Development of Smart Campus in Improving the Quality of Learning

Zul Setiawan[1], Asep Yudi Permana[1*], Juang Akbardin[2], Sumarto Sumarto[3]

[1] *Architecture FPTK, Indonesian University of Education, Bandung, Indonesia*
[2] *Civil Engineering FPTK Indonesian University of Education, Bandung, Indonesia*
[3] *Electrical Engineering Education FPTK Indonesian University of Education, Bandung, Indonesia*
[*] *Corresponding author. E-mail:yudi.permana@upi.edu*

ABSTRACT

Smart learning is successful when teachers, coaches, and students are familiar with mobile devices being used for targeted communication. However, traditional learning methods are slowly disappearing due to the increase in information communication and learning technology due to the development of Internet learning. Consequently, the development of information technology over the last decade, both software and hardware, has created the concept that higher education can be learned anytime and anywhere (Ubiquitous learning/ U-Learning). With the presence of the Covid-19 pandemic outbreak in 2020, Ubiquitous Learning is a strategic choice in carrying out learning for almost all levels of education. The exploitation of smart device technology is growing rapidly with the rise of the Internet of Things (IoT), The current education system leads to multi-disciplinary intelligence, where renewable technology devices dominate most of the education industry, and intelligent technology support can give birth to new learning patterns. Updating learning models supported by smart technology should not conflict with traditional learning systems, on the contrary, digital learning models can be expected to improve deficiencies in traditional learning systems. Smart learning promotes the use of information and communication technology as a learning method in updating traditional cultures and societies. The increasing public need for higher education, as well as the role of industry in the need for a qualified workforce, encourages intense competition between campuses, the quality of education and the capacity of campuses in the future requires innovation and smart steps to be able to compete with each other in developing the physical facilities and infrastructure of campus buildings. increasingly limited land and the cost of infrastructure development which continues to increase is one of the challenges for the existence of a campus. The utilization of technology provides significant solutions in responding to these challenges. This research aims to provide innovation in the use of information and technology in higher education. The purpose of this research is to explore the challenges faced by campuses in adopting technological advances, related to learning design and the formation of smart campuses (environments) of the future, and to help solve the problem of limited development of campus areas. The results of this study provide benefits in terms of theory in contributing to science in terms of architectural theory, especially for the development of campus architectural designs related to learning by utilizing smart technology to lead to future smart campuses, as well as supporting the future of education and the architectural profession.

Keywords: Communication *technology*, *information technology, innovation, a learning method.*

1. INTRODUCTION

Higher education is an important element in forming a pillar of a country's economic and social strength. One of the institutions that is an integral part of higher education is the campus. The development of information technology has affected various aspects of human life, including education. The concept of "Smart Campus" has become a global trend, involving the use of technology to increase the efficiency and quality of education.

Over the last few decades, universities around the world have undertaken various initiatives to design and implement the Smart Campus concept. Smart Campus integrates digital technology, data analytics, and internet connectivity in all aspects of campus operations, including teaching, research, and administration. This technology can facilitate increased operational efficiency, collaboration, and better problem-solving.

However, various challenges arise in efforts to achieve the Smart Campus concept. First, major

A. Kusumastuti et al. (eds.), *5th Vocational Education International Conference (VEIC 2023)*,
Advances in Social Science, Education and Humanities Research 813,
https://doi.org/10.2991/978-2-38476-198-2_136

structural and cultural changes are needed to integrate technology into all aspects of campus life. Second, there are issues related to privacy and data security that need to be addressed. Third, there are challenges in assessing the impact of Smart Campus implementation on the quality of learning.

Given the importance of this challenge, this research aims to explain and formulate an effective strategy for developing Smart Campus and assess its impact on the quality of learning. This research seeks to understand how technology can be used to help universities achieve their educational goals, as well as what obstacles they may face in this process. In this context, this research also aims to assist policymakers and decision-makers in universities in designing and implementing Smart Campus strategies.

To achieve this goal, this study will attempt to answer several research questions. First, what is the role of technology in the development of the Smart Campus concept? Second, what are the obstacles and challenges faced by the university in the Smart Campus development process? Third, what is the impact of implementing Smart Campus on the quality of learning at universities? And lastly, what are the most effective strategies for overcoming obstacles and challenges in developing Smart Campus?

Through this research, we hope to provide a better understanding of how the development of a Smart Campus can affect the quality of learning and how existing challenges can be overcome. The results of this research are expected to be a guide for universities and other higher education institutions that are trying to implement the Smart Campus concept.

2. Literature Review

The current education system leads to multi-disciplinary intelligence, where renewable technology devices dominate most of the education industry, and intelligent technology support can give birth to new learning patterns. Updating learning models supported by smart technology should not conflict with traditional learning systems, on the contrary, digital learning models (as shown in Figure 1) can be expected to improve deficiencies in traditional learning systems. Smart learning promotes the use of information and communication technology as a learning method in updating traditional cultures and societies[1].

