INDONESIAN JOURNAL OF EDUCATIONAL RESEARCH AND REVIEW
Volume 5 Nomor 2 2022, pp 242-251
E-ISSN: 2621-8984; P-ISSN: 2621-4792
DOI: https://doi.org/10.23887/ijerr.v5i2.50359

Developing Self-Study Competence of Students through Experiential Activities in the Digital Environment

Thanh Tu Ngo[1*], Nhung Kim Thi Vu[2], Thanh Chi Phan[3]
[1,2]Institute of Engineering Education in Hanoi University of Science and Technology, Vietnam
[3]Quang Tri Teacher Training College, Ha Noi University of Science and Technology, Vietnam
*Corresponding author: thanh.ngotu@hust.edu.vn

Abstrak

Teknologi Digital termasuk Big Data, Artificial Intelligence (AI), dan Data Mining telah menciptakan revolusi dalam pendidikan: beralih dari metode pengajaran tradisional ke metode belajar mandiri, yang dapat memaksimalkan kompetensi belajar mandiri peserta didik untuk menghadapi perubahan teknologi digital. Penelitian ini bertujuan untuk mengembangkan metode untuk menyelenggarakan experiential teaching guna memaksimalkan kemampuan belajar mandiri siswa di lingkungan digital dan memenuhi perkembangan ilmu pengetahuan dan teknologi yang maju. Penelitian ini menggunakan metode campuran antara kualitatif dan kuantitatif untuk analisis dan penilaian. Penelitian ini berfokus pada experiential learning tingkat tinggi yang merupakan pengalaman: diskusi kelompok, eksperimen & praktik untuk mata pelajaran tertentu, yaitu sistem tertanam. Hasil penelitian ini telah mempresentasikan dasar ilmiah untuk mengembangkan kompetensi belajar mandiri melalui kegiatan experiential di lingkungan digital dan mengusulkan dua strategi untuk mengatur kegiatan experiential di lingkungan digital untuk mengembangkan self-efficacy siswa.

Kata kunci: *Kompetensi belajar mandiri, Mengembangkan kompetensi belajar mandiri, Pengajaran berdasarkan pengalaman, Pembelajaran berdasarkan pengalaman, Lingkungan digital*

Abstract

Digital Technologies including Big Data, Artificial Intelligence (AI), and Data Mining have created a revolution in education: switching from traditional teaching method to self-teaching method, which can maximize the self-study competence of learners to meet changes in digital technologies. The research aims to develop methods of for organizing experiential teaching in order to maximize the self-learning abilities of students in the digital environment and meet the development of advanced science and technology. This research used mixed which qualitative and quantitative methods to analysis and assessment. This research focuses on high-level experiential learning which an experience is: group discussion, experimentation & practice for certain subjects, namely the embedded system. The result of this research has presented the scientific basis for developing self-study competence through experiential activities in the digital environment and proposed two strategies to organize experiential activities in the digital environment to develop students' self-efficacy.

Keywords: Self-study competence, Developing self-study competence, Experiential teaching, Experiential learning, Digital environment.

History:
Received : May 19, 2022
Revised : May 20, 2022
Accepted : July 19, 2022
Published : July 25, 2022

Publisher: Undiksha Press

1. INTRODUCTION

Self-study competence is a learning method where students direct their own studying outside the classroom and without direct supervision (Roll, 2021; Valverde-Berrocoso et al., 2021). Since students are able to take control of what (and how) they are learning, self-study can be a very valuable way for many students to learn. Self-study and traditional classroom learning can be used together to help your child get the most out of his or her learning experience (Jones & Lee, 2021; Önder et al., 2020). Together, these methods help students learn and retain information better, helping boost comprehension, grades, and motivation. Using self-study, students are able to go beyond simply learning what their class textbooks and instructors teach them (Evans & Cleghorn, 2022; Schneider & Bodensohn, 2017; Yurdakul, 2017). By practicing self-study, they are encouraged to further explore topics they

are interested in, developing stronger study skills as a result (Gelen Assoc, 2018; Labouta et al., 2018; Valverde-Berrocoso et al., 2021). One of the major advantages of self-study is that students can take control over their own learning. And when students have control, they become even more interested in learning (Liang, 2012; Sujarwo et al., 2020). Digital experiential learning is a concept that places individuals in an interactive learning environment, either physically or virtually (Chen & Hsu, 2020; Hite et al., 2019; Meyer et al., 2019). The goal is to replicate and engage in real-world scenarios to teach particular skills or techniques. Traditional methods of learning, such as classroom instruction and videos, are slowly being phased out in favor of a more hands-on approach like digital experiential learning (Chandrasekera & Yoon, 2018; Chick et al., 2020; Paepe et al., 2018). When supported by VR, these methods allow us to learn skills through 3D simulations that closely reflect real-world scenarios. This type of interactive learning plays a huge role in boosting memory recall, and is one of the best ways to learn and practice hands-on skills, like those of the skilled trades (Ilona et al., 2011; Ryoo & Bedell, 2017; Vagg et al., 2020).

