Available *online* at: http://journal.unj.ac.id

Jurnal Pensil | Pendidikan Teknik Sipil

Journal homepage: http://journal.unj.ac.id/unj/index.php/jpensil/index

IMPROVING THE CREATIVE SKILL OF VOCATONAL HIGH SCHOOL STUDENTS THROUGH FLIPBOOK WITH AUGMENTED REALITY IN SOCIETY 5.0

Hani Rahmiyanti[1], Sri Rahayu[2]*
[1,2] Pendidikan Teknik Bangunan, Fakultas Pendidikan Teknologi dan Industri, Universitas Pendidikan Indonesia
Jalan Dr. Setiabudhi, No 229, Bandung, Jawa Barat, Indonesia
[1]hanirahmiyanti24@upi.edu, [*2]srirahayu@upi.edu

P-ISSN: 2301-8437
E-ISSN: 2623-1085

ARTICLE HISTORY
Accepted:
23 Maret 2025
Revision:
13 Mei 2025
Published:
30 Mei 2025

ARTICLE DOI:
10.21009/jpensil.v14i2.54280

Jurnal Pensil : Pendidikan Teknik Sipil *is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License* (CC BY-SA 4.0).

Abstract

Society 5.0 has transformed education through digitalization and requires schools to develop students' creativity skills. Vocational schools play a major role in preparing students for change. The use of learning technology, especially virtual-based technology, is important to continue the developments. This study aims to measure the increase in students' creativity skills in vocational schools. The method used is a quasi-experiment to measure the increase in students' creative skills using control and experimental groups. The subjects in the quasi-experimental method were students in class X.3 and class X.4. The results of the study showed that the use of Flipbook learning media with Augmented Reality significantly improved the creative skills of vocational school students as seen from the increase in values in the Creative aspect in the experimental class showing a striking increase compared to the control class. In creative skills with a percentage of 91% for each experimental class, while the control class reached 70% each. These results indicate that the use of flipbooks with AR has succeeded in improving the creative skills of vocational high school students.

Keywords: Creative, Augmented Reality, Flipbook, Society 5.0, Vocational School

Introduction

Currently, the Society 5.0 era is marked by technological advances that have a wide influence, including in the education sector (Ihsan, 2023; Rijwani et al., 2024). The concept of Society 5.0 invites society to utilize technology to improve the quality of life (Roblek et al., 2020). Therefore, educational institutions, especially vocational schools(Fania et al., 2024; Rahayu et al., 2024), need to innovate in learning so that their graduates are ready to compete in the world of work (Al Hanif et al., 2024; Pambudi & Harjanto, 2020). 4C skills (Critical Thinking, Collaboration, Communication, and Creativity) are important in Society 5.0, where technology and these skills are combined to create competent graduates who are able to enhance the standard of living for society (Thornhill-Miller et al., 2023; Van Laar et al., 2020).

Creativity, one of the 4C skill, is crucial. Where this skill is very important in facing challenges in the Society 5.0 era because it is the key to creating innovations that are relevant to the development of the times (Fricticarani et al., 2023; Sappaile et al., 2024). Amidst the rapid advancement of technology and automation, creativity differentiates humans from machines (Miroshnichenko, 2018), enabling individuals to generate unique, effective and sustainable solutions in a variety of fields (Amankwah-Amoah et al., 2024; Andirasdini, 2024). In the world of work, companies increasingly prioritize individuals who are able to think creatively (Damayanti, 2024; Sueb & Sopiah, 2023). This is to develop business strategies, create new products, and improve operational efficiency (Hughes et al., 2018). In addition, creativity also plays a role in dealing with uncertainty and rapid change (Sari et al., 2023), where creative individuals are more flexible, adaptive, and able to find opportunities amidst challenges (Wilson et al., 2017). With creativity, graduates will not only become job seekers, but also innovators who can create jobs and have a positive impact on society (Aithal & Aithal, 2023). Therefore, these skills must be developed so that future generations are ready to face the complexities of the modern world with innovative and visionary solutions. Student creativity can develop with innovations in learning media, one of which is the integration of technology (Al Muwali et al., 2019).

