by Bidarra et al. (2017) examined blended learning in science learning using ICT-based tools, called the Science Learning Activities Model (SLAM), which consists of design dimensions: context, technology, and pedagogy. Coll & Coll (2017) enacted blended learning in science learning to observe students' learning experiences both inside and outside the class using digital learning management system (LMS) technology. Siddiqui et al. (2020) reported that blended learning in chemistry science learning has a significant and positive impact on students' academic achievement, albeit internet connection becomes an obstacle.

Creswell (1998) affirmed that science learning could be done both inside and outside of the class by observing the surrounding environment. Chang et al. (2020) reported that there was a significant increase in students' learning motivation using computers, compared to learning under conventional conditions. Anchored by the importance of exploring blended learning in science classes, the present study was designed to document students' perceptions of the benefits and challenges of adopting blended learning in science classes.

Theoretically, blended learning is a combination of various learning media and different learning styles enacted to obtain an optimal learning environment. Keogh et al. (2017) suggest that blended learning can improve students' learning outcomes and help them learn both online and face-to-face. In order to be effective, blended learning should make use of interactive and stimulating online material and complement face-to-face sessions. Understanding students' perceptions help teachers in considering blended learning in their teaching. Yashwant et al. (2020) enacted blended learning and revealed the effectiveness of fostering students' performance. Han et al. (2020) captured that students gained diverse experiences in blended learning. Dakduk et al. (2018) investigated pre-

determined factors in enacting blended learning using an online questionnaire. Their study suggests that motivation, performance expectations, and efforts were envisaged to adopt blended learning. Their findings also showed that no significant influence on social and habitual influences related to blended learning enactment.

Blended learning both in the forms of face-to-face and online allow interactions among students in a classroom discussion. Blended learning also raises positive attitudes and interactions among students and teachers. Students gain experience and knowledge both in classroom discussions and presentations and reinforce their understanding of curriculum content and understanding of the knowledge discussed. Online learning allows students to share experiences and provide feedback. Online assignments for students allow them to comment on their classmates' works directly, although it was found that 20% of the comments made by students were mostly disparaging criticism without suggestions for improvement. In the learning process, video was also used. Students contended that videos are helpful in knowing the content and helping them understand topics of classroom presentation. Videos are also advantageous for showing what a good presentation should look like (Bo Tso, 2015).

Six stages in designing and implementing blended learning can be adopted, including 1) determining the types of relevant teaching materials to be applied face-to-face and online; 2) designing a facilitative learning system done face-to-face and online. In so doing, several aspects should be considered, such as (a) how the teaching materials are presented, (b) which teaching materials must be studied and which ones are recommended to enrich knowledge, (c) how students can access these two components of learning, (d) what supporting factors are needed, for example, software, and whether group or individual work is required; 3) determining online learning forms, whether the teaching materials are available in PDF, video, Yahoo, Google, Facebook, or others; 4) conducting tests on the designed learning. This test should be carried out to find out whether the designed learning is well implemented, by giving attention to the learning effectiveness and efficiency; 5) organizing blended learning, starting from the introduction of the tasks of each educational component, how to access teaching materials, and so forth; and lastly, 6) preparing criteria for conducting an evaluation (Slemer, 2005).

Coronavirus disease (COVID-19) pandemic has required schooling sectors worldwide to lockdown. Consequently, teachers and parents are forced to adopt technology in order for teaching and learning is enacted online, albeit many schools are well-equipped. However, teachers and parents alike have attempted to equip themselves with e-learning tools and resources. Combining classroom teaching with e-learning is critical in realizing the impact of technology. Access to various learning media leads to motivating teaching and learning enactment.

