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Exploring Python Programming: A Project Based Learning-Centric Learning Experience

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ABSTRAK

Teknologi informasi telah mengalami perkembangan yang signifikan dalam ilmu pengetahuan dan teknologi, termasuk bahasa pemrograman. Salah satu bahasa pemrograman yang populer saat ini adalah Python. Namun masih banyak siswa yang kesulitan mempelajari bahasa pemrograman Python. Kesulitan tersebut disebabkan oleh kurangnya media pembelajaran yang fokus pada bahasa Python, penjelasan modul yang sulit dipahami, dan kurangnya pemahaman terhadap library dalam bahasa Python. Penelitian ini bertujuan untuk membuat modul pembelajaran bahasa pemrograman Python dengan fokus pendekatan project-based Learning (PjBL). Metodologi yang digunakan dalam penelitian ini adalah Research and Development (R&D). Data yang diperlukan dalam penelitian ini dikumpulkan melalui angket dan ujian hasil belajar dengan subjek sebanyak 28 siswa. Data pada aspek efektivitas menggunakan Uji T-Test. Penelitian ini menghasilkan modul pembelajaran bahasa pemrograman Python berbasis PjBL yang valid, praktis, dan efektif. Modul ini dinilai valid oleh ahli pada aspek media dengan nilai 0,85 dan aspek materi dengan nilai 0,89. Kepraktisan modul ini dibuktikan melalui respon positif dosen sebesar 88,75%, respon mahasiswa pada uji terbatas sebesar 88,5%, dan uji coba penggunaan sebesar 86,96%. Sedangkan keefektifan modul ini dilihat dari tingkat ketuntasan klasikal sebesar 82% dan gain score sebesar 57%, serta uji t menunjukkan bahwa modul ini meningkatkan hasil belajar siswa pada bahasa pemrograman Python secara signifikan.

ABSTRACT

Information technology has experienced significant developments in science and technology, including programming languages. One of the most popular programming languages today is Python. However, many students still have difficulty learning the Python programming language. These difficulties are caused by the lack of learning media that focus on the Python language, module explanations that are difficult to understand, and a lack of understanding of the library in the Python language. This research aims to create a Python programming language learning module focusing on the project-based Learning (PjBL) approach. The methodology used in this research is Research and Development (R&D). The data needed in this study were collected through questionnaires and learning outcomes exams with a subject of 28 students. The data in the effectiveness aspect is using the T-Test Test. This research results in a valid, practical, and effective PjBL-based Python programming language learning module. This module is considered valid by experts in media aspects with a value of 0.85 and material aspects with a value of 0.89. The practicality of this module is proven through positive responses from lecturers of 88.75%, student responses in the limited test of 88.5%, and the usage trial of 86.96%. Meanwhile, the effectiveness of this module can be seen from the classical completion rate of 82% and the gain score of 57%, and the t-test shows that this module significantly increases student learning outcomes in the Python programming language.

1. INTRODUCTION

The rapid development of technology has transformed digital systems into equipment that affects various lines of human life (Amani et al., 2021; Budayová et al., 2022; Muskhir et al., 2023). Our understanding of the mechanisms by which digital systems work is a primary thing that must be mastered to adapt to rapid changes. Various aspects, including programming languages, have influenced changes and developments in information technology. A programming language is a computer operation executed according to the desired command using standard instructions (Cole & Feng, 2015; Gabbrielli & Martini, 2023). Desktop and Web applications that can be developed with programming languages continue to experience upgraded versions with increasingly complex and complicated programming languages. In addition, other fields, such as modeling science, also use programming languages as an intermediary medium between computers and users (Susanto et al., 2020; Yudertha et al., 2021). Programming languages are imperative in software development (Felleisen et al., 2018). One of the programming languages that is often used in the world today is the Python programming language.

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The Python programming language has gained significant prominence in scientific computing. Python, a high-level language, facilitates rapid development practices and simplifies program maintenance (Gorelick & Ozsvald, 2020; Sun et al., 2018). Python is the predominant choice among programming languages related to artificial intelligence (AI) owing to its relatively straightforward programming syntax, gentle learning curve, and versatile and extensive range of application (Martin et al., 2017; Sucre-Rosales et al., 2020). Utilizing Python often results in the swift creation of uncomplicated and pragmatic applications, thus bolstering learners' sense of accomplishment, making it particularly suitable for novices (Holman & Hacherl, 2023; Ling et al., 2021).