The use of technology, especially in the world of education, namely learning media, has been widely used, such as PowerPoint (Budianti et al., 2023; Cerya et al., 2021), module (Evenddy et al., 2024) and so on, but not all have reached the optimal level (Indriani & Abidin, 2022; Kalyani, 2024). Therefore, there needs to be innovation in the form of virtual-based learning media (Ariwibowo et al., 2024; Leliavia, 2023), such as flipbooks with Augmented Reality (AR), which can optimize students' needs in honing other skills and technological developments in the Society 5.0 era.

Flipbook is an interactive media that allows for all types of learning interactivity such as listening, reading, writing, even video (Bunari et al., 2024), while AR is a technology that projects virtual objects into the real world (Dargan et al., 2023). Where, AR can have more benefits from the current technological development phenomenon and help students to be more adaptable (Al-Ansi et al., 2023). This study focuses on the use of flipbooks with AR as a learning medium in vocational schools, especially vocational schools, because in the society 5.0 era, students attending vocational schools have three employment options that call their creative abilities (Poláková et al., 2023; Rusman et al., 2023). This study's primary goals are to evaluate the viability of learning media and the degree of creativity possessed by students in vocational schools. The study's benefits include improving creative skills that can be created or learned through the usage of flipbook learning media with augmented reality and offering interactive learning materials in the form of flipbooks for use in vocational school learning activites.

Research Methods

This research was conducted at a Vocational scholl (SMK) in Bandung which has the status of a center of excellence school. The subjects of this study were grade X students of expertise in Construction and Housing Engineering (TKP) 2 and Building Modeling and Information Design

(DPIB) 3 and DPIB 4 with elements of technology and green building materials in the Basics of Expertise Program subjects as learning materials in flipbooks with AR that were developed.

In this study, the RnD (Research and Development) method is used along with the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development model, which is described in Figure 1. This model is used to develop and test the feasibility of learning media.

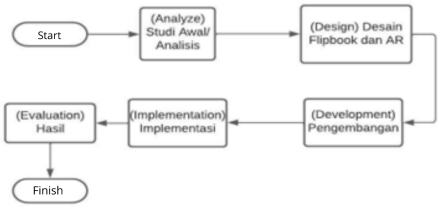

Figure 1. ADDIE Development Model

Furthermore, a quasi-experimental method (Non-equivalent Group Pretest Posttest Design) was used using a control group and an experimental group to measure the increase in creative skill in students with the scheme in Figure 2.

NR_1	O_1	X	O_2
NR_2	O_3		O_4

Figure 2. Model Non-equivalent Group Pretest Posttest Design

In the development of learning media, this stage begins with an initial study or needs analysis and identifying problems that include evaluation of the audience, materials, media, and technology. After that, the researcher carries out the Design or planning stage. At this stage, flowcharts and storyboards are made (Singh & Saha, 2021), which is then continued with the design of a learning media concept that is adjusted to the creativity aspect, before finally being developed through the application named VOFISIL.

The next stage is Development. At this development stage, researchers design teaching modules and learning media in the form of flipbooks equipped with Augmented Reality. The testing process at the development stage in this study consists of several stages, namely Alpha Testing, which includes validation tests by media experts, validation tests by material experts (Sulistyanto et al., 2022) and Beta Testing which involves product usage testing (Sulistyanto et al., 2022). The feasibility test was conducted by material experts, namely the subject teacher of the Basic Program at one of the vocational schools in Bandung and the UPI Architecture lecturer. In addition, the test also involved two media experts, namely lecturers from the Educational Technology Study Program and the UPI Multimedia Study Program. The validation of this media and material focuses on ensure whether the teaching media that has been developed is feasible to use or not (Sulistyanto et al., 2022). Table 1 used as a reference in determining conclusions from the results of the feasibility test. After the validation stage is complete, revisions are made to the teaching media until they meet the feasibility criteria for use (Sulistyanto et al., 2022).

Table 1. Eligibility Criteria for Expert Judgement Validation Results

Percentage	**Category**
81%-100%	Very Feasible
61%-80%	Feasible

Percentage	Category
41%-60%	Decent Enough
21%-40%	Less Feasible
0%-20%	Very Less Feasible

(Więckowski et al., 2023)

The research continued to the Implementation stage by implementing the Vofisil learning media. At this stage, Vofisil was tested on a limited sample, namely class X TKP 2 consisting of 30 students. The last stage in the ADDIE method is Evaluation, which aims to assess the effectiveness of the learning media that has been developed. The purpose of this evaluation stage is to find out feedback on the development of learning media with aspects of ease of use of the media, media appearance and whether or not the use of media in learning is good (Widarto et al., 2022). At this stage, a questionnaire was distributed to students to collect their responses after using Vofisil. The purpose of this stage is to measure the level of user assessment of the learning media in the form of flipbooks with AR technology that has been developed, with reference to Table 2.