Gitoga (2020) expressed some evidence why blended learning should be enacted, including: Individualized learning, complementing classroom teaching with e-learning allows students to learn at their own pace. Students can get individualized support from an online teacher, especially for those who are reluctant to engage in the classroom discussions; Feedback, limiting direct input; Online quizzes and tests, directing immediate feedback through the automatic alert feature available on the online platform. It creates space for the teacher that otherwise can help weak students through one-on-one interaction; Multiple learning forms, learning can be done using pictures, videos, podcasts, and games; Collaboration, allowing for interactions between the teacher and students. Technology opens the doors for students to work in groups with classmates, other schools, and even on a global scale. They can share ideas about projects while gaining a broader perspective on global issues, which is a huge motivation for learning; Parental involvement, using technology under the supervision of parents. Parents are a major component in the learning process. Technology enables parents to participate in the learning process by providing guidance and support at home; Achievement of Future Work Skills, requiring students to impart certain life skills in order to be successful. Students are required to practice self-discipline, time management, and online etiquette. They also need to be digital savvy within an online-led environment, such as skills for sending email and presentation using technology.

Learning science with blended learning under the participatory and interactive approach can be supported by an ICT-based tool called the Science Learning Activities Model (SLAM). Students are more motivated and highly responding to science learning (Bidarra & Rusman, 2017). Coll & Coll (2017) suggest that learning science using digital technology consists of a learning management system (LMS) that matches the students' experience and digitalized world. Digital learning encourages students to collaborate and increases students' motivation to learn collaboratively and is positively correlated with increased academic achievement.

Keogh et al. (2017) asserted that students generally have a diminutive initial understanding of blended learning. When blended learning is implemented, it can improve learning outcomes and help students attend

online learning using Internet services. Tolentino et al. (2009) contend that technology-based science learning using interactive digital media creates a decent learning environment. This happens in both conventional and online classes. Students' ability to thinking and reasoning is improved since learning takes place effectively through collaborative work. The teacher also demonstrates the teaching and learning process, which is part of practical scientific investigation activities for science learning.

Method

Geared by an interview design, data in this study were garnered through questionnaires and semi-structured interviews. The interview focused on students' perceptions of the benefits and challenges of adopting blended learning in science classes. Participants were interviewed and asked follow-up questions based on their responses. This interview was prepared to obtain the same types of data from participants. The interview guide focuses on the benefits and challenges of adopting blended learning in science classes. These guidelines were revisable after the interview because new ideas emerge later.

Participation and Blended Learning in Science Learning in Indonesia

Participant recruitment in this study was based on the convenience method and availability and access ease. Thirty participants who have experienced blended learning were recruited, consisting of 10 biology education students (5 male and 5 female), 10 chemistry education students (5 male and 5 female), and 10 physics education students (5 male and 5 female). For ethical considerations, informed consent was first given to the participants.

Currently, Indonesia has implemented innovative learning to produce competitive Human Resources (HR). Blended learning is a teaching and learning strategy that aims to achieve learning objectives by combining online and face-to-face learning using information and technology resources with independent control of time, place, sequence, and learning speed. Various innovations in the use of learning technology are widely scattered, combining class-based learning with online-based learning as an appropriate choice in today's digitalized era.

Data Collection Procedure

Data collection started for two months from August to September 2020. The data were garnered from the questionnaire and semi-structured interviews. The questionnaire was disseminated through a Google form

application using Indonesian language. Interviews were conducted by asking questions via video call to each participant within 20-30 minutes. Interviews were conducted in using Indonesian language. The interview was conducted to excavate deeper into information about the benefits and challenges of adopting blended learning in science classes. Basically, interview procedure goes through the following stages: Identification of participants based on the selected sampling procedure. Identification was done to determine which participants would be recruited.

Participants were taken from first-year students of a public university in East Kalimantan, Indonesia; Determining interview type. In this study, a semi-structured interview was used; Preparing a recording device. The recording device used was a mobile phone; Determining a place to conduct interviews. Interviews were conducted online using video calls so participants' non-verbal expressions, such as laughing, patting on the forehead, and others, are seen; Giving informed consent to participants. Prior to conducting this study, we asked for approval and permission from the participants for their willingness to be interviewed; Interviews were conducted in accordance with the prepared questions. Participants were asked questions about the benefits and challenges they encountered during blended learning enactment. From these two main questions, follow-up questions were developed. To collect more data, a more in-depth and exploratory interview was carried out.

Data Analysis

Data in this study were analyzed using thematic analysis involving the process of coding information. In this context, data coding from recordings is substantial for the analysis. We coded participants' behavior, feeling, and actions garnered through the interview and questionnaire. The coding analysis involved several processes such as raw data code, start code, and end code. Column 1 presents raw data. Column 2 documents codes per sentence in the raw data, while column 3 informs the code of the data segment as a whole (Johnny, 2009).

