International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 46 No. 2 September 2024, pp. 411-420

Improving Learning Activities Through Interactive Digital Book Applications in Project-Based Learning

Diana Susanti[1*], Vivi Fitriani[1], Liza Yulia Sari[1], Aulia Afza[1]

Universitas PGRI Sumatera Barat, Jalan Gunung Pangilun, Padang, West Sumatera, Indonesia[1]

*Corresponding Authors: Diana Susanti1;dianasusantimpd@yahoo.co.id

https://orcid.org/0000-0003-2925-9422

Abstract – 21st-century learning is usually accompanied by projects that can foster students' creativity in building their knowledge. Interactive digital books with projects are not used in the courseThis research focuses on student activities using project-based interactive digital books while studying. This research is experimental, samples were taken from a total sampling of 32 students who were attending lectures. The instruments used are activity questionnaires in five observation activities, namely studying basic questions, discussing with lecturers, discussing with friends, discussing project activities to be carried out, and presenting product results. Data was obtained quantitatively and processed using SPSS. The results obtained show that the use of project-based interactive electronic books makes student learning active because projects can improve students' skills.

***Keywords* – Interactive Digital Book, Project-Based Learning, Biology Learning Strategy.**

I. INTRODUCTION

Many learning innovations are present thanks to technological developments, one of which is the use of digital books in learning. Digital books are books published in digital form. Digital books are digitally, operated on a computer with an ebook reader [1]. Figure, text, and sound components are contained in e-books and can be read on other electronic devices [2]. Digital books made digital rarely exist in print form [3].

Digital books are widely applied in higher education, as well as in strategy and learning design courses. There are many recent innovations regarding interactive digital books. One of the results is that this interactive digital book has been tested for its validity and practicality. In the interactive digital book developed there is a controller that can be operated by the user, so that the user is free to choose the next process [4]. Digital book organizers include an introduction, materials, conclusion, and evaluation [5].

Interactive digital book that has been designed has not been applied to learning. Lecturers use learning resources from the internet and printed books in lectures. Lecturers also take advantage of various learning videos sourced from experts and obtained through YouTube. Video learning has increased student interest, knowledge, and attitudes [6]. Besides that, educational videos can make an important contribution to motivation and learning [7]. Video material can be used to identify additional related information with the theme appearing in the video [8]. Educational videos affect the learning process as a useful source of education and motivate students [9].

Even in the lecture process, lecturers have not implemented project-based learning. Lecturers have used various learning models. Recommendations for improving students' academic and metacognitive classroom effectiveness must be implemented [10]. With this learning model, students will actively discover concepts and explore, so they can construct their knowledge through direct activities [11]. In the learning model, some activities are carried out in an orderly manner and each activity has an impact on

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 46 No. 2 September 2024, pp. 411-420

students' learning abilities [12]. Learning models often use a discussion step, starting with students presenting their ideas on how to solve a given problem and finding the simplest method to solve it based on the discussion [13].

The lectures are carried out by providing students with workbooks and assignments. Student activities are only monitored from the results of the collected assignments and it is not seen how the task process is carried out as in project-based learning. Student activity in learning can be helped by the use of projects in learning [14]. Students look responsible and actively play a role because they present products in project learning so that it is easy to understand the learning [15]. Project Based Learning makes the learning experience more effective [16]. PjBL focuses on the characteristics of individuals who work with groups useful for improving all aspects of learning [17]. Project-learning is best done in groups [18].

Student learning outcomes increased in the skill and cognitive categories because so far the lecture methods, learning models and use of media have not been able to achieve good results. It is necessary to implement interactive digital books using projects in this course. Because the results of previous research have been tested for validity and practicality. So it needs further application in this lecture. Learning with projects stimulates students in solving problems and creating goods as a result of the difficulties they face [19]. The resulting products have gone through various project stages. With project learning, students can discover, manage, and produce knowledge and products and present them in class [20].

The research objective is to review student activities in learning assisted by interactive electronic books with projects.