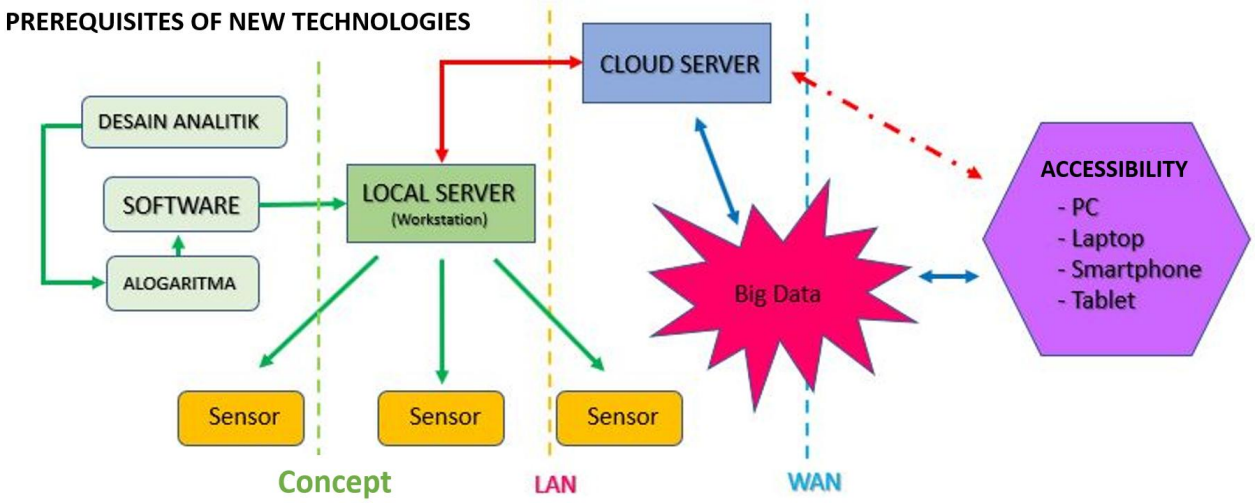

Figure 1. New Technology Requirements.

In recent decades, very little has changed, as universities have remained conventional despite the rapid and widespread proliferation of technology in our society and the growing enthusiasm of students for smart gadgets, which are increasingly being used productively as learning something new at all times. Learning devices using smart gadgets help change the way students learn by connecting them to various information and communication technologies. Information and communication technology (ICT) has accelerated progress in smart education as many students turn to be more mobile from different individual skills to educational technology [2-4].

Therefore, smart learning will be successful if educators, instructors, and students are fluent in the use of the intended technology. Discrepancies often occur considering a person's ability to adapt to different technologies, so it is necessary to make several levels of adjustment in understanding the smart technology that will be used. The next stage of problem analysis is the availability of internet network infrastructure on campus, the availability of application platforms that contain information and application platforms for connected learning with smart class networks as well as the physical infrastructure of buildings and environments that support learning anywhere in the campus environment.

The development of smart technology is a necessity, how can the development of physical space Integrated architecture of smart technology in the campus environment become a comprehensive issue towards the concept of a smart campus? Internet-based smart technology supports the dissemination of information and scientific distribution in a relatively short time, not limited by space and time. Several research studies show that today's learners prefer autonomy over strict guidance, to construct their knowledge in personalized ways. The development of digital media-based teaching materials encourages students to more easily obtain information and process it according to their mastery. Utilization of IoT in the campus environment provides convenience for campus administrative management,

2.1 Smart Campus Concept

The Smart Campus concept has become an increasingly popular research topic in recent years. Digital technology and internet connectivity play an important role in formulating and strengthening the Smart Campus concept [5-8]. Research by He et al. (2019) focuses on how digital technology can be used to integrate campus operations and provide a better learning environment.

Meanwhile, the use of data analytics in Smart Campus has also become the focus of several studies. For example, Wang et al. (2020) show that data analytics can be used to understand student learning behaviour and assist in optimizing the learning process [9]. This research also shows that the use of data in education can assist in identifying at-risk students and providing timely interventions [10].

Cloud-based technology also plays an important role in the development of Smart Campuses, as explained by Zhang et al. (2021). They argue that cloud technology can assist in integrating systems and data across campuses and facilitate better access to learning resources [11].

However, the implementation of digital technology and data analytics in education is not without challenges. Data privacy and security is a significant issue [12]. Singh et al. (2020) identified the need for better solutions to protect student privacy and ensure data security in education [12].