Result and Discussion

Blended learning was carried out in the even semester of the 2019/2020 academic year. The data generated in this study consisted of questionnaire responses collected using the Google form application to determine students' demographic information and interview data to explore students' perceptions of the benefits and challenges of blended learning in science classes. Interviews were carried out through video calls,

due to COVID-19 pandemic, causing teaching and learning activities to be carried out online.

Students' Perceptions of the Benefits of Blended Learning in Science Classes

In the context of face-to-face learning, students are bound by the dimensions of space and time in their face-to-face class. Consequently, students are put together with the teacher in a traditional class that hampers new knowledge construction among the students. Blended learning is enacted online to internalize students' content knowledge via online platforms. In this case, students rely on materials from the teacher per se, but they are engaged in a self-directing learning by looking for materials from the internet, watching learning tutorials, and asking their friends. The combination of both face-to-face and online learning is one character of a digitalized world that raises students' learning independence. This finding is illustrated in the following excerpts: (1) The blended learning system makes me more independent because learning does not only take place in class, but students are given the opportunity to study online to find more material either through the website or through other media online, and to make them understand more deeply, they were using technology. So, a spirit of independence will emerge from within me. (Agung, interview through video call, 24 August 2022). (2) Get more independent knowledge about using online learning media applications (Tri, interview through video call, 24 August 2022). (3) Independent in finding my study material for study materials and makes I understand more and easier to remember (participant with initial Henock, interview through video call, 25 August 2022). (4) Make me independent in learning and learn more to understand new applications, look for lecture material independently, and independently make and edit presentation videos as attractive as possible (Soraya, interview through video call, 25 August 2022). (5) By utilizing science and technology, we can learn to solve problems independently and be able to do tasks independently so that you can explore yourself to learn independently in working on a problem. (Hairun, interview through video call, 9 September 2022).

Voices conveyed by Agung, Tri, Henock, Soraya, and Hairun evoke that blended learning is a teaching and learning strategy that can train students to be independent in looking for teaching materials, using technology and various applications and editing videos for learning. In line with such illustrations, Wong (2019) reported that blended learning provides a variety of learning opportunities both collectively and independently.

Earlier, Coll & Coll (2017) expose that learning science using digital technology consists of a learning management system (LMS) providing students with experiences in the digital world. Digital learning encourages students' motivation to learn collaboratively and improve their academic achievement. The following is an excerpt from an interview from a participant with regard to digital learning: (1) The science learning process is more effective, efficient and interesting with the blended learning approach. Some students say that with blended learning other than face-to-face online, they understand the application "online learning. (Muh, interview through video call, 26 August 2022). (2) Mastering technology better with various learning media, including zoom meetings, Google meet and schoology (Imam, interview through video call, 26 August 2020). (3) Understanding technology is not clueless because part of the learning is done online (Efi, interview through video call, 27 August 2022). (4) The ability to use technology increases both in the use of software and hardware (Fathur, interview through video call, 29 August 2022). (5) Increase knowledge about online learning media, such as Zoom, Google Meet, etc. Indirectly also learn how to use it (Emanuel, interview through video call, 29 August 2022).

Looking at the interviews with Muh, Imam, Efi, Fathur, and Emanuel, blended learning is viewed as a teaching and learning strategy that can improve students' understanding of science and technology. Viewing the importance of blended learning in a digitalized era, it thus serves as a strategic choice for students' learning advancement. Echoing such impressions, Bidarra & Rusman (2017) support that learning science using blended learning and supported by ICT-based tools would lead to active and inspirational learning activities.