Table 2. Validation Result Eligibility Criteria and Percentage of Response Results

Percentage	Category
80% - 100%	Very Good
60-79,9%	Undecided
40-39-59,9%	Decent Enough
20-39,9%	Not Good Enough
0-19,9%	Very Good

(Holtom et al., 2022)

Following the completion of learning media development, the research was continued with a quasi-experimental method used to measure the improvement of students' creative skills. This stage began with a trial of the test instrument in class X TKP 2 to enhance the questions quality, taking into account their level of difficulty, validity, reliability, and distinctiveness. The tested question instruments can then be used by researchers as instruments to measure students' critical thinking skill, measurements are made through pre-tests and post-tests. The pre-test was used to assess the initial skill of students in the control class (X DPIB 3) and the experimental class (X DPIB 4). After that, the experimental class was given treatment in the form of implementing flipbooks with AR technology. While the control class was not given special treatment in the form of Project-based learning (PjBL), it only used the expository learning method. After that, students were given a post-test in both the experimental and control classes to measure differences in the level of students' critical thinking skill. Furthermore, to measure creativity skills, researchers provided case studies by applying the Project Based Learning (PjBL) method and conducted observations using assessment rubrics in both classes.

Data collection techniques in this study include validation sheets and questionnaires for the ADDIE method, while for the quasi-experimental method, tests and observations are used. Validation sheets are used to assess the feasibility of learning media by material experts and media

experts before being applied in learning. The use of questionnaires focuses on determine user assessments of the developed learning media.

The test is used to determine critical thinking skills with indicators analyzing sustainable buildings, green buildings, and green materials obtained by students in the control and experimental classes. While observations are carried out with the aim of observing and knowing students' communication, collaboration, and creativity skills.

Communication skills with indicators of articulating thoughts and ideas, listening to learning and instructions, using communication with various purposes, utilizing flipbook media, and communicating effectively. Collaboration skills with indicators of effective cooperation, adaptation, mutual respect with the group and being responsible for each other's work. Creativity skills with indicators of developing, implementing, and communicating new ideas, being open and responsive to new perspectives, and demonstrating originality and creativity in discussions, drawing results, and presentations.

The data analysis method employs a descriptive quantitative methodology. To determine the level of application feasibility, a descriptive validation analysis and evaluation through a user assessment questionnaire were carried out. After the data from the validators and the user assessment questionnaire were obtained, the average value was calculated using the following Formula (1):

$$V = \frac{TSe}{TSh} \times 100\% \quad \text{.....} \quad (1)$$

Description:

V = Validation

TSe = Total empirical score (validation results from experts)

TSh = Total maximum expected score

This study was conducted in two classes, namely X DPIB 3 as the control class and X DPIB 4 as the experimental class, by applying the quasi-experimental method. The research steps began with a test used to measure Critical Thinking skills carried out in class X DPIB 3 as the control class and class X DPIB 4 as the experimental class. To process the results of creativity skill data, researchers referred to the assessment rubric according to (Wang & Long, 2024).

Research Results and Discussion

The needs analysis's findings indicate that pupils are already utilizing smartphones, while teachers still rely on PowerPoint in learning. Although Wi-Fi access is available, learning methods are still limited to lectures and the use of whiteboards or PowerPoint. To overcome this limitation, interactive learning was developed through flipbooks with Augmented Reality. In designing the Vofisil application, researchers used Unity software with Vuforia to develop AR features. This application is designed to be used on Android devices version 7 that support AR features. Vofisil consists of two main menus, namely Flipbook and Augmented Reality. In addition, there are additional menus such as Information, Credit, and Exit, as shown in Figure 3. In the Flipbook menu, the proccess of teaching and learning involves the utilization of resources and instructional materials. The material is equipped with audio and video to help students understand the learning content more easily. Meanwhile, the Augmented Reality menu presents 3D images that can be projected using a smartphone camera.