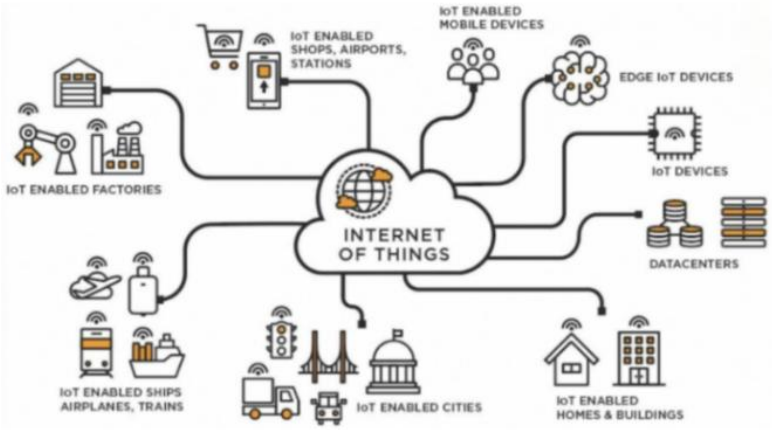

Figure 2. Network map with IoT.

In addition, cultural and structural changes in education are also needed to implement the Smart Campus concept [10-14]. This research shows that these changes are often difficult and require a careful and planned approach [14].

Li et al. (2022) focus on how Smart Campuses can also affect the quality of learning [15] where the use of technology can increase the efficiency and effectiveness of learning, but also requires adjustments from students and teachers[15].

Based on this study, it appears that the development of a Smart Campus involves the integration of various technologies and structural and cultural changes in education. However, some challenges need to be addressed, including privacy and data security concerns.

2.2 Digital Education

Digital education has become a major concern in the world of education in recent years. Over the last few years, the use of technology in education has increased rapidly, along with increased access to the internet and digital devices. Research by Selwyn (2019) shows that technology has helped in shaping and facilitating teaching and learning processes, making education more inclusive and affordable [16].

In terms of student engagement, research by Sangrà et al. (2020) show that the use of technology in

education can help in increasing student engagement [17]. They note that technology can make students feel more involved in the learning process, which in turn can improve their learning outcomes.

Related to adaptation to new technologies in education, research by Brown et al. (2019) shows that teachers often face challenges in adapting their teaching methods to new technologies [18]. This research shows that appropriate professional training and support can assist teachers in adapting to new technologies and in leveraging them to improve teaching quality.

Meanwhile, it appears that the use of technology in education is not without challenges. Data security and privacy, for example, have become major issues in digital education [19]. They emphasized the need for better solutions to protect student data privacy and security in digital education.

In line with this, research by Macgilchrist et al. (2020) shows that the increased use of technology in education has changed the way student data is collected, stored, and used [20]. They note that while there is significant potential for using this data to improve education, there are also significant ethical and privacy challenges. In the context of distance and online learning, technology plays an important role. Research by Dhawan (2020) shows that technology can facilitate effective distance learning and can help address some of the challenges associated with distance education [21].

2.3 Technology in Education

The use of technology in education has become an increasingly popular research topic in recent years. There are many ways in which technology can impact education, from the way teaching and learning are done to how educational institutions are run.

In the teaching and learning aspect, technology has enabled the development and dissemination of new methods. For example, research by Kim et al. (2019) showed that game-based learning can be an effective way to increase student motivation and learning outcomes [22-23]. Huang et al. (2020) have shown that the use of virtual reality in education can enhance students' learning experiences and assist them in understanding difficult concepts [24].

However, technology is not just a tool to assist in the teaching and learning process. As shown by research by Lee et al. (2020), technology can also be used to assist in the management and administration of educational institutions [25-26]. They show how data analytics can be used to assist in making data-driven decisions and improve operational efficiency.

The challenges faced in the implementation of technology in education, one of which is the issue of data security and privacy. For example, the use of technology in education increases risks to data security and privacy. They argue that more efforts need to be made to protect student data and ensure that technology is used safely and ethically [4].

In addition, another challenge is the required change in practice and attitudes toward education. Research by Ertmer et al. (2021) indicate that there are significant challenges in changing teaching and learning practices to integrate technology [27]. They suggest that professional support and training for teachers can assist in this transition.

Regarding distance learning, research by Bao (2020) shows that technology can facilitate effective learning in situations where face-to-face learning is not possible [28]. They show that technology, such as online learning platforms and digital collaboration tools, can facilitate interaction and collaboration in distance learning contexts.

Ultimately, this research shows that technology has significant potential to assist in education, both in teaching and learning and in administration. However, there are also significant challenges that need to be addressed, including issues of data security and privacy and changes in practice and attitudes toward education.

2.4 Learning Analytics

Learning Analytics is a research field that has developed rapidly in recent years. Learning Analytics is the use of data and analytics to understand and optimize learning and the environment in which it occurs. Learning Analytics collects, analyzes, and reports data about students and their context, with the aim of understanding and optimizing learning and the environment in which it occurs [29].