Keogh et al. (2017) revealed that blended learning can increase students' learning outcomes and effectiveness and help them not to attend face-to-face learning activities. This is illustrated from the interview with the participants: (1) Blended learning when online time becomes flexible, where the time is easier to find to adapt to the conditions and needs (Safhira, interview through video call, 31 August 2022). (2) During face-to-face learning, not all can participate due to time constraints, when online students participate because of the lack of time and place constraints or place efficiency, they can study anywhere as long as there is an internet connection (Elisabeth, interview through video call, 31 August 2020). (3) Learn how to set your class time with activities at home (Lusi, interview through video call, 2 September 2022). (4) When learning online, wherever we are, we can still take part in learning, both outside the home and outside the city and if we are sick, we can still

attend lectures because it is done at home (Handoko, interview through video call, 2 September 2022). (5) If you are outside the house, or if there are events outside, you can still attend lectures and follow what material is being given (Taufiq, interview through video call, 3 September 2022). (6) Increasing the effectiveness of learning with better student performance and discussion activities taking place online/offline and taking place outside of class hours, discussion activities take place both between students and lecturers and between students themselves (Gita, interview through video call, 3 September 2022).

Anchored by the voices of Shafira, Elisabeth, Lusi, Handoko, Taufiq, and Gita, blended learning is construed as a teaching and learning strategy that can increase learning effectiveness since the flexibility of blended learning is allow students excluded from face-to-face learning. Thus, the enactment of blended learning can enhance students' learning effectiveness.

Yashwant et al. (2020) contended that blended learning caters to students with a variety of learning experiences. The following is an excerpt from the participant interview, which states that learning with a blended learning strategy can cater to students with learning experiences of learning science and technology. Some of the learning experiences encountered by the students are captured in the interview. (1) Increase knowledge how to use distance learning applications (Nahsir, interview through video call, 10 August 2022). (2) The learning process is easier because it can document subject matter and files can be stored and reopened when needed (Julia, interview through video call, 10 August 2022). (3) Can document the subject matter easily, this is because all learning activities occur online so that we can save the learning material that we have previously received. (Kopong, interview through video call, 5 September 2022). (4) In the learning process it is easier because the files or materials provided can be stored and if any time, we need it we can learn from it (Dewi, interview through video call, 8 September 2022). (5) Can document subject matter easily and can repeat lessons easily (Rindoi, interview through video call, 8 September 2022).

Based on the interview, participants view blended learning as a teaching and learning strategy that can cater to students with learning experiences, particularly on how to store teaching materials online. Enacting blended learning in science classes is possible in accordance with the development of information and communication technology and the proliferation of supporting applications. Various forms of learning strategies, models, and methods applied and utilized properly and appropriately in education would expand students' learning opportunities, increase efficiency,

improve the quality of learning, facilitate skill formation, and encourage lifelong learning.

Students' Perceptions of the Challenges of Blended Learning in Science Classes

Thomas (2020) reported that the use of blended learning in science learning has a significant and positive impact on students' academic achievement, although there are still problems with internet signal interference during online learning. This obstacle is a challenge when attending science classes using blended learning. Following are excerpts from participant interviews regarding the challenges of blended learning in science learning: (1) Obstacles to the implementation of practicum in the laboratory, because so far practicum activities are carried out face-to-face, this is a challenge that needs to be considered a solution, how to carry out practicum activities when online (Dewi, interview through video call, 8 September 2022).

Dewi argued that a challenge for teachers in blended learning is practicum activities. Gitoga (2020) asserted that learning could be done using pictures, videos, podcasts, and games that appeal to all senses. Besides, Tolentino et al. (2009) contend that technology-based science learning using interactive digital media creates a good learning environment. Teachers can demonstrate the teaching and learning process, which is part of practical activities on scientific investigations for science learning.

Siddiqui et al. (2020) reported that the use of blended learning in science learning has a significant and positive impact on academic achievement, although there are still obstacles to internet signal interference. The following is an interview with participants about the challenges of blended learning in science learning related to internet signal disturbances. (1) The signal is suddenly lost, especially in areas that are quite far from the city center and this hinder the online presentation process (Elisabeth, interview through video call, 31 August 2022). (2) Inadequate internet package, annoying voice at home and unstable internet connection (Henokh, interview through video call, 25 August 2022). (3) Limited quota, frequent downtime networks, challenges in dividing time between college assignments and homework as a child, and so on that I can't type one by one (Imam, interview through video call, 26 August 2022). (4) Inadequate and unstable internet network (Rindoi, interview through video call, 26 August 2022). (5) The network is unstable, and often down because the location where you live is so far from the city that you often miss learning material online (Julia, interview through WhatsApp, 26 August 2022). (6) The network is inadequate especially when it rains. So, when learning takes place it can be choked up and become unclear, so

that sometimes you don't understand the material being discussed (Lusi, interview through video call, 2 September 2022). (7) The signal is often down, resulting in lagging in learning (Tri, interview through video call, 24 August 2022). (8) Network is also influential when you want to enter the lecture room (Safhira, interview through video call, 31 August 2022).