Over the past two decades, information and communication technology (ICT) has developed rapidly, they have strongly influenced the change of education in general and teaching competency in particular (Avando Bastari et al., 2021; Thanh et al., 2021). Previous research reported that the use of an online environment combined “face to face” classes had an impact on the development of thinking for students (Sunday & Vera, 2018; Tran et al., 2020). The develop students' creative competency will help students participate and self-assess learning outcomes. The develop of technology and the role of it in flipped classroom model to promoting and the growth of online learning environments should be enhanced (Chai & Kong, 2017; Thanh et al., 2021). It is supported by other previous research that found a positive impact on students' activities and learning outcomes at many levels and subjects (Amoako Atta & Brantuo, 2021; Griffin et al., 2012). Besides the goal of introducing a style-based blended teaching-learning model to develop learning competencies in general, and at the same time develop a specific competency for the ability to integrate tools to support learning activities (Asuman et al., 2018; Liang, 2012; Prestiadi et al., 2020). In which ICT is the core tool, direction is completely consistent with the online teaching method in education and training in educational institutions, and adapting to the current Covid-19 pandemic (Hung et al., 2021; Mardiana, 2020; Peterson et al., 2020). There are a lot of research projects on developing self-study competence through experiential activities in real environment. However, in the digital environment, experience activities imply their own characteristics and are different from the real environment. This study focuses on develop the scientific basis of experiential learning in the digital environment. We propose solutions to develop students' self-study competence through experiential activities in the digital environment (Tran et al., 2020; Xia et al., 2021).

2. METHODS

This research used mixed which qualitative and quantitative methods to analysis and assessment (Almeida, 2020; Creswell, 2008). Due to the limited scope of the article, the content of this section only focuses on higher-level experiential learning which are experiences: group discussion, experiment & practice, and immediately passing the knowledge that is already gained to others for a specific subject: Embedded systems. This study provides students with characteristics, structure of FPGA, and role of FPGA in embedded applications. After self-studying the content of the lesson, students will be able to recognize the structure of FPGA, analyze the role of FPGA and apply FPGA in the design of embedded systems. After introducing the characteristics and structure of FPGA, the role of FPGA in embedded applications for students through textbooks and videos in online

classrooms (digital part of B-Learning), the lecturer directly presented the exercise at online classes (real part of B-Learning) according to the teaching schedule of the Embedded System Design module. The form of teaching under B-Learning is now digital B-Learning.

3. RESULTS AND DISCUSSION

Results

Via research on self-study, self-learning competency, physical environment, digital environment, and experiential education, it is possible to point out physical environment and Digital environment. The physical environment composes of the tangible physical entities and objects that the human can see, observe and perceive, it includes: the social environment, the natural environment and the artificial environment. All entities that previously "lived" together but cannot be linked each other. In a connectionless entity environment, teaching and learning at school is completely independent and not connected to the surrounding entity. Physical and digital environment is show in Figure 1.