The popularity of the Python language, which is used in various kinds of programming, makes it a language that must be learned by students, especially those studying programming (Ling et al., 2021; Rosa, 2023). However, to learn the Python language, there are still many students who have not been able to master the material. Difficulties experienced by students in learning programming languages include. Firstly, they were new to programming languages (Gabbrielli & Martini, 2023; Zhao et al., 2022). Secondly, students only focus on the PowerPoint material delivered by the lecturer. Third, the modules or teaching materials studied are less focused on the core of the learning material. In addition, the cause of students' difficulties in understanding programming languages is that the way of thinking in programming languages is different from the students' habits. Hence, they need more time to understand it (Rear, 2017; Yudertha et al., 2021). Learning programming languages is a complex learning challenge that requires the right strategies and methods as a learning medium (Farhan et al., 2019; Susanto et al., 2020).

Based on observation data conducted in the Scientific Programming course, Informatics Engineering Education Study Program, FT, UNP, using an online questionnaire distributed in the class, when researchers distributed questionnaires to students, they got 23 students who filled out the questionnaire. Then, researchers found several cases in the Scientific Programming course, Informatics Engineering Education Study Program, FT, and UNP from the questionnaires distributed. From the questionnaires, it is known that 82.6% of students said they had difficulty learning or understanding the Python language in the scientific programming course. Based on the observation data, several factors are found that make students have difficulty understanding the Python language, including the lack of learning media that discuss the Python language; the explanation of existing teaching materials is difficult to understand; they are new to the Python language; and they have not mastered the library in the Python language. The indicator of difficulty in understanding the Python programming language can be caused by several factors, including the fact that programming is not an easy subject to learn because it deals with abstract concepts, then learning in a class that involves many people with different abilities means that the teacher has difficulty in designing methods that are suitable for the needs of each student (Holman & Hacherl, 2023; Rosa, 2023).

Seeing students' difficulty understanding Python programming language learning material, it is necessary to develop a module as an appropriate learning medium that students easily understand. Module development can be innovated with various learning model approaches. One of the practical learning approaches for improving students' understanding and ability to solve problems in learning is project-based learning (PjBL), or project-based learning (Siew & Ambo, 2018; Yunita & Untari, 2018). PjBL-based learning is one of the innovative learning methods that lecturers can use in the learning process.

The PjBL model is frequently described as an instructional approach that incorporates problem scenarios within its framework to aid students in comprehending and assimilating the presented theory more effectively. The PjBL Model employs a contextual strategy and nurtures students' proficiency in critical thinking, enabling them to assess the most optimal decisions as solutions to the presented problems (Fajriyanti et al., 2018; Rizkamariana et al., 2019). The project-based learning model has advantages, including 1) increasing learners' motivation to learn, 2) encouraging their ability to do meaningful work, and 3) requiring them to be appreciated. 2) Improve the ability to solve problems; 3) Increase learners' activeness in solving complex problems (Maruti, 2022; Triningsih & Mawardi, 2020). Besides that, this PjBL model is a learning model that involves the active role of students in producing products or projects that can encourage students' ability to understand knowledge through a systematic syntax (Fajriyanti et al., 2018; Rizkamariana et al., 2019).

This research aims to develop a learning module based on project-based Learning (PjBL) in the subject of Python programming language, aiming to create a simple, comprehensive, and easily digested by students. The module development process involves the evaluation of validity, practicality, and effectiveness as essential stages in the preparation of the module (Encheva et al., 2019; Liao et al., 2018). The novelty of this study is strongly emphasizes students' skills so that they can create or produce a project and makes students feel like they are working in the real world to produce something. Various research results have shown that learning outcomes obtained using PjBL can improve the quality of learning in various disciplines. So, the relevance of developing a Python programming language learning module with the PjBL model can solve the difficulties students face when learning Python programming languages. So, with the development of this PjBL-based learning module, it is hoped that teaching and learning activities will be more meaningful, systematic, and practical to increase student productivity and creativity in learning the Python programming language.

2. METHOD

The method used in this research is research and development (R&D). R&D is a research method used in creating certain products and testing their effectiveness. The essence of development research is not to design or conduct theoretical studies but to develop effective products used in educational institutions (Sugiyono, 2014). The development research carried out is described by Borg and Gall. The research and development steps of the Borg and Gall model can be seen in Figure 1.

Figure 1. The Steps of Research and Development of the Borg and Gall Model

The subjects in this study were 28 students of the Undergraduate Study Program in Informatics Education, Department of Informatics Engineering, Faculty of Engineering UNP, who took scientific programming courses in the January–June 2023 semester, along with 2 lecturers teaching programming courses in the Undergraduate Study Program in Informatics Education, Department of Informatics Engineering, Faculty of Engineering UNP.