Learning Analytics systems can provide useful insights for students, teachers, and policymakers. For example, Learning Analytics can be used to provide personalized feedback to students, which can assist them in understanding their strengths and weaknesses. In addition, Learning Analytics can also be used by teachers and policymakers to make data-driven decisions. For example, Learning Analytics can be used to identify patterns and trends in student data, which can be used to guide learning and policy decisions.

However, Learning Analytics also has its challenges. One of them is the issue of privacy and ethics. For example, the collection and analysis of student data in Learning Analytics can raise privacy and ethical issues, and researchers should be careful in navigating these issues. In addition, there are challenges in the

implementation and adoption of Learning Analytics. Research by Tsai et al. (2018) show that there are various barriers to the adoption of Learning Analytics, including a lack of understanding and skills in analytics, and technical challenges in implementing Learning Analytics systems [30-32].

However, despite the challenges, Learning Analytics has significant potential to support more effective learning and teaching. For example, Learning Analytics can be used to support adaptive learning, enabling personalized teaching based on individual needs and preferences. Ultimately, this research shows that Learning Analytics is a promising field with a lot of potential to support more effective learning and teaching. However, some challenges need to be addressed, including privacy and ethical issues and challenges to Learning Analytics implementation and adoption.

3. Research Methods

The research method will follow a qualitative research design. This method provides a framework that allows this research to explore the perspectives and experiences of various stakeholders regarding smart campuses as well as collect data that can be measured to verify qualitative findings.

The subject of this research will cover the entire academic community, which has adopted the smart campus concept. The sampling technique used was purposive sampling, in which participants were selected based on certain criteria relevant to the research. Data will be collected through online surveys, in-depth interviews, and direct observation. The survey will target quantitative aspects, such as the level of use, satisfaction, and perceptions of the influence of smart campuses on the quality of learning. Interviews and observations will be used to gain in-depth qualitative insights.

The parameters of this study involve various aspects. First, the level of adoption and use of campus smart technology by the academic community. Second, the level of user satisfaction with smart campus facilities and technology. Third, the impact of using smart campus technology on the quality of learning. Finally, the perception of the academic community regarding the effectiveness of smart campuses in supporting the learning process and improving its quality.

4. Results and Discussion

4.1 Smart Campus Technology

The learning technology ecosystem is growing with the presence of Internet of Things (IoT) technology. The planting of several sensors, actuators, and several other devices in a smart campus environment aim not only for learning but can also be useful for administrative and environmental security purposes, at a higher level the use of IoT can regulate energy use more efficiently. There are 3 basic smart technology developments, namely smart cards, face scanners, and motion sensors.

The first is smart card, this technology gives someone access to reach several destination points, Smart Access or smart access consists of a series of digital codes stored in a device which is generally currently in the form of a card (smart card) as shown in Figure 3.

Figure 3. Smart cards.

Smart cards or smart cards contain data that has been programmed containing individual identities, which can be designated for access purposes. The use of smart card can be used as a security and registration function for administrative purposes.

Second, facial scanning technology by analyzing facial biometrics, facial scanning technology maps in detail the shape of the face in 3 dimensions through the camera, then connected to a special terminal that is capable of sending data to available servers for processing as needed. The application of this technology can also help monitor and control at a macro level, (all visitors to the institutional building) for data collection or security purposes, as shown in Figure 4.

Third, a motion sensor is an electronic device designed to detect and measure motion. The motion sensor is intended to control the lighting factor in terms of energy use for saving purposes. With the application of motion sensors both indoors and outdoors, the function of artificial lighting can be minimized, limited to spaces that are being used, signals received by sensors due to motion, activating lighting mode, otherwise if the room is empty (no there is movement) then the lighting will turn off automatically, as shown in Figure 5.

Figure 4. Personnel identification via Face scanner.

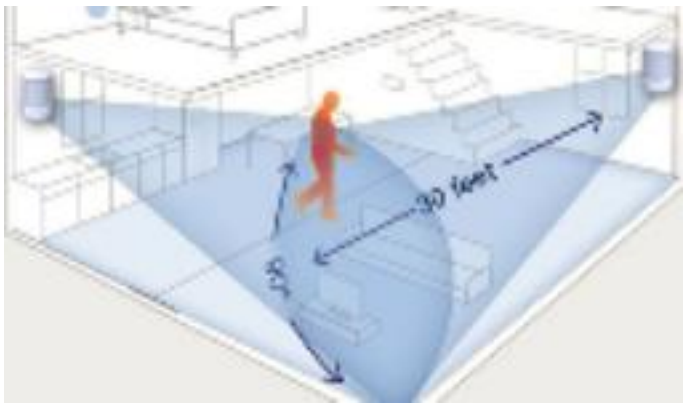

Figure 5. Graphical sensor work diagram.