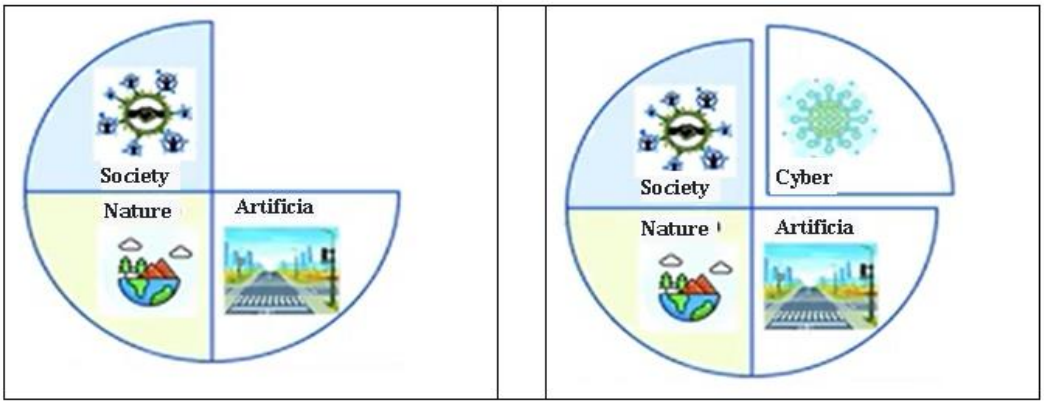

Figure 1. Physical and Digital Environment

Base on Figure 1 the digital environment is the physical environment with additional digital space - Cyber. In addition, digital technology organically integrates with social organizations (businesses, agencies, residential communities, etc…, physical resources and assets (houses, vehicles, roads, etc.) and the natural eco-environment make up the ubiquitous digital environment. In the digital environment, entities are gradually digitized and create data that can be interconnected to formulate a digital space. When every entity is digitized, the data will become big data, making the digital space more abundant and diverse with increasing connectivity. Self-study competence: Self-study competence is the ability to identify learning tasks voluntarily and proactively; to set learning goals by themselves and try the best to achieve them; it is also the ability to gain effective learning methods and adjust their own errors and limitations when performing learning tasks through self-assessment or suggestions from teachers and friends; moreover, it is the ability to actively seek supports when having difficulties in learning. Digital self-study competence: More advance than self-study competence, "digital self-learning competence" includes the ability to exploit digital technology to self-study in the digital environment to personalize learners in order to transform data to knowledge and perception. Studying in the same class, in the same learning environment, and in the same digital environment, the better "digital self-learning ability" a student has, the better he gains knowledge. Traditional Blended learning is a form of teaching organization that combines traditional face-to-face teaching and online teaching to optimize

the advantage of each form, to ensure the optimal effectiveness for the achieved education. B-Learning model between real part and digital part is show in Figure 2.

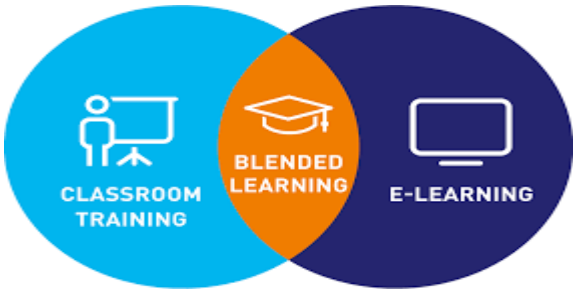

Figure 2. B-Learning Model Between Real Part (Left) and Digital Part (Right)

Base on Figure 2 show the number part (on the right) of B-Learning is for students to self-study video clips of online lecture. They will take note if they do not understand. The real part (on the left) of B-Learning is held by the lecturer in a workshop, exchanging "face to face" with students. Students ask questions when they cannot understand in studying online. With this model, lecturer will answer or students present the topic while the lecturer and other students listen and discuss. Digital B-Learning: Digital B-Learning is a high-level development of traditional B-learning, where face-to-face teaching is implemented in a digital environment thanks to digital technology. In the digital environment, Digital B-Learning, combining self-study with "face to face" becomes simple. Because it has been digitized and connected, the real-left part of Figure 2, lecturers and students can interact, exchange and communicate on the web like a real environment. Experiential education: This is a category including many methods in which learners will be encouraged to reflect and summarize these experiences to enhance understanding and develop skills. Experiential learning is a trend in teaching practice. Many studies have proven that the knowledge presented by reading, seeing, listening, speaking... is the least effective experience and the most difficult to remember. In entity environment without communication, teaching and learning at school is completely independent, which is not connected to the surrounding entity. The theory of experiential learning was initiated by David Kolb a century ago, when the concept of a digital environment was not yet born.

Scientific basis for developing self-study competence through experiential activities in the digital environment

The group discussion method is used to help all students actively participate in the learning process, creating opportunities for students to share knowledge, experiences, and ideas to solve problems which are relevant to the lesson content; it creates opportunities for students to exchange and learn from each other to solve common tasks. If group teaching is well organized, it will promote positivity and responsibility; develop students' ability to work collaboratively and to communicate. However, the conditions for group discussion are quite complicated. Firstly, there must be a place to gather members to attend and the members must be in the same class and with the same schedule. For a big group of a class with over 150 students, when 1 student presents and discusses, only the lecturer and a few students can listen, and more than 100 other students make noise or play with the phone. If this type of class is divided into 10 groups, then 10 separate rooms and 10 teaching assistants are needed. However, it is extremely difficult to have 10 private classrooms and 10 teaching assistants to support related to paying for teaching hours and to renting classrooms.