II. RESEARCH METHODS

Types of research

This activity was conducted using an experimental method at PGRI University, West Sumatra. The technique used was applying interactive digital books in four face-to-face lectures. At the first meeting, the annual program material digital book was implemented. The second meeting of the semester program material, the third meeting of the syllabus material and the fourth material of the learning program plan.

Research procedure

Research activities were carried out in 4 meetings using a project-based digital book, with the following stages.

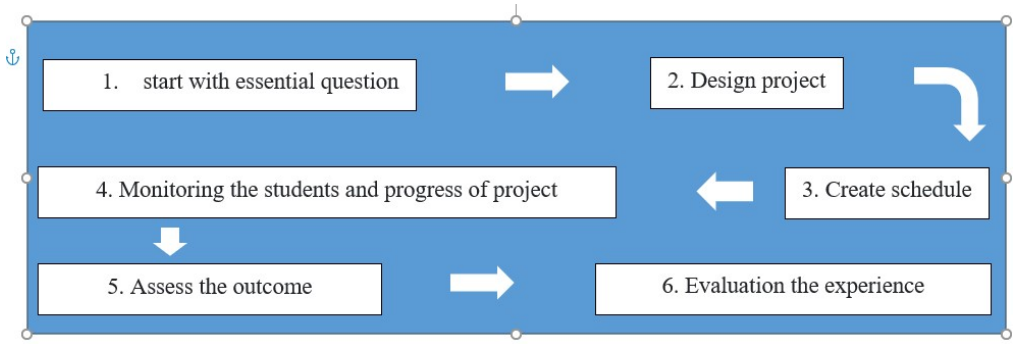

Figure 1. Project based learning activities

Instruments and Data Analysis

During the learning process using project-based interactive digital books, student activities were observed using a questionnaire. Aspects observed are studying basic questions, discussing with lecturers, discussing with friends, discussing project activities to be carried out, and presenting product results. In the first activity, observations were made of lecture activities. In observing this, observers filled out questionnaires according to the existing assessments. The assessments were carried out per student in one group. If the student does not carry out the aspects observed by the observer, he gets a value of 0. The results of the assessment are analyzed using a formula supported by SPSS and the criteria for student activity level pelase check this table [21].

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 46 No. 2 September 2024, pp. 411-420

Table 1. Standards for Student Learning Outcomes

Criteria	Range Persentase
Very good	80-100
Good	66-79
Fair	56-65
Poor	40-55
Very Poor	0-39

III. RESULTS AND DISCUSSION

Detailed data on student activity results in the first learning activity are shown in the table.

Table 2. First Meeting Student Activity Analysis

Indicator	Criteria		Frequency	Percent	Valid Percent	Cumulative Percent
Studying basic questions,	Very good	0	3	9.4	9.4	9.4
		1	29	90.6	90.6	100.0
		Total	32	100.0	100.0	
Discussing with lecturers,	Very good	0	3	9.4	9.4	9.4
		1	29	90.6	90.6	100.0
		Total	32	100.0	100.0	
Discussing with friends,	Very good	0	3	9.4	9.4	9.4
		1	29	90.6	90.6	100.0
		Total	32	100.0	100.0	
Discussing project activities to be carried out,	Very good	0	3	9.4	9.4	9.4
		1	29	90.6	90.6	100.0
		Total	32	100.0	100.0	
Presenting product results	Very good	0	3	9.4	9.4	9.4
		1	29	90.6	90.6	100.0
		Total	32	100.0	100.0	

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 46 No. 2 September 2024, pp. 411-420

Based on the table above, it can be seen that at the first meeting, only 29 students attended the lectures from 32 students. From these data, the use of interactive digital books is declared valid in the range of 90.6% with a very good category. Of the five indicators, all students who attended had carried out activities that became activities in the application of interactive digital books.

Details of the two activities are listed in the table.