Figure 3. Display of Vofisil

After the teaching media was completed, the research continued to the development stage. Technological developments require students to be able to utilize media digitalization optimally and independently in the learning process (Andriushchenko et al., 2021). Learning process based on the results of expert judgment shown in Figure 4, the average overall aspect of the expert validation results reached 80.8%. The highest percentage was obtained from the aspect of the suitability of the independent concept, with a value of 90%. The difference in scores on the "material" and "learning" aspects compared to other aspects is due to the different focus and emphasis of each expert on the substance of the content. One expert considered that the material presented could still be improved in terms of depth and suitability with vocational learning outcomes, thus giving a lower score (60 for "material" and 75 for "learning"). Meanwhile, another expert assessed that the structure of the delivery and completeness of the information were adequate, thus giving a higher score. This difference reflects the perspective and experience of each validator on the quality of learning material delivery, but in general it still shows that the learning media is in the appropriate category for use.

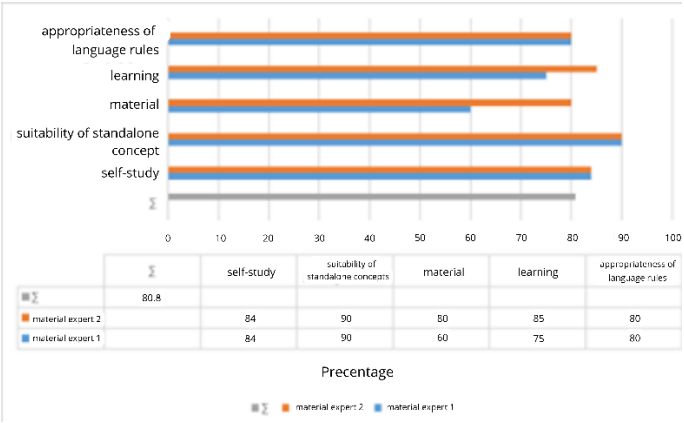

Figure 4. Results of Material Expert Judgement

The average percentage of the media validation assessment results reached 80.5%, as shown in Figure 5. The aspect with the highest percentage in media feasibility is the display, with a value of 81%. The display in the media has an important role because it can improve students' understanding and help strengthen their memory of the learning material (Haryana et al., 2022). Thus, based on the validation results from material and media experts, Vofisil is deemed apropriate for use after a number of modifications.

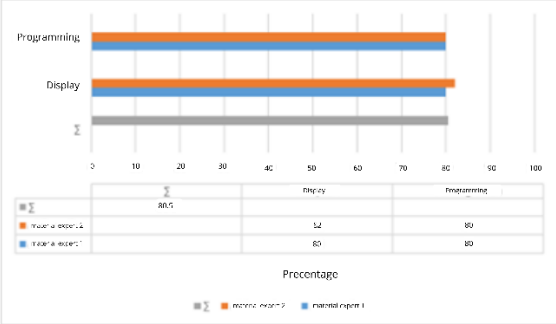

Figure 5. Result of Media Expert Judgement

After expert judgment, the Vofisil application was tested to obtain feedback on the use of learning media, a questionnaire was distributed to class X TKP 2 students at SMKN 5 Bandung. Respondents' responses are important for media development, as the main element in the application development process, this role also contributes to encouraging the progress of innovative and more interactive learning media (Pasaribu et al., 2024). The results of the questionnaire measuring user assessment of the developed learning media can be found in Figure 6, which presents data on student responses to the effectiveness and feasibility of the media.

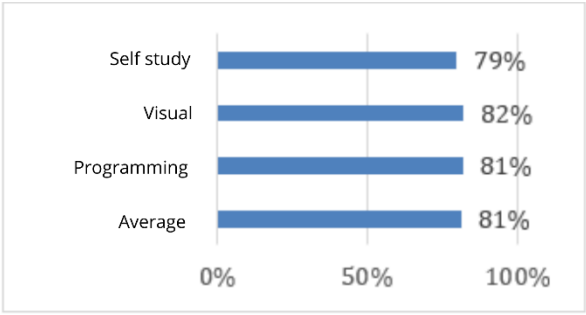

Figure 6. Respondent Questionnaire Results

Figure 6 shows that the average value obtained from all aspects is 81% with the average details per aspect, namely in independent learning of 79%, visual aspects of 82%, and programming aspects of 81%. In the results of this study, therefore it can be said that using flipbooks as learning resouces falls under the area of appropriate use. The assessment involving a number of statements shows that most aspects of the flipbook media are assessed by users (Sulistriyaniva et al., 2024).