The instruments used consist of validity instruments, practicality instruments and effectiveness instruments. The research design used is the one-group pretest-posttest design type. This type is an experiment conducted on one group without a comparison group (Sriyanti et al., 2021). The effectiveness test with objective questions was carried out twice with the same questions, namely before the experiment (pretest) and after the experiment (posttest) with one group of subjects. The product trial design is presented in Table 1.

Table 1. Product Trial Design

Pretest	Treatment	Posttest
O_1	X	O_2

The assessment of the effectiveness of the generated products can be derived from the evaluation tools used to gauge the learning outcomes of both the experimental and control groups. The assessment was conducted after the instruction involving the Python programming language learning module based on PjBL. This test was administered to appraise the module's efficacy by contrasting the learning outcomes between the control and experimental groups.

This study's analytical methods encompass product validity, practicality, and effectiveness analyses. A Likert scale was employed for the evaluation of media validity. The outcomes of the product validity analysis, computed using Aiken's V statistics. The range of V obtained will be between 0 and 1.00. A range of ≥ 0.6 can be interpreted as a reasonably high coefficient to be categorized as valid in the valid category (Azwar, 2012).

Table 2. Product Validity Categories

Number	Level of Achievement	Category
1	0.60 – 1.00	Valid
2	< 0.60	Not Valid

In the analysis of product practicality, test data can be seen from the response questionnaire of lecturers and students, and the analysis of the practicality of the media developed using a Likert scale. Furthermore, the value of practicality results is categorized according to the category of product practicality; in Table 3, a category of product practicality is categorized.

Table 3. Product Practicality Categories

Number	Level of Achievement (%)	Category
1	61 – 100	Practical
2	0 – 60	Not Practical

Effectiveness analysis is determined from student learning outcomes before (pretest) and after (posttest) using the PjBL-based programming language learning module. The effectiveness test uses the one-group design method with one sample group without a comparison group. The use of learning modules is effective if the value of learning outcomes after using the module (posttest) is higher than before using the module (pretest). Product effectiveness testing was carried out in three ways: effectiveness based on classical completeness, gain score, and t-test. The determination of the percentage based on the interval of learning provisions put forward is presented in Table 4.

Table 4. Interval of completeness

Number	Level of Achievement (%)	Category
1	0 – 39	Very Less
2	40 – 55	Less
3	56 – 65	Simply
4	66 – 79	Good
5	80 – 100	Very Good

The effectiveness of this study was also reviewed from the gain score aspect. The gain score aspect is carried out to determine the increase in student learning outcomes seen from the difference between pretest and posttest results. First, the test subjects were given a pretest, and at the end of the learning, they were given a posttest. After obtaining individual student completeness data, determine the total number of students who achieve completeness. Analyzing the improvement of learning outcomes from the pretest and posttest using the N-Gain score categories is show in Table 5.

Table 5. Gain Score Categories

No	Gain Score	Category
1	N – gain > 70	High
2	30 ≤ N – gain ≤ 70	Medium
3	N – gain < 30	Low

In the effectiveness aspect based on the T-Test Test, researchers conducted descriptive and inferential quantitative analysis approaches to determine whether there was a difference between the average data results before and after treatment so that it could be stated whether or not the treatment had an effect. A normality test is first carried out before the analysis is carried out. This test is carried out to determine the data analysis carried out by being able to use parametric statistics in the form of a t-test.

3. RESULT AND DISCUSSION

Result

Developed Learning Module

Developing a Python programming language learning module based on project-based learning (PjBL) is based on the development method carried out, which is research described by Borg and Gall. This research aims to produce a Python programming language learning module based on project-based learning (PjBL) that is valid, practical, and effective. The validity and practicality analyses were conducted using Aken's V formula. The effectiveness of the learning module is seen in the student's learning outcomes in the usage trial.

Validation Results of Material Experts and Media Experts

Based on the validity data analysis, it can be concluded that the assessment of three validators, material experts and learning media experts is shown in Table 6.