Table 3. Second Meeting Student Activity Analysis

Indikcator	Citeria		Frequency	Percent	Valid Percent	Cumulative Percent
Studying basic questions,	Very good	0	1	3.1	3.1	3.1
		1	31	96.9	96.9	100.0
		Total	32	100.0	100.0	
Discussing with lecturers,	Very good	0	1	3.1	3.1	3.1
		1	31	96.9	96.9	100.0
		Total	32	100.0	100.0	
Discussing with friends,	Very good	0	1	3.1	3.1	3.1
		1	31	96.9	96.9	100.0
		Total	32	100.0	100.0	
Discussing project activities to be carried out,	Very good	0	1	3.1	3.1	3.1
		1	31	96.9	96.9	100.0
		Total	32	100.0	100.0	
Presenting product results	Very good	0	1	3.1	3.1	3.1
		1	31	96.9	96.9	100.0
		Total	32	100.0	100.0	

The results above show that of the 32 students who took part in the activities carried out, 31 people seemed to be actively participating in the activities and the results obtained from the five activities that had been observed, that 96.9% of students had carried out activities in the very good category. Details of the third activity are presented in the table.

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 46 No. 2 September 2024, pp. 411-420

Table 4. Third Meeting Student Activity Analysis

Indicator	Criteria		Frequency	Percent	Valid Percent	Cumulative Percent
Studying basic questions,	Very good	0	3	9.4	9.4	9.4
		1	29	90.6	90.6	100.0
		Total	32	100.0	100.0	
Discussing with lecturers,	Very good	0	3	9.4	9.4	9.4
		1	29	90.6	90.6	100.0
		Total	32	100.0	100.0	
Discussing with friends,	Very good	0	3	9.4	9.4	9.4
		1	29	90.6	90.6	100.0
		Total	32	100.0	100.0	
Discussing project activities to be carried out,	Very good	0	3	9.4	9.4	9.4
		1	29	90.6	90.6	100.0
		Total	32	100.0	100.0	
Presenting product results	Very good	0	3	9.4	9.4	9.4
		1	29	90.6	90.6	100.0
		Total	32	100.0	100.0	

At the third meeting, 29 people were seen doing activities with a percentage of 90.6% and the category was very good. The activity you can see table 5.

Table 5. Fourth Meeting Student Activity Analysis

Indicator	Criteria		Frequency	Percent	Valid Percent	Cumulative Percent
Studying basic questions,	Very good	0	0	0	0	0
		1	32	100	100	100.0
		Total	32	100.0	100.0	
Discussing with lecturers,	Very good	0	0	0	0	0

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 46 No. 2 September 2024, pp. 411-420

		1	32	100	100	100.0
		Total	32	100.0	100.0	
Discussing with friends,	Very good	0	0	0	0	0
		1	32	100	100	100.0
		Total	32	100.0	100.0	
Discussing project activities to be carried out,	Very good	0	0	0	0	0
		1	32	100	100	100.0
		Total	32	100.0	100.0	
Presenting product results	Very good	0	0	0	0	0
		1	32	100	100	100.0
		Total	32	100.0	100.0	

The results of the activity analysis for the fourth meeting showed that all students took part in activities in lectures. Seen from the five aspects observed have been implemented as much as 100% with very good criteria.

Learning the basic questions in the project-based learning step can stimulate students to understand the initial learning material. The results of the study show that students have shown very good activities in learning basic questions. Judging from the percentage of each meeting one to four, namely 90.6%, 96.9%. 90.6% and 100%. the value at the third meeting decreased due to students who did not attend lectures. The activity of studying the basic questions in project-based learning is the first step in understanding the material. This shows that project-based learning can be a bridge between individual learning and advanced learning [22]. Another study stated that students' speaking skills improved in the implementation using project-based learning [23]. The application of project-based learning made students able to develop stimuli and students become enthusiastic about projects and also build their creativity and improve thinking skills [24]. Students who have critical thinking skills can investigate problems to test ideas and generate relevant hypotheses [25]. Project-based learning can improve student achievement [26].