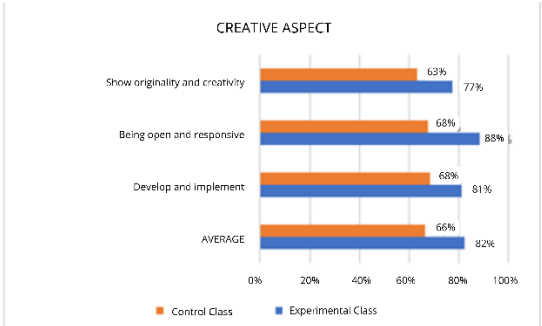

Figure 7. Results of creative skill

From the results shown in Figure 7, it is known that the level of student creativity in the control class reached 66% with a sufficient category, while the experimental class had a higher percentage, namely 82% with a good category. This difference shows that the learning method applied in the experimental class has a positive impact on increasing student creativity. Creativity

is a crucial skill in the modern era because it plays a role in helping students face ever-growing challenges (George et al., 2024).

In addition, creativity is closely related to critical thinking and problem-solving skills, which are crucial elements in the workplace. The procces of learning that encourages the exploration of ideas and the application of more flexible concepts can increase students' creativity. In this case, an interactive learning environment supported by appropriate learning media plays a role in honing students' skill in finding innovative solutions. Thus, the use of more varied learning methods has an influence on the development of student creativity in vocational schools.

Conclusion

The use of Flipbook learning media based on Augmented Reality (AR) through the Vofisil application has proven effective in improving students' creativity skills in vocational schools. Considering the study's findings, the Flipbook with AR experimental class significantly outperfomed the control group, with a percentage reaching 82% (good category) compared to 66% in the control class (sufficient category). These results indicate that the integration of interactive technology in learning can create a more interesting and effective learning environment in developing 21st century skills, so that Flipbook AR can be an innovative solution to support the digitalization of education in vocational schools, especially in improving student creativity.

References

Aithal, P. S., & Aithal, S. (2023). Super innovation in higher education by nurturing business leaders through incubationship. *International Journal of Applied Engineering and Management Letters (IJAEML)*, *7*(3), 142–167.

Al-Ansi, A. M., Jaboob, M., Garad, A., & Al-Ansi, A. (2023). Analyzing augmented reality (AR) and virtual reality (VR) recent development in education. *Social Sciences & Humanities Open*, *8*(1), 100532.

Al Hanif, M., Mahmudah, F. N., & Biddinika, M. K. (2024). Learning and Innovating Skills in Vocational High Schools: Systematic Literature Review. *TGO Journal of Education, Science and Technology*, *2*(1), 59–75.

Al Muwali, A., Zaki, Y., & Mahdi, N. (2019). The Effectiveness of Social Media and Multimedia-Based Pedagogy in Enhancing Creativity among Art, Design, and Digital Media Students. *International Journal of Emerging Technologies in Learning*, *14*(21).

Amankwah-Amoah, J., Abdalla, S., Mogaji, E., Elbanna, A., & Dwivedi, Y. K. (2024). The impending disruption of creative industries by generative AI: Opportunities, challenges, and research agenda. In *International Journal of Information Management* (Vol. 79, p. 102759). Elsevier.

Andirasdini, I. F. (2024). Pengaruh Model Pembelajaran Problem Baseed Learning Terhadap Keterampilan Berpikir Kreatif Peserta Didik Pada Pembelajaran Biologi: Literature Review:(The Influence of the Problem Baseed Learning Model on the Creative Thinking Skills of Students in Biolog. *BIODIK*, *10*(2), 156–161.

Andriushchenko, K., Khaletska, A., Ushenko, N., Zholnerchyk, H., Ivanets, I., Petrychuk, S., & Uliganets, S. (2021). Education process digitalization and its impact on human capital of an enterprise. *Journal of Management Information and Decision Sciences*, *24*(5), 1–9.

Ariwibowo, B., Bahtiar, F. Z., Atika, A., & Consuelo, J.-B. L. (2024). Development of a virtual reality-based learning model for automotive competence. *Jurnal Taman Vokasi*, *12*(2), 189–200.