Table 6. Validity Result of Material Experts and Media Experts

Expert	Score	Average Score	Category
Material Expert	205	0.85	Valid
Media Expert	225	0.89	Valid

Base on Table 6, the assessment of three programming language material experts on the PjBL-based Python programming language learning module obtained an overall average score of 0.85 and received a valid category. Likewise, the assessment of three media experts on the PjBL-based Python programming language learning module obtained an overall average score of 0.89 and received a valid category. The conclusion of product validation results from learning media experts and programming language material experts is that overall, the PjBL-based Python programming language learning module is suitable for this study. The feasibility was followed by several improvements that researchers made to the PjBL-based Python programming language learning module by the validator's suggestions and the validity test results.

Practicality Results of Learning Media

At this stage, researchers conducted a module practicality test by distributing practicality instruments to 28 students who had taken part in learning using PjBL-based modules in Scientific Programming courses. Instrument experts first validated the practical instruments given to students. Based on the practicality analysis of the usage trial by students in the Scientific Programming course, the practicality of using the PjBL-based Python programming language learning module shows an average value of 86.96% in the practical category. The practicality of the learning module obtained from this usage trial was also followed by improvements according to student suggestions as module users.

Effectiveness Test Results of Learning Media

The pretest and posttest data were used to determine the effectiveness of the PjBL-based learning module. To analyze the level of effectiveness of this PjBL-based learning module, researchers used three methods: the effectiveness test based on classical completeness, the gain score, and the t-test. The results of the effectiveness analysis based on the classical completeness of 28 students who have done the pretest and posttest can be seen in Table 7.

Table 7. Product Effectiveness (Classical Completeness)

Description (Number of Students)	Pretest	Posttest
Examinees	28	28
Completed Participants	3	23
Incomplete Participants	25	5
The Percentage of Completeness (%)	11	82
Category	Not Effective	Effective

Based on Table 7, the analysis of classical completeness, it can be seen that before using the PjBL-based Python programming language learning module, the pretest results of 28 students were known to be only 3 people who were complete with a completeness percentage of 11%. This means that before using the PjBL-based module, student learning outcomes were categorized as ineffective. Meanwhile, after using the PjBL-based Python programming language learning module, the posttest results of 28 students were known to be 23 complete people, with a percentage of completeness of 82% in the practical category. So, it can be concluded that using the PjBL-based Python programming language learning module in terms of classical completeness is adequate to be used as a learning medium because there is an increase in student learning outcomes after using the PjBL-based module.

The results of the effectiveness analysis based on the gain score of 28 students who have done the pretest and posttest can be seen in Table 8.

Table 8. Results of Effectiveness Test Analysis Based on Gain Score

N	Average		N-Gain Score	% N-Gain Score
	Post-test - Pre-test	S_Ideal - Pretest		
28	29.14	49.54	0.57	57

Based on Table 8, the effectiveness test analysis results using the gain score of the pretest and posttest scores of 28 students, an average N-Gain score of 0.57 was obtained in the moderate category. So, it can be concluded that using the PjBL-based Python programming language learning module is effective as a learning medium.

Based on group design experiments that have been carried out, learning outcomes data are obtained in the form of pretest and posttest data from 28 students. Pretest data is obtained before treatment, and posttest data is obtained after treatment or using PjBL-based learning modules as learning media. To determine the statistical test for comparing student learning outcomes, the first step must be to test the normality of the learning outcomes data and then determine the statistical test to be used. Two statistical tests can be used, namely parametric statistical tests in the form of t-tests or non-parametric tests in the form of Wilcoxon Signed-Rank tests. The data normality test used is the Shapiro-Wilk test with an error rate of 5%, or 0.05. Decision-making from the Shapiro-Wilk normality test is seen from the P-value obtained from the test results. If the P-value is smaller than 0.05, the test data is categorized as not normally distributed; otherwise, if the P-value is more significant than 0.05, the test data is categorized as normally distributed. Normality test analysis is assisted by using JASP 0.17.1 software. The results of the Shapiro-Wilk normality test data analysis can be seen in Table 9.

Table 9. Shapiro-Wilk Test Normality Test Results

Descriptive Statistic		
	Pretest	**Posttest**
Valid	28	28
Mean	50.464	79.536
Std. Deviation	17.178	13.043
Shapiro-Wilk	0.957	0.928
P-value of Shapiro-Wilk	0.297	0.056