Some strategies to organize experiential activities in the digital environment to develop students' self-study competence

Transferring knowledge from the lecturers' guide to students' self-study and doing their own exercises. It is a mean of providing new knowledge for students because the knowledge that students gain is through the experiential activity of solving "learning by doing" exercises.Not all lessons and new knowledge of the subject can be turned into problems for students to solve. Students after watching a video will study on by themselves, read a lecture syllabus, then state the structure of the FPGA including programmable logic blocks and gates. I/O interface, two types of programming block structure in FPGA; Good and excellent students will be able to distinguish the similarities and differences between the two types of programmable block structures MUX and LUT. In Exercise 2, the lecturer may ask a question: what is the role of FPGA in the embedded system of measuring room temperature with a thermal sensor with I2C interface? Fair students only understand that the embedded system measures room temperature with a thermal sensor with I2C interface requires an FPGA, but good and excellent students can make comments: If a regular MCU without I2C interface is used, it will be very difficult (they have to program to interrupt, catch edge, level of pulse). Also, if only FPGA in this application is used, it does not work because certain difficulties in arithmetic calculations may appear. At this time, lecturer gives a question concerning to the role of the FPGA in the system: For example, the temperature in degrees Fahrenheit is measured by the sensor, while degrees Celsius is required displayed. However it is FPGA does not support to perform math operations such as addition, subtraction, multiplication and division to convert degrees F with degrees C. In this case, the co-design method can be proposed. The FPGA is in charge of communicating with the I2C sensor and returns the raw data to the MCU to perform arithmetic calculations. At the time of this class, this is a situation that is not included in the syllabus and does not have a sample exercise. Because there is no sample exercise to follow, in order to analyze the role of FPGA in the embedded system, students has to brainstorm to bring the above problem to a new problem in which there are connections. Students will define and determine the role of FPGA in the system: Co-design Co-design combines the hardware capabilities of the FPGA with the advantage of software processing of the microcontroller to create a powerful embedded system.

Experiential activities through practical activities to form new knowledge

Through practical activities to create new knowledge for students, skills in drawing circuits, writing programs to perform system control functions. Instead of teaching practical content in the textbook, lecturers assign practical activities with corresponding content for students to practice remotely (real part on digital environment). The results of students' practice are new knowledge (KTM) in the curriculum.

The steps are conducted, first the lecturer assigns practical activities in the online class

For an embedded system using the PIC16F877A described as follows:

+ 4 Port B pins (PB4-PB7) each pin connects to an active low-level pushbutton

+ 4 Port D pins (PD4-PD7) each connected to a single LED

+ When the button is pressed, the corresponding LED will light up

Draw a detailed circuit diagram for the above system using Proteus software?

Write a C program to perform the above system control function and simulate the system?

Then Students self-study the content in the textbook related to the requirements for practical homework. Students watch the instructional video in the online class to determine the goals to be performed in the online practice lesson, think about writing a control program according to the requirements of the exercise. In practice time, students enter the online

classroom to access the computer in the remote practice room with the online guidance of the lecturer and the support of Teamviewer or Ultraviewer software to draw circuits, write programs, and compile program and conduct simulation, check the program and circuit if errors appear, and re-simulate. Draw circuit is show in Figure 3.