4.2 Smart Classes

Smart classrooms include both online and offline classrooms. The literature on smart classrooms tends to focus on technical systems and the technical feasibility of implementation [33]. Utilizing internet technology with Wi-fi (wireless) technology devices refers to the use of IoT systems, cameras, sensors, and other computing devices that carry out physical surveillance of educational participants in their environment to manage the educational process, to help provide teaching and learning facility services about data search. on internet sites, virtual data storage, virtual libraries, digital books, digital registration, and digital presentations to support learning systems both face-to-face and remotely. The notion of 'classroom' originates in traditional educational settings, and is used in the context of distributed learning environments, whether online, blended, and/or distance learning (as shown in Figure 6). These forms of education delivery often differ not only in terms of student demographics, costs, retention, and dropout, but also pedagogical strategies, admission requirements, and flexibility[10,27,34,35].

Figure 6. Smart class implementation.

Smart classrooms are equipped with smart boards, and cameras, integrated into the internet network on smart devices (laptops, PCs, tablets, smartphones), which can be accessed in real-time to serve the learning process, at a higher level, IoT systems with the help of sensors, will gather new sources of data on student participation (e.g. hand raising and discussion), facial expressions, posture, and engagement. Based on this information, it is hoped that it will generate new insights about individual and group behavior in the classroom. Influence analysis is a popular form of analytics that assesses the emotions and moods expressed in intelligent classrooms [36-39]. Emotional states are thought to perform functions that signal problems such as boredom, confusion, anxiety, and frustration.

Education (no matter what the delivery format) is always using a variety of data (eg demographic and behavioral data) for planning, operational and pedagogical purposes, smart technology offers new opportunities to broaden the 'view of data'. Thus, smart classrooms offer not only new forms of data, but also greater variety, granularity, and speed of data that can

be used, among other things, to inform teaching and learning processes. Cameras and sensors are typically used to transform learning environments for a variety of purposes, including informing pedagogical strategies, using surveillance, monitoring, and sharing outside of face-to-face contexts. In general smart classrooms can stand alone, or can be integrated with broader campus initiatives.

To be 'smart', technology and policy processes often require large amounts of information to personalize experiences and power artificial intelligence systems. In the imaginary data that appears, economies, policies, buildings, cities, houses, cars, and various other 'things' will be 'data' so that they can be analyzed by computers. Such computational transformations of pre-digital societies incorporated commercial and mass government surveillance into things and processes of everyday life.

4.3 Digital learning concept

Information and Communication Technology (ICT) is a broader term for Information Technology (IT), which refers to all communication technologies, including the internet, wireless networks, mobile phones, computers, software, middleware, video conferencing, social networks, and more. Media applications and services that enable users to access, retrieve, store, transmit, and manipulate information in digital form as shown in Figure 7.

In the era of the Industrial Revolution 4.0, computing technology became concise and sophisticated with the presence of smartphones and tablets, mobile devices have been shown to function as an ideal facility platform to increase the efficiency of campus life. Because they are portable and easily accessible, they have become essential devices used by millions of students in their daily lives, and the use of mobile devices on campus has become widespread in recent years.

Figure 7. Smart device illustration.
Source: https://www.pngegg.com/.

With a smartphone connected to the campus network infrastructure, it allows users to be more mobile in accessing information and communication, delivering learning anywhere and anytime, making it a pleasant experience. Furthermore, this encourages campus organizers to create a comfortable and harmonious campus environment.

Distance learning is a term that was used before the wide spread of digital approaches to learning and was originally associated with courses delivered by correspondence. Distance education programs are constantly evolving, new technologies are present rapidly influencing learning patterns that evolve continuously. Figure 3 shows the evolution of distance education, up from Generation 6 to industrial revolution 5.

One of the principles of distance education is to prioritize independent learning activities for students without or with minimal dependence on others. As a consequence, learning materials in distance education are developed in such a way as to enable students to learn independently (self-learning) to be a very important part.

Distance Education or Learning from Home (LFH) is carried out by referring to the theory of the "Learning Pyramid" by Edgar Dale [40]. In this theory, the learning pyramid is divided into three major parts, namely auditory (hearing), visual (seeing), and kinaesthetic (moving and discussing). The auditory part is a category of passive absorption of learning, namely by the lecture method with an absorption of about 5% while reading, watching, and demonstrations have an absorption power of 10%, 20% respectively, and 30%. The kinaesthetic part has a higher absorption power than the auditory and visual. This is obtained from the discussion method with 50% absorption, 75% direct practice, and 90% direct tutorial (see Figure 8).