Based on Table 9, the Shapiro-Wilk normality test, the p-value for the pretest data is 0.297, and for the posttest, it is 0.056. These outcomes lead to the inference that the pretest data exhibits a p-value (0.297) exceeding 0.05, indicating normal distribution. Similarly, the posttest data displays a p-value (0.056) greater than 0.05, signifying normal distribution as well. Given the normal distribution of both pretest and posttest learning outcomes data, it can be established that the statistical test employed in the study is a parametric statistical test in the form of a t-test. The t-test is employed to compare students' learning outcomes before and after the implementation of treatment (utilizing the PjBL-based Python programming language learning module). The objective of comparing these learning outcomes through the t-test is to determine whether a significant difference exists between the learning outcomes before and after utilizing the PjBL-based learning module. The decision-making process based on the t-test hinges on the probability value (p) derived from the test results. If the p-value is less than 0.05, the null hypothesis (H0) is rejected, indicating a significant difference. Conversely, if the p-value exceeds 0.05, H0 is accepted, suggesting no significant difference. The t-test analysis was facilitated using JASP 0.17.1 software. The outcomes of the t-test data analysis are illustrated in Table 10.

Table 10. Parametric Statistics Test Results (T-Test)

Paired Samples T-Test				
Measure 1	Measure 2	t	df	p
Pretest	Posttest	-8.596	27	<0.001

Based on Table 10, the outcomes of parametric statistical tests (t-tests), the resulting p-value is 0.001. Consequently, it can be deduced that the p-value (0.001) is less than 0.05, signifying the rejection of the null hypothesis (H_0) or the presence of a significant difference in student learning outcomes following the utilization of the PjBL-based Python programming language learning module as an instructional tool. Furthermore, upon comparing the t-count value to the t-table value for degrees of freedom (df) at 27, which is -1.703, it is evident that the t-count value (-0.8596) is less than the t-table value (-1.703). This observation reaffirms the rejection of H_0 and indicates a significant difference in student learning outcomes after adopting the PjBL-based Python programming language learning module as an instructional medium.

Discussion

The undertaken development in this research endeavors to create a product, specifically a Python programming language learning module grounded in project-based learning (PjBL). This product is envisaged as an innovative solution for enhancing the learning experience in Scientific Programming courses. The developmental research follows the Borg and Gall development model. This model encompasses ten sequential stages of development, commencing with the identification of potential and problems, followed by data collection, product design, product validation, product design refinements, limited trials, product revisions, usage trials, further product refinements, and culminating in the creation of the final product (Alhayat et al., 2023; Nurfathurrahmah et al., 2020).

The PjBL-based learning module produced in this study makes learning easy for students, especially in understanding the Python programming language material in the Scientific Programming course. One of the comparisons of research results with previous research is that previous research was not developed using the PjBL model in the learning module (Holman & Hacherl, 2023). The ease of learning using this PjBL-based module can also improve students' understanding of materials and concepts in digital simulation and communication subjects (Alhayat et al., 2023; Irman, 2020). Then, the PjBL-based learning module in this development research passed all stages of development, including feasibility assessment by experts, so that the learning module produced is a product that is recognized and can be accounted for. Product validity testing can be carried out by presenting experienced experts or experts related to the product to obtain a valid development product.

After conducting the product's validity assessment, an effectiveity examination involving a sizable cohort of 28 students was conducted during the utilization trial. The practicality outcomes derived from the utilization trial indicated an 86.96% practicality rating, categorizing it as an effective learning tool. Consequently, from the perspective of practicality, it can be concluded that the PjBL-based programming language learning module is deemed practical for deployment as an instructional medium. Based on the results of the practicality analysis obtained from the trial use, it is known that students and lecturers can use the PjBL-based Python programming language learning module easily. The time used becomes more effective by the learning of scientific programming courses. The ease of use of PjBL-based learning modules is research known to measure the level of practicality of learning modules, as can be seen from the consideration of lecturers as educators and students as learners (Fajriyanti et al., 2018; Saputra & Sujarwanta, 2021).

In assessing product effectiveness, the success of employing the PjBL-based Python programming language learning module is discernible through the improvement in student learning outcomes. This effectiveness assessment was conducted during a trial involving a substantial group of 28 students. The effectiveness analysis was evaluated using classical completeness, gain score, and t-test criteria (Rosa, 2023; Saputri et al., 2023). In terms of classical completeness, it was observed that 82% of students achieved scores surpassing the minimum completion criteria. While some students still fell below the minimum completion threshold, employing PjBL-based modules was deemed adequate based on the percentage of classical completeness. In assessing effectiveness using gain scores, the n-gain value 0.57 fell within the medium category. Finally, evaluating effectiveness through the paired sample t-test comparing pretest and posttest results, it was determined that the p-value of 0.001 is less than 0.05. This signifies a significant difference in results after utilizing the PjBL-based learning module. The effectiveness analysis demonstrates that the PjBL-based programming language learning module has successfully enhanced student learning outcomes (Dewi, 2022; Ferrero et al., 2021).