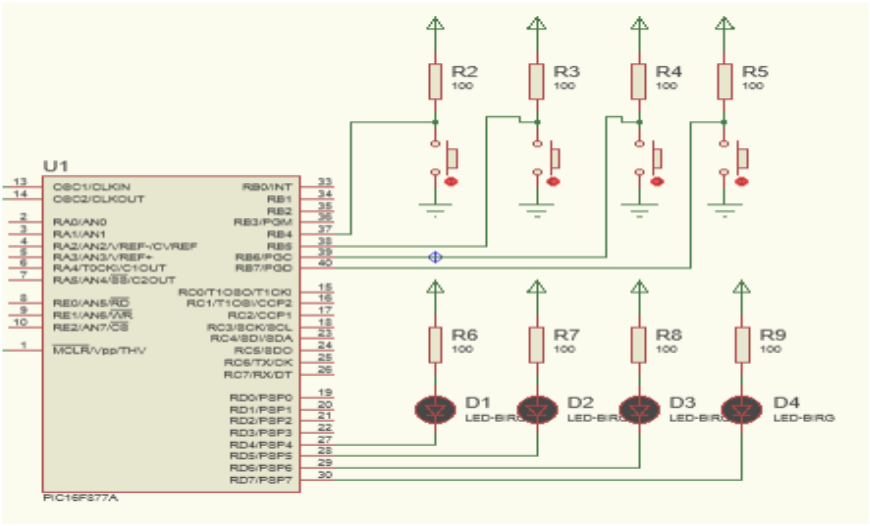

Figure 3. Draw Circuit

The next step students report the results of the practical activites, the lecturer checks and accepts the actual results of each student. In case students have computer which installs circuit drawing and simulation software, they can present the content of the exercise at home and report the practice results through the online class to the lecturer. Thus, through practical experience activities, students may create circuit drawing skills, programming thinking according to problem requirements. Fair student can draw different system design circuits and prepare simulation programs guided by the teacher in advance. Good and exellent students will be able to think and write a program depending on the requirements of each problem.

Discussion

The teaching method in the digital environment is: everyone learns from each other, the first learners teach the latter, the first to understand teaches the latter. So everyone becomes a teacher (Leite et al., 2020; Xia et al., 2021). The most effective experiential learning is that after understanding the lesson, the learners reteach it to others, which can reach a 90% memory level. Therefore, when all entities are connected, the world is in the palm of your hand, the person who gains first will reteach the next person, not only by imparting knowledge, but more importantly, through teaching to understand deeply, remember better the contents you have studied, turn the knowledge you are learning into your own knowledge. Creating a class on digital space is simple, not as complicated as a traditional classroom on a traditional university campus. Digital tools to create virtual classrooms such as: *MSTeam, Zalo, Facebook, Zoom* (Kumalawati et al., 2021; Mu'awanah et al., 2021; Rahmah et al., 2019). All members can connect in the classroom. One advantage of the virtual classroom is that it can connect people from all over the country, who are interested in a topic of discussion. Students enter the class do not need to move physically, but just by clicking on the link sent by the class host. A digital environment requires corresponding telecommunications infrastructure. That means, instead of building expensive lecture halls, expanding the school area, etc., we will invest in building telecommunications

infrastructure, BTS telecommunications stations, connecting 5G and 6G telecommunications networks. Once the telecommunications infrastructure is available, the connection among entities in the University will be digitized through the digital environment which forms the digital assets of the University (Abdulbasit & Seyoum, 2021; Sholihah, 2019). If the university has a library containing tens of thousands of books without digitization, there will be no "digital assets" for students to carry out experience activities in the digital environment. Therefore, in order to have a true digital environment, it is necessary to digitize documents to form a digital library and build smart laboratories. So students can connect and do online practice experiments remotely. It is in line with previous study that state there cannot be a digital environment when managers and lecturers do not have the right mindset about the digital environment (Davis et al., 2018).

Therefore, there must be synchronous solutions to “upgrade”, update the qualifications, thinking and skills of using digital technology for managers as well as lecturers. Training to develop digital competence for lecturers to digitize lectures and learning materials. From that, a digital learning center will be formed, which puts digital learning materials into the cyberspace to train, research and share knowledge. It is also supported by other previous study that state once the data has been digitized, the next step is to connect to big data (Sutarni et al., 2021). Finally, the corresponding equipment and smart software must be done. Along with digital libraries, digital learning materials are documents, information data, documents that are digitized and archived in service of teaching and learning. The implication of this study hopefully will help students maximize their self-study competence not only in the Embedded System Design module but also in other subjects. Applying this method in teaching can form new knowledge to develop self-study competence for students. Depending on the teaching purpose, lecturer can choose the appropriate topics. The limitation of this research is limited to experiential activities through exercises that involve the real part of the organizational form. B-Learning is carried out through a digital environment with the support of LMS – learning management system and digital application software. So it is very possible to get different results in the application of independent learning competencies in other areas of knowledge.

4. CONCLUSION

The research has presented the scientific basis for developing self-study competence through experiential activities in the digital environment and proposed two strategies to organize experiential activities in the digital environment to develop students’ self-efficacy. They are: experiential activities through doing exercises to form new knowledge; Experiential activities through practical activities to form new knowledge. In these strategies, the real part of the form of organization of B-Learning is performed through the digital environment with the support of the LMS – learning management system and digital application software. Learners acquire new knowledge hemselves in the subject curricula, thereby contributing to innovating teaching methods in the direction of approaching advanced technologies, meeting the needs of digital transformation in teaching and learning of the industry Education today.