In this interview, most of the participants (see Elisabeth, Enokh, Imam, Rindow, Julia, Lusi, Tri, and Safira) put forward the same challenges, namely, network problems or disruption of internet signals and limited quota costs. This hamper sustained materials understanding by the students. Besides, the interview captured a challenge for teachers to solve problems related to the internet signal. Teachers are also suggested to provide online videos accessible to students. In line with this, Bo Tso (2015) uncovered that the students much hold positive preference to learn from online videos as these can help them understand the material contents and guide them to create well-prepared presentations.

Blended learning is carried out in both face-to-face and online supported by e-learning platforms. When learning is carried out online, students need adequate internet quota. This is another problem and a challenge, especially for students with low economic conditions. It is depicted in the interviews with the participants: (1) The challenge for offline may only be in access to campus, which is to be motorized and traffic jams occur. As for the challenges online, namely spending more on quotas, which costs quite a lot, and it is difficult to digest learning so you have to really read other references to understand them (Soraya, interview through video call, 25 August 2022). (2) The quota is limited, so that when learning online learning activities are interrupted (Imam, interview through video call, 26 August 2022). (3) A lot of data plan is required (Elisabeth, interview through video call, 31 August 2020, and Nahsir, interview through video call, 31 August 2022). (4) Must always provide internet quota that is high enough (Gita, Interview through video call, 3 September 2022). (5) Insufficient internet quota, hampering the online teaching and learning process (Taufiq, interview through video call, 3 September 2022).

The participants in these interviews expressed the challenges of blended learning in science learning related to students' economic conditions, namely, limited internet quota, the cost of internet quota, which is relatively expensive, thus hindering students from motivating learning activities. Blended learning as a combination of face-to-face teaching and online teaching should deal with these complexities. To reduce costs in procuring internet quotas, learning activities with blended learning need to arrange a time between face-to-face and online. This echoes what Means et al. (2013) reported previously. They argued that the percentage of time in blended learning could be carried out with 75% face-to-face and 25% online, using the discussion, presentation, and question and answer methods. Meanwhile, Bo Tso (2015) suggests that blended learning should be enacted with 70% of face-to-face lectures and 30% online, using discussion, presentation, question and answer methods.

Online learning is mostly carried out via the internet. The learning takes place entirely via the internet, where all instructions regarding content are conveyed via the internet, including downloading references and submitting assignments. Online learning can also be carried out in classrooms, homes, using technologies such as audio/video streaming, the Internet, podcasting, chat, simulations, and video conferencing.

Conclusion

This study aims to explore students' perceptions of the benefits and challenges of adopting blended learning in science classes in Indonesia. The results showed that four themes of the benefits anchored in blended learning are documented, namely, training students' learning independence, increasing students' understanding of science and technology, increasing students' learning effectiveness, and providing students with a variety of learning experiences. The effectiveness of blended learning is supported by these advantages, that is, learning can be carried out anytime and anywhere by utilizing the internet network system. Meanwhile, our study also captured challenges of blended learning, namely, practicum activities during online learning, internet signal, and students' economic condition, with regard to providing quota fees. Furthermore, conducting conventional learning would result in students' ineffective learning, such as the inability to think contextually and independently searching for online sources. It has been discussed that blended learning is central to enhancing students' learning outcomes. The combination of conventional learning aided with the use of the internet improves students' learning achievement. Therefore, blended learning is possible to be implemented, along with the development of information and communication technology in terms of the proliferation of supporting applications. It is also supported by the use of technology in the midst of the community so that deficiencies, as mentioned earlier, can be dealt with. Albeit blended learning is superior to the other learning methods, our study has signaled that this method can be a catalyst for sustained learning.