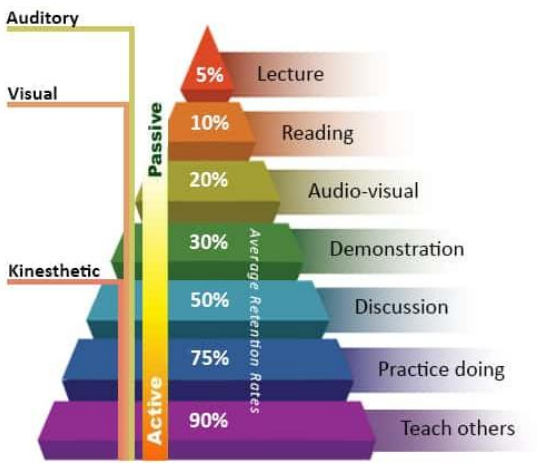

Figure 8. Dale's Learning Pyramid.

Concerning Dale's Learning Pyramid theory, learning activities also undergo evolution towards the 5.0 era, including synchronous, asynchronous, and blended learning.

Synchronous learning means studying remotely and attending class sessions virtually every week, at the same time as the instructor and classmates. Classes are a firm weekly time commitment that cannot be rescheduled. Much like on-campus classes, there are readings and assignments to complete outside of class time to help prepare for participation in discussions. Student preparation is like this, along with a special agenda set by the instructor, to ensure that each class session is productive, as shown in Figure 9.

Synchronous Learning aims to build community and relationships between individuals/groups, establish interactive discussions in smaller groups, initiate personal instruction and coaching, facilitate face-to-face virtual interaction (Video Conference), facilitate collaboration between students, carry out interactive discussions in both large groups or small groups, so that they can provide direct feedback, in solving problems.

Figure 9. Interactive learning.
Source: https://www.pngegg.com/.

Asynchronous learning makes it possible to study according to a schedule that we set for ourselves, within a certain period. You can access and complete lectures, readings, homework, and other study materials at any time during a one- or two-week period. Online asynchronous classes can include short videos teaching key concepts that can be watched repeatedly if needed. In some classes, students can also complete homework assignments and receive immediate feedback, without waiting for the instructor to grade them.

Asynchronous Learning aims to direct students/students to read and take notes, watch learning videos, attend lectures, to further explore available material, engage in online discussions, work on and complete exercises, and reflect on learning outcomes, as shown in Figure 10.

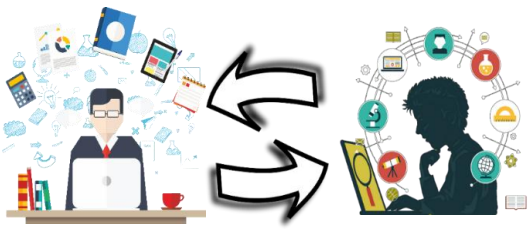

Figure 10. Illustration of Asynchronous Learning.
Source:https://www.pngegg.com.

Blended learning refers to a mixture of asynchronous text-based online materials and synchronous face-to-face learning [31][41], but as technology develops, so does its definition. This detailed description of blended learning introduces the concepts of strong and weak blended, depending on the amount of eLearning, and also discusses the variable mix of media and activities available. The Joint Information Systems Committee (Jisc) defines blended learning (as shown in Figure 11) as “a combination of face-to-face learning and dynamic digital content and activities that facilitate anytime/anywhere learning”.

The strengths of blended learning include increasing the digital literacy skills of lecturers and students, compiling teaching material content that is by current standards, unlimited sources of information, responsible and enthusiastic students, accommodating differences in educational learning styles, and flexibility in space and time [42].

Figure 11. Illustration*Discussion group.*
Source: https://www.pngegg.com.

This advantage can encourage an increase in student academic and non-academic achievements. We, therefore, recognize the significant potential for maximizing student learning through the use of Active blended learning strategies. Based on the definition of blended learning, components of eLearning and synchronous asynchronous learning can be inherently active, and thus blended learning can be described as Active blended learning.

5. CONCLUSION

The development of smart campuses has shown a significant impact in improving the quality of learning. With a variety of integrated advanced technology applications, smart campuses provide a more interactive, dynamic and personalized learning environment. This not only supports more effective teaching and learning, but also encourages active student collaboration and participation, and provides easier and faster access to learning resources.

However, challenges remain, especially in terms of technology adoption and acceptance by the academic community. In order to maximize the potential of smart campuses in improving the quality of learning, it is important for educational institutions to ensure that the entire academic community has the necessary understanding and skills to use this technology effectively. In addition, privacy and security issues must also be considered. Nonetheless, with the right development and adjustments, smart campuses have great potential to shape the future of higher education.

ACKNOWLEDGMENTS

We thank the parties who have provided insights and expertise that have greatly assisted this research. We also thank the Principal of SMKN 6 Bandung, the teachers and students as respondents who shared their experiences with us during this research.

REFERENCES

[1] Al-Emran, Mostafa and T. Teo, Do knowledge acquisition and knowledge sharing really affect e-learning adoption? An empirical study, Educ. Inf. Technol., no. 1–16, 2019.