5. REFERENCES

Abdulbasit, K., & Seyoum, Y. (2021). Status of Learning Facilities for Primary School Physics Curriculum Implementation in Eastern Ethiopia. *International Journal of Educational Research Review*, *6*(3), 218–225. https://doi.org/10.24331/ijere.894943.

Almeida, F. (2020). Strategies To Perform A Mixed Method Study. *European Journal of*

Education Studies, *7*(1), 326–337. https://doi.org/10.5281/zenodo.1406214.

Amoako Atta, S., & Brantuo, W. A. (2021). Digitalizing the Teaching and Learning of Mathematics at the Senior High Schools in Ghana: The Case of Flipped Classroom Approach. *American Journal of Education and Practice*, *5*(3), 29–37. https://doi.org/10.47672/ajep.869.

Asuman, B., Khan, M. S. H., & Clement, C. K. (2018). Integration of web-based learning into higher education institutions in Uganda: Teachers' perspectives. *International Journal of Web-Based Learning and Teaching Technologies*, *13*(3), 33–50. https://doi.org/10.4018/IJWLTT.2018070103.

Avando Bastari, Adi Bandono, & Okol Sri Suharyo. (2021). The development strategy of smart campus for improving excellent navy human resources. *Global Journal of Engineering and Technology Advances*, *6*(2), 033–043. https://doi.org/10.30574/gjeta.2021.6.2.0011.

Chai, C. S., & Kong, S.-C. (2017). Professional learning for 21st century education. *Journal of Computers in Education*, *4*(1), 1–4. https://doi.org/10.1007/s40692-016-0069-y.

Chandrasekera, T., & Yoon, S.-Y. (2018). The Effect of Augmented and Virtual Reality Interfaces in the Creative Design Process. *International Journal of Virtual and Augmented Reality*, *2*(1), 1–13. https://doi.org/10.4018/ijvar.2018010101.

Chen, Y.-L., & Hsu, C.-C. (2020). Self-regulated mobile game-based English learning in a virtual reality environment. *Computers & Education*, *154*, 103910. https://doi.org/https://doi.org/10.1016/j.compedu.2020.103910.

Chick, R. C., Clifton, G. T., Peace, K. M., Propper, B. W., Hale, D. F., Alseidi, A. A., Vreeland, T. J., Chick, R. C., Clifton, G. T., Peace, K. M., Propper, B. W., Hale, D. F., Alseidi, A. A., & Vreeland, T. J. (2020). Using technology to maintain the education of residents during the COVID-19 pandemic. *Journal of Surgical Education*, *77*(4), 729–732. https://doi.org/10.1016/j.jsurg.2020.03.018.

Creswell, J. (2008). Research design, qualitative, quantitative, and mixed methods approaches (third ed.). In *California: Sage Publication*. Sage Publication.

Davis, D., Chen, G., Hauff, C., & Houben, G. J. (2018). Activating learning at scale: A review of innovations in online learning strategies. *Computers and Education*, *125*(June), 327–344. https://doi.org/10.1016/j.compedu.2018.05.019.

Evans, R., & Cleghorn, A. (2022). Do student teachers see what learners see? – Avoiding instructional dissonance when designing worksheets. *South African Journal of Childhood Education*, *12*(1). https://doi.org/10.4102/sajce.v12i1.1015.

Gelen Assoc, I. (2018). Academicians' Predictions Of 21 St Century Education And Education In The 21 St Century. *European Journal of Education Studies*, *4*, 165–204. https://doi.org/10.5281/zenodo.1233478.

Griffin, P., McGaw, B., & Care, E. (2012). Assessment and teaching of 21st century skills. *Assessment and Teaching of 21st Century Skills*, 1–345. https://doi.org/10.1007/978-94-007-2324-5.

Hite, R. L., Jones, M. G., Childers, G. M., Ennes, M., Chesnutt, K., Pereyra, M., & Cayton, E. (2019). Investigating Potential Relationships Between Adolescents' Cognitive Development and Perceptions of Presence in 3-D, Haptic-Enabled, Virtual Reality Science Instruction. *Journal of Science Education and Technology*, *28*(3), 265–284. https://doi.org/10.1007/s10956-018-9764-y.