Budianti, Y., Rikmasari, R., & Oktaviani, D. A. (2023). Penggunaan media PowerPoint interaktif

untuk meningkatkan hasil belajar siswa sekolah dasar. *Jurnal Inovasi Pendidikan Dan Pembelajaran Sekolah Dasar*, *7*(1), 127.

Bunari, B., Setiawan, J., Ma'arif, M. A., Purnamasari, R., Hadisaputra, H., & Sudirman, S. (2024). The Influence of Flipbook Learning Media, Learning Interest, and Learning Motivation on Learning Outcomes. *Journal of Education and Learning (EduLearn)*, *18*(2), 313–321.

Cerya, E., Wahid, R. N., Maulidina, Y., & Hildayati, A. (2021). The use of digital economy learning media in the VUCA Era: A literature review. *Seventh Padang International Conference On Economics Education, Economics, Business and Management, Accounting and Entrepreneurship (PICEEBA 2021)*, 290–295.

Damayanti, B. F. (2024). Job Crafting di Era Perkembangan Teknologi yang Pesat: A Systematic Literature Review. *Industrial and Organizational Psychology*, 1–10.

Dargan, S., Bansal, S., Kumar, M., Mittal, A., & Kumar, K. (2023). Augmented reality: A comprehensive review. *Archives of Computational Methods in Engineering*, *30*(2), 1057–1080.

Evenddy, S. S., Gailea, N., & Syafrizal, S. (2024). Implementation of E-Module in Indonesia EFL Higher Education: A Literature Review. *IJORER: International Journal of Recent Educational Research*, *5*(5), 1174–1185.

Fania, M., Iriani, T., & Arthur, R. (2024). Improving vocational student competencies through industrial class-based experiantial learning. *Jurnal PenSil*, *13*(1), 120–129.

Fricticarani, A., Hayati, A., Ramdani, R., Hoirunisa, I., & Rosdalina, G. M. (2023). Strategi pendidikan untuk sukses di era teknologi 5.0. *Jurnal Inovasi Pendidikan Dan Teknologi Informasi (JIPTI)*, *4*(1), 56–68.

George, A. S., Baskar, T., & Srikaanth, P. B. (2024). The erosion of cognitive skills in the technological age: How reliance on technology impacts critical thinking, problem-solving, and creativity. *Partners Universal Innovative Research Publication*, *2*(3), 147–163.

Haryana, M. R. A., Warsono, S., Achjari, D., & Nahartyo, E. (2022). Virtual reality learning media with innovative learning materials to enhance individual learning outcomes based on cognitive load theory. *The International Journal of Management Education*, *20*(3), 100657.

Holtom, B., Baruch, Y., Aguinis, H., & A Ballinger, G. (2022). Survey response rates: Trends and a validity assessment framework. *Human Relations*, *75*(8), 1560–1584.

Hughes, D. J., Lee, A., Tian, A. W., Newman, A., & Legood, A. (2018). Leadership, creativity, and innovation: A critical review and practical recommendations. *The Leadership Quarterly*, *29*(5), 549–569.

Ihsan, I. (2023). The challenges of elementary education in society 5.0 era. *International Journal of Social Learning (IJSL)*, *3*(3), 341–360.

Indriani, R., & Abidin, Z. (2022). Literature review: Pengembangan media pembelajaran augmented reality pada mata pelajaran biologi. *Jurnal Wahana Pendidikan*, *9*(2), 139–148.

Kalyani, L. K. (2024). The role of technology in education: Enhancing learning outcomes and 21st century skills. *International Journal of Scientific Research in Modern Science and Technology*, *3*(4), 5–10.

Leliavia, L. (2023). Literature review: Media pembelajaran augmented reality (AR) sebagai inovasi di era revolusi industri 4.0. *Khatulistiwa Profesional: Jurnal Pengembangan Sdm Dan Kebijakan Publik*, *4*(1), 1–12.

Miroshnichenko, A. (2018). AI to bypass creativity. Will robots replace journalists?(The answer is "yes"). *Information*, *9*(7), 183.

Pambudi, N. A., & Harjanto, B. (2020). Vocational education in Indonesia: History, development, opportunities, and challenges. *Children and Youth Services Review*, *115*, 105092.

Pasaribu, F. M. Z., Kurniawan, M. S. K., & Widyanti, N. K. W. (2024). Pengembangan Instrumen Kevalidan Media Digital dalam Pembelajaran. *Journal of Education: Research and Conceptual (JERC)*, *1*(1), 1–7.