[2] A. Manal, A. Eman and A. Qasim, Smart Learning environment for HEIs in Oman, in In 2nd students research conference, 2019, p. edited by SQU, 37. SQU: SQU.

[3] S. Adapa, Indian smart cities and cleaner production initiatives–Integrated framework and recommendations, J. Clean. Prod., 2018,

[4] P. Abbott, The human resource function contribution to human development in South Africa, SA J. Hum. Resour. Manag., 2013,

[5] Y. Liu and L.-S. Shao, Construction of Smart Campus Based on Situational Awareness in the Era Of Big Data, in 2016 International Conference on Computer Engineering and Information Systems (CEIS-16), vol. 52, 2016 doi: 10.2991/ceis-16.2016.46.

[6] J. He, S. L. Baxter, J. Xu, J. Xu, X. Zhou, and K. Zhang, The practical implementation of artificial intelligence technologies in medicine, Nat. Med., vol. 25, no. 1, pp. 30–36, 2019, doi: 10.1038/s41591-018-0307-0.

[7] H. Zhou, Y. Zhang, and J. Xu, The Construction of Smart Campus Based on Digital Technologies, IEEE Access, vol. 7, 2019.

[8] K. Jangjarat, P. Klayklung, P. Chocksathaporn, and P. Maskran, The Impact of Smart Education on Learning Outcomes in the Digital Era : A Systematic Review, Adv. Knowl. Exec., vol. 2, no. 2, pp. 1–10, 2023.

[9] F. Wang, Y. Zhang, and J. Zou, Using Data Analytics for Better Learning Outcomes in Smart Campus., J. Educ. Technol. Soc., vol. 23, no. 1, 2020, pp. 25–38.

[10] L. K. R. Bandeira, A. H. T. Casimiro, and E. S. de Lima, Smart Campus E a Gestão Da Informação: Aplicabilidades Na Universidade Federal De Campina Grande, Perspect. em Gestão Conhecimento, vol. 10, no. Special, 2020, doi: 10.21714/2236-417x2020v10nep23.

[11] X. Zhang, J. Wang, and Z. Chen, Cloud-based Smart Campus: Architecture, System, and Implementation, J. Cloud Comput., vol. 10, no. 1, 2021, pp. 1–16.

[12] D. Singh, B. Pati, C. R. Panigrahi, and S. Swagatika, Security Issues in IoT and their Countermeasures in Smart City Applications, Adv. Intell. Syst. Comput., vol. 1089, no. March, 2020, pp. 301–313, doi: 10.1007/978-981-15-1483-8_26.

[13] A. Y. Permana, R. Mardiana, N. Indra, K. Dewi, R. Vena, and V. Sumanta, Evaluation of Classroom Performance in The Post-Covid-19 New Normal Era at The Building Program Vocational High School, J. Soutwest Jiaotong Univ., vol. 57, no. 2, 2022, pp. 126–145.

[14] N. Lopez, J. Valenzuela, and A. Calderon, “Barriers and Challenges in the Implementation of Smart Campus,” in Computers & Education, vol. 168, 2020, p. 104210.

[15] Y. Li, X. Wang, and Q. Huang, Impact of Smart Campus on the Quality of Learning: A Systematic Review, J. Educ. Comput. Res., vol. 60, no. 1, 2022, pp. 183–204.

[16] N. Selwyn, “Digital education: Beyond the ‘wow’ factor,” Palgrave Macmillan, vol. 76, no. 4, 2019, pp. 494–507.

[17] A. Sangrà, D. Vlachopoulos, and N. Cabrera, “Building an inclusive definition of e-learning: An approach to the conceptual framework.,” Int. Rev. Res. Open Distrib. Learn., vol. 13, no. 2, 2020, pp. 145–159.

[18] M. Brown, M. McCormack, J. Reeves, C. Brooks, and S. Grajek, 2020 Educause Horizon Report Teaching and Learning Edition. Educause, Louisville, CO., 2019.

[19] P. Kumar, M. Singh, and M. M. Rathore, Securing IoT for Smart Campus: Issues, Challenges, and Solutions., in IEEE Access, 8, 2020, pp. 31875-31892.

[20] F. Macgilchrist, H. Allert, and A. Bruch, Students and society in the 2020s. Three future ‘histories’ of education and technology, Learn. Media Technol., vol. 45, no. 1, 2020, pp. 76–89.

[21] S. Dhawan, Online Learning: A Panacea in the Time of COVID-19 Crisis, J. Educ. Technol. Syst., vol. 49, no. 1, 2020, pp. 5–22.

[22] B. Kim, H. Park, and Y. Baek, Not just fun, but serious strategies: Using meta-cognitive strategies in game-based learning, Comput. Educ., vol. 133, 2019, pp. 97–122.