Hung, V. T., Thanh, C. P., Huy, T. L., Loc, P. H., Tien, M. P., & Hung, T. T. (2021). A Systematic Style-Based Blended Teaching for Competence Enhancement of Lecturers in the COVID-19 Pandemic Situation: A Case Study for Teaching in Higher Education. Turkish. *Journal of Computer and Mathematics Education*, *12*(11), 4394–4408. https://turcomat.org/index.php/turkbilmat/article/view/6575.

Ilona, B., Márta, K., Ildikó, L., & Tímea, M. (2011). Technological support of web based project work in higher education. *2011 14th International Conference on Interactive Collaborative Learning, ICL 2011 - 11th International Conference Virtual University, VU'11, September*, 209–213. https://doi.org/10.1109/ICL.2011.6059577.

Jones, J. M., & Lee, L. H. (2021). Multicultural Competency Building: a Multi-year Study of Trainee Self-Perceptions of Cultural Competence. *Contemporary School Psychology*, *25*(3), 288–298. https://doi.org/10.1007/s40688-020-00339-0.

Kumalawati, R., Murliawan, K. H., Yuliarti, A., Kartika, N. Y., & Noermelani, E. (2021). Utilization of information technology for learning in Covid-19 disaster conditions. *IOP Conference Series: Earth and Environmental Science*, *716*(1). https://doi.org/10.1088/1755-1315/716/1/012001.

Labouta, H. I., Kenny, N. A., Li, R., Anikovskiy, M., Reid, L., & Cramb, D. T. (2018). Learning science by doing science: an authentic science process-learning model in postsecondary education. *International Journal of Science Education*, *40*(12), 1476–1492. https://doi.org/10.1080/09500693.2018.1484966.

Leite, E. A. M., Lencastre, J. A., Silva, B. D., & Neto, H. B. (2020). Learning style in a virtual environment: a study with elementary school teachers at in- service training. *Angewandte Chemie International Edition, 6(11), 951–952.*, *9*(7), 1–27. https://doi.org/https://doi.org/10.33448/rsd-v9i7.3790.

Liang, J. S. (2012). Learning in troubleshooting of automotive braking system: A project-based teamwork approach. *British Journal of Educational Technology*, *43*(2), 331–352. https://doi.org/10.1111/j.1467-8535.2011.01182.x.

Mardiana, H. (2020). Lecturers' Adaptability to Technological Change and Its Impact on The Teaching Process. *JPI (Jurnal Pendidikan Indonesia)*, *9*(2), 275–289. https://doi.org/10.23887/jpi-undiksha.v9i2.24595.

Meyer, O. A., Omdahl, M. K., & Makransky, G. (2019). Investigating the effect of pre-training when learning through immersive virtual reality and video: A media and methods experiment. *Computers and Education*, *140*(December 2018), 103603. https://doi.org/10.1016/j.compedu.2019.103603.

Mu'awanah, N., Sumardi, S., & Suparno, S. (2021). Using Zoom to Support English Learning during Covid-19 Pandemic: Strengths and Challenges. *Jurnal Ilmiah Sekolah Dasar*, *5*(2), 222. https://doi.org/10.23887/jisd.v5i2.35006.

Önder, A., Gülay Ogelman, H., & Göktaş, İ. (2020). Examining The Predictive Effect of Teacher–Child Relationship on Young Children's Self-Perception. *Early Child Development and Care*, 1–8. https://doi.org/10.1080/03004430.2020.1759574.

Paepe, L. De, Brussel, V. U., Zhu, C., Brussel, V. U., & Depryck, K. (2018). *Online Language Teaching : Teacher Perceptions of Effective Communication Tools , Required Skills and Challenges of Online Teaching Online Language Teaching : Teacher Perceptions of Effective Communication Tools , Required Skills and Challenges of Online*. *February*. https://www.learntechlib.org/p/181352.

Peterson, C. N., Tavana, S. Z., Akinleye, O. P., Johnson, W. H., & Berkmen, M. B. (2020). An idea to explore: Use of augmented reality for teaching three-dimensional biomolecular structures. *Biochemistry and Molecular Biology Education*, *48*(3), 276–282. https://doi.org/10.1002/bmb.21341.

Prestiadi, D., Maisyaroh, Arifin, I., & Bhayangkara, A. N. (2020). Meta-Analysis of Online Learning Implementation in Learning Effectiveness. *Proceedings - 2020 6th International Conference on Education and Technology, ICET 2020*, 109–114. https://doi.org/10.1109/ICET51153.2020.9276557.