References

Ali, A., Khan, R. M. I., & Alouraini, A. (2023). A Comparative Study on the Impact of Online and Blended Learning. *SAGE Open, 13*(1). https://doi.org/10.1177/21582440231154417

Bidarra, J., & Rusman, E. (2017). Towards a Pedagogical Model for Science Education: Bridging Educational Contexts through a Blended Learning Approach. *Open Learning: The Journal of Open, Distance and e-Learning, 32*(1), 6-20. https://doi.org/10.1080/02680513.2016.1265442

Bo Tso, A. W. (2015). Reflections on Blended Learning: A Case Study at the Open University of Hong Kong. *Asian Association of Open Universities Journal, 10*(1), 77-86. https://doi.org/10.1108/AAOUJ-10-01-2015-B008

Bouilheres, F., Le, L. T. V. H., McDonald, S., Nkhoma, C., & Montera, L. J. (2020). Defining Student Learning Experience through Blended Learning. *Education and Information Technologies, 25*, 3049–3069 (2020). https://doi.org/10.1007/s10639-020-10100-y

Campagnaro, T., McIntosh, N., Trentanovi, G., & Sitzia, T. (2022). Capacity Development Challenges and Solutions for Natura 2000: An Approach through Blended Learning. *Oryx, 56*(5), 764-773. https://doi.org/10.1017/S0030605322000679

Chang, C. J., Liu, C. C., Wen, C. T., Tseng, L. W., Chang, H. Y., Chang, M. H., Chiang, S. H. F., Hwang, F. K., & Yang, C. W. (2020). The Impact of Light-Weight Inquiry with Computer Simulations on Science Learning in Classrooms. *Computers & Education, 146*. https://doi.org/10.1016/j.compedu.2019.103770

Chowdhury, F. (2020). Blended Learning: How to Flip the Classroom at HEIs in Bangladesh? *Journal of Research in Innovative Teaching & Learning, 13*(2), 228-242. https://doi.org/10.1108/JRIT-12-2018-0030

Coll, S. D., & Coll, R. K. (2017). Using Blended Learning and Out-of-School Visits: Pedagogies for Effective Science Teaching in the Twenty-First Century. *Research in Science & Technological Education, 36*(1), 1-20. https://doi.org/10.1080/02635143.2017.1393658

Creswell, J. W. (1998). *Qualitative Inquiry& Research Design: Choosing Among Five Traditions*. Thousand Oaks: Sage Publication.

Cutri, R. M., & Whiting, E. F. (2018). Opening Spaces for Teacher Educator Knowledge in a Faculty Development Program on Blended Learning Course Development. *Studying Teacher Education a Journal of Self-Study of Teacher Education Practices, 14*(2), 1-16. https://doi.org/10.1080/17425964.2018.1447920

Dakduk, S., Santalla-Banderali, Z., & van der Woude, D. (2018). Acceptance of Blended Learning in Executive Education. *SAGE Open, 8*(3), 1-16. https://doi.org/10.1177/2158244018800647

Dziuban, C., Graham, C. R., Moskal, P. D., Norberg, A., & Sicilia, N. (2018). Blended Learning: The New Normal and Emerging Technologies. *Int J Educ Technol High Educ, 15*(3). https://doi.org/10.1186/s41239-017-0087-5

Gitoga, P. (2020). *Top 6 Benefits of Blended Learning*. Retrieved from https://elearningindustry.com/6-benefits-blended-learning-looking-beyond-covid

Han, F., & Ellis, R. A. (2020). Initial Development and Validation of the Perceptions of the Blended Learning Environment Questionnaire. *Journal of Psychoeducational Assessment, 38*(2), 168–181. https://doi.org/10.1177/0734282919834091

Ibrahim, F., Padilla-Valdez, N., & Rosli, U. K. (2022). Hub-and-Spokes Practices of Blended Learning: Trajectories of Emergency Remote Teaching in Brunei Darussalam. *Education and Information Technologies, 27*(1), 525-549. https://doi.org/10.1007/s10639-021-10754-2

Islam, Md. K., Sarker, Md. F. H., & Islam, M. S. (2022). Promoting Student-Centred Blended Learning In Higher Education: A Model. *E-Learning and Digital Media, 19*(1), 36-54. http://dx.doi.org/10.1177/20427530211027721

Johnny, S. (2009). *The Coding Manual for Qualitative Researchers*. London: Sage Publications Sandhya.