Discussions with lecturers showed very good results with the results of the analysis from the first meeting to the fourth meeting, namely: 90.6%., 96.9%., 90.6%., and 100%. Interactive digital books based on project-based learning, and project-based learning can make students help each other with their assignments [27]. The use of software in learning is a project-based learning idea that helps teachers and students [28]. In addition, because the tools developed are project-based, they can increase learning activities and improve reading habits, which opens up opportunities to produce more meaningful findings in discussions [29]. Technology development for learning can solve problems through project-based learning [30].

Discussing with friends after being analyzed from the first meeting to the fourth meeting got a score of 90.6%., 96.9%., 90.6% and 100%. This indicates that this assessment received very good response regarding the use of project-based interactive digital books. e-books can grow the effectiveness of teaching materials with learning activities, e-books can increase high academic results [31]. The use of e-books, trains children to learn independently and is useful for group discussions that can improve student understanding [32]. The use of e-books in the learning process increases student motivation and improves student learning outcomes [33]. Ebooks can outperform students' competitiveness in reading compared to reading ordinary books [34]. The use of ebooks creates student-centered activities and embodies participation among students, the interaction between students, and a safe learning environment [35].

Discussing project activities carried out by students during four meetings got the same value as the previous activity, namely 90.6%., 96.9%. 90.6% and 100%, this can be due to discussion activities in the use of project-based interactive digital books to increase discussion and creativity activities in building student knowledge. The project-based learning approach improves students' problem-solving abilities creatively, especially in identifying problems, then finding solutions and evaluating them [36]. Project-based learning is favored by many students because project-based learning can show students' weaknesses and be able to measure their success [37]. The results of the discussion using project-based learning show that students are creative in solving problems, in terms of identifying and finding solutions and evaluating [38]. On the other hand, project-based learning increases understanding of supporting concepts and fosters creative experiences in building knowledge and learning experiences [39]. Besides, it can increase students' creativity in the implementation of project-based learning [40].

Presenting product results received a very good rating for each meeting with an average of 90.6% per meeting, 96.9%. 90.6% and 100% in using project-based interactive digital books. The use of interactive digital books is able to increase students' abilities in terms of elaborating learning materials [41]. In addition, project learning improves the quality of learning and develops the abilities of students [42]. Project-based learning is able to make students learn more meaningful because it has an impact on creativity [43]. Project learning is necessary in developing 21st century students' creativity, critical thinking, research, and problem-solving skills [44].

IV. CONCLUSION

The implementation of interactive e-books in five meetings was able to increase student activity in four aspects, namely studying basic questions, discussing with lecturers, discussing with friends, discussing project activities to be implemented, and presenting product results. Therefore, in the future project-based learning can be implemented in learning because it can increase student activity in learning both individually and in groups.

REFERENCES

[1] L. M. & R. P. H. Wayne, "History of the Ebook: The Changing Face of Books," *Technical Services Quarterly*, vol. 29, no. 4, pp. 292–311, 2012.

[2] S. H. Norshuhada Shiratuddin, Monica Landoni, Forbes Gibb, "Education, E-book technology and its potential applications in distance," *Journal of Digital Information*, vol. 3, no. 4, pp. 89–90.

[3] S. Mawarni and A. Muhtadi, "DEVELOPING INTERACTIVE DIGITAL BOOK FOR 'THE DEVELOPMENT OF INTERACTIVE MULTIMEDIA LEARNING COURSE' FOR EDUCATIONAL TECHNOLOGY STUDENTS," *Jurnal Inovasi Teknologi Pendidikan*, vol. 4, no. 1, pp. 84–96, 2017.

[4] M. I. Fathoni and E. Marpanaji, "DEVELOPING INTERACTIVE E-BOOK ON INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) LESSON FOR GRADE OF VOCATIONAL HIGH SCHOOL," *Jurnal Inovasi Teknologi Pendidikan*, vol. 5, no. 1, pp. 70–81, 2018, doi: 10.21831/jitp.v5i1.17149.