Rahmah, N., Lestari, A., Musa, L. A. D., & Sugilar, H. (2019). Quizizz Online Digital System Assessment Tools. *Proceeding of 2019 5th International Conference on*

Wireless and Telematics, ICWT 2019, 3–6. https://doi.org/10.1109/ICWT47785.2019.8978212.

Roll, M. J. J. (2021). Multidisciplinary digital competencies of pre-service vocational teachers. In *Empirical Research in Vocational Education and Training* (Vol. 13, Issue 1, pp. 1–25). SpringerOpen. https://doi.org/10.1186/S40461-021-00112-4.

Ryoo, K., & Bedell, K. (2017). The effects of visualizations on linguistically diverse students' understanding of energy and matter in life science. *Journal of Research in Science Teaching*, *54*(10), 1274–1301. https://doi.org/10.1002/tea.21405.

Schneider, C., & Bodensohn, R. (2017). Student Teachers' Appraisal of the Importance of Assessment in Teacher Education and Self-Reports on the Development of Assessment Competence. *Assessment in Education: Principles, Policy and Practice*, *24*(2), 127–146. https://doi.org/http://dx.doi.org/10.1080/0969594X.2017.1293002.

Sholihah, N. K. (2019). Management of Education Facilities and Infrastructure. *International Conference on Education Innovation (ICEI 2019)*, 186. https://doi.org/10.2991/icei-19.2019.24.

Sujarwo, S., Sukmawati, S., Akhiruddin, A., Ridwan, R., & Suharti Siradjuddin, S. S. (2020). An Analysis of University Students' Perspective On Online Learning in The Midst of Covid-19 Pandemic. *Jurnal Pendidikan Dan Pengajaran*, *53*(2), 125. https://doi.org/10.23887/jpp.v53i2.24964.

Sunday, C. E., & Vera, C. C. E. (2018). Examining information and communication technology (ICT) adoption in SMEs: A dynamic capabilities approach. *Journal of Enterprise Information Management*, *31*(2), 338–356. https://doi.org/10.1108/JEIM-12-2014-0125.

Sutarni, N., Ramdhany, M. A., Hufad, A., & Kurniawan, E. (2021). Self-Regulated Learning And Digital Learning Environment: Effect On Academic Achievement During The Pandemic. *Jurnal Cakrawala Pendidikan*, *40*(2). https://doi.org/10.21831/cp.v40i2.40718.

Thanh, C. P., Phuong, A. L., Tien, M. P., Loc, P. H., Huy, T. L., Thanh, T. N., Dung, T. N., & Hung, V. T. (2021). Identifying and Applying the Information Technology Competence Framework in an Online Teaching Environment. *In Handbook of Research on Barriers for Teaching 21st-Century Competencies and the Impact of Digitalization*, 356–382. https://doi.org/10.4018/978-1-7998-6967-2.ch019.

Tran, T., Phan, H. A., Le, H. Van, & Nguyen, H. T. (2020). ICT integration in developing competence for pre-service mathematics teachers: A case study from six universities in Vietnam. *International Journal of Emerging Technologies in Learning*, *15*(14), 19–34. https://doi.org/10.3991/ijet.v15i14.14015.

Vagg, T., Balta, J. Y., Bolger, A., & Lone, M. (2020). Multimedia in Education: What do the Students Think? *Health Professions Education*, *6*(3), 325–333. https://doi.org/doi.org/10.1016/j.hpe.2020.04.011.

Valverde-Berrocoso, J., Fernández-Sánchez, M. R., Dominguez, F. I. R., & Sosa-Díaz, M. J. (2021). The educational integration of digital technologies preCovid-19: Lessons for teacher education. *PLoS ONE*, *16*(8 August), 1–22. https://doi.org/10.1371/journal.pone.0256283.

Xia, K., Sacco, C., Kirkpatrick, M., Saidy, C., Nguyen, L., Kircaliali, A., & Harik, R. (2021). A digital twin to train deep reinforcement learning agent for smart manufacturing plants: Environment, interfaces and intelligence. *Journal of Manufacturing Systems*, *58*, 210–230. https://doi.org/10.1016/j.jmsy.2020.06.012.

Yurdakul, C. (2017). An Investigation of the Relationship between Autonomous Learning and Lifelong Learning. *International Journal of Educational Research Review*, *2*(1), 15–20. https://doi.org/10.24331/ijere.309968.