Poláková, M., Suleimanová, J. H., Madzík, P., Copuš, L., Molnárová, I., & Polednová, J. (2023). Soft skills and their importance in the labour market under the conditions of Industry 5.0. *Heliyon*, *9*(8).

Rahayu, S., Meirawan, D., Muktiarni, M., Ghinaya, Z., & Sabitri, Z. (2024). Analyzing transferable skills of vocational students to align with industry demands. *Jurnal Pensil*, *13*(1), 34–46.

Rijwani, T., Kumari, S., Srinivas, R., Abhishek, K., Iyer, G., Vara, H., Dubey, S., Revathi, V., & Gupta, M. (2024). Industry 5.0: A review of emerging trends and transformative technologies in the next industrial revolution. *International Journal on Interactive Design and Manufacturing (IJIDeM)*, 1–13.

Roblek, V., Meško, M., Bach, M. P., Thorpe, O., & Šprajc, P. (2020). The interaction between internet, sustainable development, and emergence of society 5.0. *Data*, *5*(3), 80.

Rusman, A., Mas'udi, M. M., Hermoyo, R. P., Yarno, Y., Yunianti, S., & Rafsanjani, H. (2023). Education transformation in 5.0 society development era. *AIP Conference Proceedings*, *2727*(1).

Sappaile, B. I., Wiliyanti, V., Mustajab, W., Prayitno, H., & Panglipur, I. R. (2024). Building the Future of Education with Curriculum Innovation Freedom to Learn in the Era of Society 5.0. *International Journal of Educational Research Excellence (IJERE)*, *3*(1), 359–366.

Sari, H. N., Rahmania, N., & Anshori, M. I. (2023). Pengembangan Karir Dalam Era Ambiguitas. *Jurnal Bintang Manajemen*, *1*(4), 25–46.

Schmidt, J. T., & Tang, M. (2020). Digitalization in education: challenges, trends and transformative potential. *Führen Und Managen in Der Digitalen Transformation: Trends, Best Practices Und Herausforderungen*, 287–312.

Singh, Y. S., & Saha, B. (2021). Implementation of Digital Techniques Process Through the Storyboard for Better Understanding in Visual Narratives. *International Conference on Research into Design*, 753–763.

Sueb, S., & Sopiah, S. (2023). Exploring the relationship between transformational leadership and innovative work behavior: A systematic literature review. *Jurnal Visi Manajemen*, *9*(2), 62–83.

Sulistriyaniva, R., Gunansyah, G., & Nasution, N. (2024). Media Komik Digital dalam Pembelajaran IPS di Sekolah Dasar: Literature Review. *Jurnal Educatio FKIP UNMA*, *10*(4).

Sulistyanto, H., Anif, S., Narimo, S., Sutopo, A., Haq, M. I., & Nasir, G. A. (2022). Education application testing perspective to empower students' higher order thinking skills related to the concept of adaptive learning media. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, 257–271.

Thornhill-Miller, B., Camarda, A., Mercier, M., Burkhardt, J.-M., Morisseau, T., Bourgeois-Bougrine, S., Vinchon, F., El Hayek, S., Augereau-Landais, M., & Mourey, F. (2023). Creativity, critical thinking, communication, and collaboration: assessment, certification, and promotion of 21st century skills for the future of work and education. *Journal of Intelligence*, *11*(3), 54.

Van Laar, E., Van Deursen, A. J. A. M., Van Dijk, J. A. G. M., & De Haan, J. (2020). Determinants of 21st-century skills and 21st-century digital skills for workers: A systematic literature

review. *Sage Open*, *10*(1), 2158244019900176.

Wang, J., & Long, H. (2024). Reexamining subjective creativity assessments in science tasks: An application of the rater-mediated assessment framework and many-facet Rasch model. *Psychology of Aesthetics, Creativity, and the Arts*, *18*(4), 536.

Więckowski, J., Kizielewicz, B., Shekhovtsov, A., & Sałabun, W. (2023). RANCOM: A novel approach to identifying criteria relevance based on inaccuracy expert judgments. *Engineering Applications of Artificial Intelligence*, *122*, 106114.

Wilson, C., Lennox, P., Brown, M., & Hughes, G. (2017). *How to develop creative capacity for the fourth industrial revolution: creativity and employability in higher education*.