The results showed that the project-based learning (PjBL) module has several advantages in learning Python. First, the PjBL-based module is designed to be easier for students. Previous research findings also state that using modules in learning makes it easier for students to understand teaching materials (Sunantri et al., 2016). Second, the PjBL module allows learners to utilize time effectively because it can be used independently. Previous research states that modules can be studied flexibly, either in a short time or longer, and can be used alone or combined with other methods (Sungkono, 2009). Third, the PjBL Module has appeal in presenting learning materials because it provides opportunities for students to produce natural products due to their learning. Previous research also states that the presentation of exciting material in learning modules can increase the motivation and activeness of students in the classroom (Negara et al., 2019).

Moreover, integrating PjBL-based modules into the instructional process presents a challenge, as not all learners or students are equally adept at implementing this approach. This is discernible from the examination of student learning outcomes, where some students still do not achieve the minimum completion score criteria. Using PjBL-based modules necessitates a collaborative approach with other instructional methods to optimize student learning outcomes. Based on these advantages, the PjBL module has an impact on increasing learning motivation, understanding of concepts and materials, and students' critical skills. Increased student motivation to learn because they are involved in projects that often involve challenges and clear goals, which can encourage students to be more enthusiastic in developing their knowledge and skills.

4. CONCLUSION

The product produced in this study is a PjBL-based Python programming language learning module that can be used as a learning medium in the Scientific Programming course at Padang State University. The PjBL-based Python programming language learning module developed is categorized as a valid learning module. This is evidenced by the validity of the results obtained from the assessments of learning media expert lecturers and programming language material experts. The developed PjBL-based Python programming language learning module is categorized as an effective learning module. This is evidenced by the results of student and lecturer response questionnaires, which show that the PjBL-based Python programming language learning module is

practical to use in scientific programming courses. The developed PjBL-based Python programming language learning module is categorized as an effective learning module.

5. REFERENCES

Alhayat, A., Utami, T., & Yustikarini, R. (2023). The Relevance of the Project-Based Learning (PjBL) Learning Model with Kurikulum Merdeka Belajar Amsal. *DWIJA CENDEKIA: Jurnal Riset Pedagogik*, *7*, 1–23. https://doi.org/10.20961/jdc.v7i1.69363.

Amani, R., Luthfi, A., Qomari, V. A., Mahdi, A., & Langputeh, S. (2021). The Innovation of Maruo's Popup Book to Help Children with Special Needs in Memorizing Alquran. *Khalifa: Journal of Islamic Education*, *5*(2), 176. https://doi.org/10.24036/kjie.v5i2.155

Azwar, S. (2012). *Reliabilitas dan validitas* (4th ed.). Pustaka Pelajar.

Budayová, Z., Pavliková, M., Al-Adwan, A. S., & Klasnja, K. (2022). The impact of modern technologies on life in a pandemic situation. *Journal of Education Culture and Society*, *13*(1), 213–224. https://doi.org/10.15503/jecs2022.1.213.224

Cole, J., & Feng, J. (2015). Effective strategies for improving writing skills of elementary English language learners. *Chinese American Educational Research and Development Association Annual Conference*, 1–25. https://eric.ed.gov/?id=ED556123

Dewi, M. R. (2022). Kelebihan dan Kekurangan Project-based Learning untuk Penguatan Profil Pelajar Pancasila Kurikulum Merdeka. *Inovasi Kurikulum*, *19*(2), 213–226. https://doi.org/10.17509/jik.v19i2.44226

Encheva, M., Zlatkova, P., Tammaro, A. M., & Brenner, M. (2019). Information Behavior of Humanities Students in Bulgaria, Italy and Sweden: Planning a Game-Based Learning Approach for Avoiding Fake Content. In *Communications in Computer and Information Science* (Vol. 989). https://doi.org/10.1007/978-3-030-13472-3_28

Fajriyanti, Z. D., Ernawati, T., & Sujatmika, S. (2018). Pengembangan LKS Berbasis Project Based Learning untuk Meningkatkan Keterampilan Proses Sains Siswa SMP. *JIPVA (Jurnal Pendidikan IPA Veteran)*, *2*(2), 149. https://doi.org/10.31331/jipva.v2i2.691