[5] D. Mentari and A. Ruyani, "Pengembangan media pembelajaran e-book berdasarkan hasil riset elektroforesis 2-d untuk mengukur kemampuan berpikir kreatif mahasiswa," vol. 2, no. 2, pp. 131–134, 2018.

[6] N. Setiyawati, N. Meilani, and N. Khafidhoh, "Effectiveness of video education on intention for cervical cancer screening," *Journal of Education and Learning (EduLearn)*, vol. 16, no. 2, pp. 284–290, May 2022, doi: 10.11591/edulearn.v16i2.20420.

[7] S. YILDIRIM, "The Effect of Educational Videos Used in History Education on Academic Success," *J Educ Elearn Res*, vol. 5, no. 3, pp. 193–207, 2018, doi: 10.20448/journal.509.2018.53.193.207.

[8] M. Onita, S. Petan, and R. Vasiu, "Review of Interactive Video–Romanian Project Proposal," *International Education Studies*, vol. 9, no. 3, p. 24, Feb. 2016, doi: 10.5539/ies.v9n3p24.

[9] İ. H. ÖZDEMİR, F. SARSAR, and Ö. ANDİÇ-ÇAKIR, "The Effects of Educational Videos on Views and Attitudes of Engineering Undergraduate Students," *OPEN JOURNAL FOR EDUCATIONAL RESEARCH*, vol. 5, no. 2, pp. 289–302, Dec. 2021, doi: 10.32591/coas.ojer.0502.12289o.

[10] A. Usman, H. Susilo, H. Suwono, and A. D. Corebima, "The contributions of metacognitive skills towards the retention of different academic ability students for the implementation of several learning models," *International Journal of Education and Practice*, vol. 9, no. 3, pp. 550–567, 2021, doi: 10.18488/journal.61.2021.93.550.567.

[11] M. M. Chusni, S. Saputro, S. Surant, and S. B. Rahardjo, "Enhancing Critical Thinking Skills of Junior High School Students through Discovery-Based Multiple Representations Learning Model," *International Journal of Instruction*, vol. 15, no. 1, pp. 927–945, Jan. 2022, doi: 10.29333/iji.2022.15153a.

[12] I. N. Suastika, I. K. Suartama, D. B. Sanjaya, and K. S. Arta, "Application of multicultural-based learning model syntax of social studies learning," *Cypriot Journal of Educational Sciences*, vol. 16, no. 4, pp. 1660–1679, Aug. 2021, doi: 10.18844/cjes.v16i4.6030.

[13] S. Sunismi and Y. E. Setiawan, "The effectiveness of IDEA learning model in mathematics concept understanding," *Journal of Education and Learning (EduLearn)*, vol. 16, no. 1, pp. 43–50, Feb. 2022, doi: 10.11591/edulearn.v16i1.20317.

[14] M.-H. Shin, "Effects of Project-based Learning on Students' Motivation and Self-efficacy," *English Teaching*, vol. 73, no. 1, pp. 95–114, Mar. 2018, doi: 10.15858/engtea.73.1.201803.95.

[15] A. M. Abuhmaid, "The efficiency of online learning environment for implementing project-based learning: Students' perceptions," *International Journal of Higher Education*, vol. 9, no. 5, pp. 76–83, 2020, doi: 10.5430/ijhe.v9n5p76.

[16] J. Alberto, F. Fregni, and J. A. Arantes Do Amaral, "Applying Neuroscience Concepts to Enhance Learning in an Online Project-Based Learning Centered Course", doi: 10.5278/ojs.jpblhe.v9i2.5892.

[17] L. O. A. Jazuli, E. Solihatin, and Z. Syahrial, "The Effects of Brain-Based Learning and Project-Based Learning Strategies on Student Group Mathematics Learning Outcomes Student Visual Learning Styles," *Pedagogical Research*, vol. 4, no. 4, Oct. 2019, doi: 10.29333/pr/5949.

[18] Rusmini, Suyono, and R. Agustini, "Analysis of science process skills of chemical education students through self-project based learning (sjbl) in the covid-19 pandemic era," *J Technol Sci Educ*, vol. 11, no. 2, pp. 371–387, 2021, doi: 10.3926/jotse.1288.