Keogh, J. W. L., Gowthorp, L., & McLean, M. (2017) Perceptions of Sport Science Students on the Potential Applications and Limitations of Blended Learning in Their Education: A Qualitative Study. *Sports Biomechanics, 16*(3), 297-312. https://doi.org/10.1080/14763141.2017.1305439

Kintu, M. J., Zhu, C., & Kagambe, E. (2017). Blended Learning Effectiveness: The Relationship between Student Characteristics, Design Features and Outcomes. *International Journal of Education Technology in Higher Education, 14*(7). https://doi.org/10.1186/s41239-017-0043-4

Laifa, M., Giglou, R. I., & Akhrouf, S. (2023). Blended Learning in Algeria: Assessing Students'

Satisfaction and Future Preferences Using SEM and Sentiment Analysis. *Innovative Higher Education*. https://doi.org/10.1007/s10755-023-09658-5

Liu, Y., & Wang, S. (2022). The Influence of Students' Ability on the Continuous Intention of Blended Learning. *SN Soc Sci, 2*(10), 195. https://doi.org/10.1007/s43545-022-00499-1.

Mayr, A., & Oppl, S. (2023). Higher Education at the Margins–Success Criteria for Blended Learning Systems for Marginalized Communities. *Education and Information Technologies, 28*, 2579–2617. https://doi.org/10.1007/s10639-022-11282-3

Means, B., Toyama, Y., Murphy, R., & Baki, M. (2013). The Effectiveness of Online and Blended Learning: A Meta-Analysis of the Empirical Literature. *Teachers College Record, 115*(3), 1–47. https://doi.org/10.1177/016146811311500307

Perera, C. J., Zainuddin, Z., Piaw, C. Y., Cheah, K. S. L., & Asirvatham, D. (2020). The Pedagogical Frontiers of Urban Higher Education: Blended Learning and Co-Lecturing. *Education and Urban Society, 52*(9), 1305–1329. https://doi.org/10.1177/0013124519894966

Siddiqui, S., Soomro, N. N., & Thomas, M. (2020). Blended Learning Source of Satisfaction of Psychological Needs: An Empirical Study Conducted on O-levels Chemistry Students in Metropolis City of Pakistan. *Asian Association of Open Universities Journal, 15*(1), 49-67. https://doi.org/10.1108/AAOUJ-11-2019-0054

Slemer, S. (2005). *Use Blended Learning to Increase Learner Engagement and Reduce Training Cost*. Retrieved from http://www.learningsim.com/content/lsnews/blended_learning1.html)

Su, F., Zou, D., Wang, L., & Kohnke, L. (2023). Student Engagement and Teaching Presence in Blended Learning and Emergency Remote Teaching. *Journal of Computers in Education*. https://doi.org/10.1007/s40692-023-00263-1

Tolentino, L., Jhonson, M. C., & Martinez, C. (2009). Teaching and Learning in the Mixed-Reality Science Classroom. *Sci Educ Technol, 18*, 501–517. https://doi.org/10.1007/s10956-009-9166-2

Wong, R. (2019). Basis Psychological Needs of Students in Blended Learning. *Interactive Learning Environments, 30*(6), 984-998. https://doi.org/10.1080/10494820.2019.1703010

Yashwant, A. V., Arayambath, B., Murugaboopathy, V., Kommi, P. B., Prashad, K. V., & Rajasekaran, U. B. (2020). Comparative Evaluation of the Effectiveness of Blended Learning Versus Traditional Learning in Cephalometrics for Undergraduates. *Journal of Indian Orthodontic Society, 54*(1), 24-30. https://doi.org/10.1177/0301574219883873

Yusoff, S., Yusoff, R., & Md Noh, N. H. (2017). Blended Learning Approach for Less Proficient Students. *SAGE Open, 7*(3). https://doi.org/10.1177/2158244017723051