Farhan, W., Razmak, J., Demers, S., & Laflamme, S. (2019). E-learning systems versus instructional communication tools: Developing and testing a new e-learning user interface from the perspectives of teachers and students. *Technology in Society*, *59*(February). https://doi.org/10.1016/j.techsoc.2019.101192

Ferrero, M., Vadillo, M. A., & León, S. P. (2021). Is project-based learning effective among kindergarten and elementary students? A systematic review. *PLoS ONE*, *16*(4 April), 1–14. https://doi.org/10.1371/journal.pone.0249627

Gabbrielli, M., & Martini, S. (2023). *Programming languages: principles and paradigms*. Springer Nature. https://doi.org/10.1007/978-3-031-34144-1

Gorelick, M., & Ozsvald, I. (2020). *High Performance Python: Practical Performant Programming for Humans*. O'Reilly Media.

Holman, J. O., & Hacherl, A. (2023). Teaching Monte Carlo Simulation with Python. *Journal of Statistics and Data Science Education*, *31*(1), 33–44. https://doi.org/10.1080/26939169.2022.2111008

Irman, S. (2020). Validasi modul berbasis project based learning pada mata pelajaran simulasi dan komunikasi digital. *Jurnal Ilmiah Pendidikan Dan Pembelajaran*, *4*(2), 260–269. https://doi.org/10.23887/jipp.v4i2.26156

Liao, S., Hong, J. C., Wen, M. H., & Pan, Y. C. (2018). Applying technology acceptance model (TAM) to explore users' behavioral intention to adopt a performance assessment system for E-book production. *EURASIA Journal of Mathematics, Science and Technology Education*, *14*(10), 1–12. https://doi.org/10.29333/ejmste/93575

Ling, H.-C., Hsiao, K.-L., & Hsu, W.-C. (2021). Can students' computer programming learning motivation and effectiveness be enhanced by learning python language? a multi-group analysis. *Frontiers in Psychology*, *11*, 600814. https://doi.org/10.3389/fpsyg.2020.600814

Martin, C. R., Ranalli, J., & Moore, J. P. (2017). Problem-based learning module for teaching thermodynamic cycle analysis Using PYroMat. *ASEE Annual Conference and Exposition, Conference Proceedings*, *2017-June*. https://doi.org/10.18260/1-2--28757

Maruti, E. S. (2022). Ketahanan Literasi Anak-Anak di Masa Pandemi melalui Aplikasi Let's Read (Children's Literacy Resilience in a Pandemic Period Through the Let's Read Application. *Indonesian Language Education and Literature*, *7*(2), 247. https://doi.org/10.24235/ileal.v7i2.9298

Muskhir, M., Luthfi, A., Julian, R., & Fortuna, A. (2023). Exploring iSpring Suite for Android-Based Interactive Instructional Media in Electrical Lighting Installation Subject. *International Journal of Interactive Mobile Technologies*, *17*(22). https://doi.org/10.3991/ijim.v17i22.42625

Negara, R. M. H. K., Suherman, A., & Yayat, Y. (2019). Pengaruh Penggunaan Modul Pembelajaran Berdasarkan Kurikulum Smk 2013 Terhadap Hasil Belajar Siswa Pada Mata Pelajaran Sistem Dan Instalasi Refrigerasi. *Journal of Mechanical Engineering Education*, *6*(1), 64–70. https://doi.org/10.17509/jmee.v6i1.18244

Nurfathurrahmah, N., Indra Jayanti, M., & Ariyansyah, A. (2020). Pengaruh Model Pembelajaran Berbasis Project Based Learning (PjBL) Untuk Meningkatkan Kemampuan Berpikir Kreatif dan Sikap Kooperatif Mahasiswa. *Oryza (Jurnal Pendidikan Biologi)*, *9*(2), 8–13. https://doi.org/10.33627/oz.v9i2.380

Rear, D. (2017). The language deficit: a comparison of the critical thinking skills of Asian students in first and second language contexts. *Asian-Pacific Journal of Second and Foreign Language Education*, *2*(1). https://doi.org/10.1186/s40862-017-0038-7

Rizkamariana, F., Diana, S., & Wulan, A. R. (2019). The Implementation of Project Based Learning to Train the Ability of 21st Century Botanical Literacy in High School Students. *Indonesian Journal of Biology Education*, *2*(1), 19–23. https://ejournal.upi.edu/index.php/asimilasi/article/view/15203

Rosa, A. P. M. D. (2023). Analyzing Programming Competency: A Student Perspective in Python Programming. *2023 8th International Conference on Business and Industrial Research (ICBIR)*, 336–340. https://doi.org/10.1109/ICBIR57571.2023.10147530