[19] F. K. Aisyi, S. Elvyanti, T. Gunawan, and E. Mulyana, "Pengembangan Bahan Ajar Tik Smp Mengacu Pada Pembelajaran Berbasis Proyek," *Innovation of Vocational Technology Education*, vol. 9, no. 2, pp. 117–128, 2017, doi: 10.17509/invotec.v9i2.4861.

[20] A. Baidowi, S. Sumarmi, and A. Amirudin, "Pengaruh Model Pembelajaran Berbasis Proyek terhadap Kemampuan Menulis Karya Ilmiah Geografi Siswa SMA," *Jurnal Pendidikan Geografi*, vol. 20, no. 1, pp. 48–58, 2015, doi: 10.17977/um017v20i12015p048.

[21] B. Budiamai, K. Komarudin, N. Nuruddin, and C. Kustandi, "Learning Design on Social Studies Through Digital Book in Senior High School," *International Journal of Interactive Mobile Technologies*, vol. 15, no. 9, pp. 154–166, 2021, doi: 10.3991/ijim.v15i09.18435.

[22] D. J. L. Jodie Birdman, Arnim Wiek, "Developing key competencies in sustainability through project-based learning in graduate sustainability programs," *Education, International Journal of Sustainability in Higher*, vol. 23, no. 5, pp. 1139–1157, 2021, doi: 10.1108/IJSHE-12-2020-0506.

[23] L. Sirisrimangkorn, "Improving EFL Undergraduate Learners' Speaking Skills Through Project-Based Learning Using Presentation," *Advances in Language and Literary Studies*, vol. 12, no. 3, p. 65, 2021, doi: 10.7575/aiac.alls.v.12n.3.p.65.

[24] C. Cummings and J. Yur-Austin, "Design thinking and community impact: A case study of project-based learning in an MBA capstone course," *Journal of Education for Business*, vol. 97, no. 2, pp. 126–132, 2022, doi: 10.1080/08832323.2021.1887795.

[25] H. B. Issa and A. Khataibeh, "The Effect of Using Project Based Learning on Improving the Critical Thinking among Upper Basic Students from Teachers' Perspectives," *Pegem Egitim ve Ogretim Dergisi*, vol. 11, no. 2, pp. 52–57, 2021, doi: 10.14527/pegegog.2021.00.

[26] S. Huang and A. Shideler, "Leveraging Student Strengths through Project-Based Learning and Authentic Assessment in an Integrated ENL Classroom," *Journal Leadership and Instruction*, vol. 20, no. 2, pp. 42–46, 2021.

[27] B. Hussein, "Addressing collaboration challenges in project-based learning: The student's perspective," *Educ Sci (Basel)*, vol. 11, no. 8, 2021, doi: 10.3390/educsci11080434.

[28] A. A. Tawfik, A. Graesser, and J. Love, "Supporting Project-Based Learning Through the Virtual Internship Author (VIA)," *Technology, Knowledge and Learning*, vol. 25, no. 2, pp. 433–442, 2020, doi: 10.1007/s10758-018-9392-x.

[29] V. Prachagool, "Literature and Project-Based Learning and Learning Outcomes of Young Children," *International Education Studies*, vol. 14, no. 12, p. 93, 2021, doi: 10.5539/ies.v14n12p93.

[30] T. T. Kiong, N. S. M. Rusly, R. I. A. Hamid, C. K. S. Singh, and Z. Hanapi, "Inventive Problem-Solving in Project-Based Learning on Design and Technology: A Needs Analysis for Module Development," *Asian Journal of University Education*, vol. 18, no. 1, pp. 271–278, 2022, doi: 10.24191/ajue.v18i1.17196.

[31] A. C. Merkle, L. K. Ferrell, O. C. Ferrell, and J. F. Hair, "Evaluating E-Book Effectiveness and the Impact on Student Engagement," *Journal of Marketing Education*, vol. 44, no. 1, pp. 54–71, Apr. 2022, doi: 10.1177/02734753211035162.