[23] A. Y. Permana, Fitriani, and T. Aulia, Analysis of Students ' Work Readiness Based on Self - Efficacy of Vocational High School in The Building Information Modelling Technology Era, J. Tech. Educ. Train., vol. 15, no. 1, 2023 pp. 192–203, doi: https://doi.org/10.30880/jtet.2023.15.01.017.

[24] H. M. Huang, U. Rauch, and S. S. Liaw, Investigating learners' attitudes toward virtual reality learning environments: Based on a constructivist approach., Comput. Educ., vol. 144, 2020, p. 103641.

[25] J. Lee, B. Cho, Y. Kim, and J. Noh, Smart education: Examining the student's perspective., in Telematics and Informatics, 2020, pp. 46, 101304.

[26] T. F. Abiodun, I. O. Oladele, Covid-19 pandemic: a disaster to nigeria's economy, educational system, workforce, and security., J. Confl. …, 2021.

[27] P. A. Ertmer, A. T. Ottenbreit-Leftwich, O. Sadik, E. Sendurur, and P. Sendurur, Teacher beliefs and technology integration practices: A critical relationship, Comput. Educ., vol. 59, no. 2, 2021, pp. 423–435.

[28] W. Bao, COVID -19 and online teaching in higher education: A case study of Peking University, Hum. Behav. Emerg. Technol., vol. 2, no. 2, 2020, pp. 113–115.

[29] G. Siemens, Learning Analytics: The Emergence of a Discipline., Am. Behav. Sci., vol. 57, no. 10, 2020, pp. 1380–1400.

[30] Y. S. Tsai et al., SHEILA policy framework: Informing institutional strategies and policy processes of learning analytics. Journal Learn. Anal., vol. 5, no. 3, 2018, pp. 5–20.

[31] A. Y. Permana, J. Akbardin, A. F. S. Permana, and H. Nurrahman, The concept of optimal workplace in providing a great experience to improve work professionalism in the interior design of PLN Corporate university, Ragunan, Jakarta, Int. J. Adv. Sci. Technol., vol. 29, no. 7, 2020, pp. 3238–3254.

[32] S. Ahmed, The Socio-cultural Dynamics of Antibiotic Misuse in Hyderabad City, India: A Qualitative Study of Dentist and Pharmacist, J. Karnali Acad. Heal. Sci., 2019,

[33] I. Abdellatif, Towards A Novel Approach for Designing Smart Classrooms., in 2019 IEEE 2nd International Conference on Information and Computer Technologies (ICICT), 2019, pp. 280–284, doi: https://doi.org/10.1109/INFOCT.2019.8711355.

[34] A. Y. Permana, S. Soetomo, G. Hardiman, and I. Buchori, Smart Architecture as a Concept of Sustainable Development in the Improvement of the Slum Settlementarea in Bandung, Int. Ref. J. Eng. Sci., vol. 2, no. 9, 2013, pp. 26–35.

[35] Y. Lu, L. Zhao, and B. Wang, From virtual community members to C2C e-commerce buyers : Trust in virtual communities and its effect on consumers ' purchase intention, Electron. Commer. Res. Appl., vol. 9, pp. 346–360, 2010, doi: 10.1016/j.elerap.2009.07.003.

[36] A. Y. Permana and K. Wijaya, Spatial change transformation of educational areas in Bandung, IOP Conf. Ser. Earth Environ. Sci., vol. 99, p. 012029, 2017, doi: 10.1088/1755-1315/99/1/012029.

[37] T. Mazuryk and M. Gervautz, Virtual Reality History , Applications , Technology and Future History, in VIRTUAL REALITY, Austria: Institute of Computer Graphics Vienna University of Technology, 1996.

[38] M. Mihelj, D. Novak, and S. Beguš, Virtual Reality Technology and Applications, vol. 68. Dordrecht Heidelberg New York London: Springer, 2014.

[39] R. V Kozinets, E-Tribalized Marketing : The Strategic Implications of Virtual Communities of Consumption, Eur. Manag. J., vol. 17, no. 3, 1999, pp. 252–264.

[40] A. Y. Permana, D. I. Aprilia, and N. Q. I. Teniola, Teacher Skills Through the Development of Design a nd Develop Learning Program Taedes 401 (gov . au) for Building Core Skill a nd Employability Skills for Vocational High School, Adv. Soc. Sci. Educ. Humanit. Res., vol. 379, 2019, pp. 385–395.

[41] J. Zheng, The Rational Planning Approach in Public Art Production: Evaluating the Quality of Urban Sculpture Plans in Shanghai, J. Plan. Educ. Res., 2020.

[42] K. Zlatanovska, J. Zarkova-Atanasova, and ..., Prevalence of temporomandibular disorders among patients with total and partial dentures, … -International J. …, 2020.