Saputra, B., & Sujarwanta, A. (2021). Tranformasi Pembelajaran Berbasis Proyek Science, Technology, Engineering and Mathematics di Masa Pandemi Covid-19. *BIOLOVA*, *2*(1), 1–8. https://doi.org/10.24127/biolova.v2i1.491

Saputri, C. L. E., Suprapto, E., & Mulyanti, E. D. S. (2023). Penerapan Model Project Based Learning Untuk Meningkatkan Kreativitas Peserta Didik Kelas Iv Pada Pembelajaran Ipas Materi Indonesiaku Kaya Budaya. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, *8*(1). https://doi.org/10.23969/jp.v8i1.8318

Siew, N. M., & Ambo, N. (2018). Development and evaluation of an integrated project-based and stem teaching and learning module on enhancing scientific creativity among fifth graders. *Journal of Baltic Science Education*, *17*(6), 1017–1033. https://doi.org/10.33225/jbse/18.17.1017

Sriyanti, I., Almafie, M. R., Marlina, L., & Jauhari, J. (2021). The effect of Using Flipbook-Based E-modules on Student Learning Outcomes. *Kasuari: Physics Education Journal (KPEJ)*, *3*(2), 69–75. https://doi.org/10.37891/kpej.v3i2.156

Sucre-Rosales, E., Fernández-Terán, R., Carvajal, D., Echevarría, L., & Hernández, F. E. (2020). Experience-Based Learning Approach to Chemical Kinetics: Learning from the COVID-19 Pandemic. *Journal of Chemical Education*, *97*(9), 2598–2605. https://doi.org/10.1021/acs.jchemed.0c00698

Sugiyono, S. (2014). *Metode Kuantitatif Kualitatif dan R & D*. Alfabeta.

Sun, Q., Berkelbach, T. C., Blunt, N. S., Booth, G. H., Guo, S., Li, Z., Liu, J., McClain, J. D., Sayfutyarova, E. R., & Sharma, S. (2018). PySCF: the Python-based simulations of chemistry framework. *Wiley Interdisciplinary Reviews: Computational Molecular Science*, *8*(1), 1340. https://doi.org/10.1002/wcms.1340

Sunantri, A., Suyatna, A., & Rosidin, U. (2016). Pengembangan modul pembelajaran menggunakan learning content development system materi usaha dan energi. *Jurnal Pembelajaran Fisika Universitas Lampung*, *4*(1), 116144. https://www.neliti.com/publications/116144/pengembangan-modul-pembelajaran-menggunakan-learning-content-development-system

Sungkono, S. (2009). Pengembangan dan pemanfaatan bahan ajar modul dalam proses pembelajaran. *Majalah Ilmiah Pembelajaran*, *5*(1). https://journal.uny.ac.id/index.php/mip/article/viewFile/6154/5341

Susanto, A., Malik, A., & Mitrayati. (2020). The challenges of learning English as a foreign language among undergraduate students. *Inovish Journal*, *5*(1), 1–11. https://doi.org/10.35314/inovish.v5i1.1341

Triningsih, R., & Mawardi, M. (2020). Efektivitas Problem Based Learning Dan Project Based Learning Ditinjau Dari Keterampilan Berpikir Kritis Siswa Sd. *JRPD (Jurnal Riset Pendidikan Dasar)*, *3*(1), 51–56. https://doi.org/10.26618/jrpd.v3i1.3228

Yudertha, A., Susanti, T., Mutamasikin, M., Bangsa, T. A., Gita, G., Ogie, O., & Gunawan, A. (2021). Pengembangan Modul Pelatihan Pengenalan Dasar Bahasa Pemrograman Java Dengan Model Arcs. *Computer Based Information System Journal*, *9*(2), 42–49. https://doi.org/10.33884/cbis.v9i2.5475

Yunita, E., & Untari, R. S. (2018). Development of a Mind Map-Based Module Using a Project Based Learning (PjBL) Model to Improve Learning Achievement in Students of the X Multimedia Computer and Informatics Engineering Expertise Program at Vocational Schools. *JICTE (Journal of Information and Computer Technology Education*, *2*(1), 18. https://doi.org/10.21070/jicte.v2i1.600

Zhao, L., Liu, X., Wang, C., & Su, Y. S. (2022). Effect of different mind mapping approaches on primary school students' computational thinking skills during visual programming learning. In *Computers and Education* (Vol. 181). https://doi.org/10.1016/j.compedu.2022.104445