[32] O. Korat, M. Tourgeman, and O. Segal-Drori, "E-book reading in kindergarten and story comprehension support," *Read Writ*, vol. 35, no. 1, pp. 155–175, Jan. 2022, doi: 10.1007/s11145-021-10175-0.

[33] S. Yorganci, "The interactive e-book and video feedback in a multimedia learning environment: Influence on performance, cognitive, and motivational outcomes," *J Comput Assist Learn*, vol. 38, no. 4, pp. 1005–1017, Aug. 2022, doi: 10.1111/jcal.12658.

[34] J. Nugroho and G. Chen, "Slideit + New Ebook Reader for Personal Computer (PC) for Improved Reading Comprehension," vol. 20, no. 2, pp. 98–103, 2021.

[35] R. Al-jarf, "Collaborative Mobile eBook Reading for Struggling EFL College Readers," *IOSR Journal of Research & Method in Education (IOSR-JRME)*, vol. 11, no. 6, pp. 32–42, 2021, doi: 10.9790/7388-1106023242.

[36] P. Chen and Y.-C. Chan, "Enhancing Creative Problem Solving in Postgraduate Courses of Education Management Using Project-Based Learning," *International Journal of Higher Education*, vol. 10, no. 6, p. 11, 2021, doi: 10.5430/ijhe.v10n6p11.

[37] J. Parker, "Students' Attitudes toward Project-Based Learning in an Intermediate Spanish Course.," *International Journal of Curriculum and Instruction*, vol. 12, no. 1, pp. 80–97, 2020.

[38] P. Chen and Y.-C. Chan, "Enhancing Creative Problem Solving in Postgraduate Courses of Education Management Using Project-Based Learning," *International Journal of Higher Education*, vol. 10, no. 6, p. 11, 2021, doi: 10.5430/ijhe.v10n6p11.

[39] P. N. Eckardt, M. Craig, and L. Kraemer, "The Impact of Project-Based Learning on Student Content Knowledge in an Undergraduate, Teacher Preparation, Foundations of Education Course," *Journal for Leadership and Instruction*, vol. 19, no. 1, pp. 38–42, 2020.

[40] S. K. Ummah, A. Inam, and R. D. Azmi, "Creating manipulatives: Improving students' creativity through project-based learning," *Journal on Mathematics Education*, vol. 10, no. 1, pp. 93–102, 2019, doi: 10.22342/jme.10.1.5093.93-102.

[41] V. Domenici, "STEAM Project-Based Learning Activities at the Science Museum as an Effective Training for Future Chemistry Teachers," *Educ Sci (Basel)*, vol. 12, no. 1, 2022, doi: 10.3390/educsci12010030.

[42] S. Syahril, R. A. Nabawi, and D. Safitri, "Students' Perceptions of the Project Based on the Potential of their Region: A Project-based Learning Implementation," *J Technol Sci Educ*, vol. 11, no. 2, pp. 295–314, 2021, doi: 10.3926/JOTSE.1153.

[43] N. N. Giang, "Project-Based Learning on the Topic of Aromatic Wax Production," *J Educ Elearn Res*, vol. 8, no. 4, pp. 395–407, Dec. 2021, doi: 10.20448/journal.509.2021.84.395.407.

[44] G. T. Chimbi and L. C. Jita, "Policy Failures with Learner-Centred Pedagogy: Case Studies from the Zimbabwean Experiment on Project-Based Learning," *Interdisciplinary Journal of Problem-Based Learning*, vol. 15, no. 1, 2021, doi: 10.14434/ijpbl.v15i1.29268.

Bionote:

The author's name is Diana Susanti. Works as a lecturer at Universitas PGRI Sumatera Barat. Last education was in the Biology Education master program at Padang State University (2013), another job was Assessor at the Indonesian national accreditation and teacher professional education program. Research related to the development of learning media and teaching materials.