JPPIPA 10(6) (2024)

Jurnal Penelitian Pendidikan IPA

*Journal of Research in Science Education*

http://jppipa.unram.ac.id/index.php/jppipa/index

# Applications to Support Smart Learning Environments in Project-Based Cooperative Learning Models in Java Programming Courses and Applied in Science

Rika Melyanti[1*], Fitri Ayu[2], Mardainis[3], Zupri Henda[4], Herianto[4]

[1] Faculty of Computer Science, Physicist, Hang Tuah University Pekanbaru, Indonesia.
[2] Physicist at Riau Business Technology Institute, Indonesia.
[3] Physicist at STMIK AMIK Riau, Indonesia.
[4] Faculty of Computer Science in Physics, Hang Tuah University Pekanbaru, Indonesia.

Received: Januari 31, 2024
Revised: May 22, 2024
Accepted: June 25, 2024
Published: June 30, 2024

Corresponding Author:
Rika Melyanti
camelya2105@gmail.com

DOI: 10.29303/jppipa.v10i6.7141



**Abstract:** This research paper proposes the development of an application to support an intelligent learning environment in a project-based cooperative learning model on Java programming courses. The application is built using the Laravel framework where the end result later lecturers can easily see the student portfolio of each learning access on the java programming course. An intelligent learning environment will enable students to learn from their experiences, adapt to new input, and perform project tasks already assigned to lecturers. This application will also help teachers in groups that are adapted from the cooperative learning model of the STAD type. The proposed application will be designed to make it easier for teachers to form groups based on the ability of students from high, medium and low, so that the groups formed are not homogeneous groups. This application will be useful for a variety of study programmer that have practical programming courses devised. This paper will discuss the benefits of cooperative learning, project-based learning, and intelligent learning environments in the context of Java programming courses. It will also provide insights into the proposed application development process. This application facilitates communication and discussion among students in a group that is easily connected with their lecturer, so that the lecturer can also monitor the activity of the group members. This paper will conclude with a discussion of the potential impact of the proposed applications on the field of education and the future in the learning environment.

**Keywords:** Application; Cooperative learning; Java programming; Project based learning; Smart learning environment

## Introduction

In the ever-evolving landscape of education, technology has emerged as a transformative force, shaping the way we facilitate learning experiences by Agbo et al. (2019), Ahmad et al. (2013), Syawaludin et al. (2022) and Azzouz et al. (2022). This study delves into the dynamic intersection of education and technology, presenting an innovative application designed to enhance the Smart Learning Environment within the Cooperative Project-Based Learning (CPBL) model, specifically applied to the Java Programming Course.

Based on Johnson et al. (2014) as the demands of the modern workforce continue to evolve, there is an increasing need for educational approaches that foster collaborative problem-solving, critical thinking, and hands-on practical skills. According to Nurbekova et al. (2020), Cooperative Project-Based Learning has emerged as a pedagogical framework that aligns well with these demands, emphasizing teamwork and real-world application of knowledge. Based on Liu et al. (2020), this

**How to Cite:**
Melyanti, R., Ayu, F., Mardainis, M., Henda, Z., & Herianto, H. (2024). Applications to Support Smart Learning Environments in Project-Based Cooperative Learning Models in Java Programming Courses and Applied in Science. *Jurnal Penelitian Pendidikan IPA*, *10*(6), 3308–3315. https://doi.org/10.29303/jppipa.v10i6.7141

article explores the development and implementation of an application tailored to support the Smart Learning Environment within the context of Cooperative Project-Based Learning. The focus is on the Java Programming Course, a subject that demands a comprehensive understanding of programming concepts and encourages students to work together on practical projects. the lack of understanding in the concepts in learning a programming language has reduced students' interest in further exploration and experimentation on their own (Tan et al., 2009).

Through this research, we aim to contribute to the ongoing discourse on technology-enhanced education by providing insights into the design, implementation, and impact of a Smart Learning Environment application. According to Haleem et al. (2022), the integration of technology in the Cooperative Project-Based Learning model aims to create an immersive and collaborative educational experience, fostering a deeper understanding of Java programming concepts and preparing students for the challenges of the digital era.

We realise that nowadays, the creation of software applications requires coordinated collaboration between one or more team members (Ding et al., 2017; Hutchins et al., 2020; Nykänen et al., 1998). According to Sancho-Thomas et al. (2009) as such, software professionals need to possess certain skills, such as effective communication, leadership, negotiation, and team management, to ensure successful teamwork, and STAD cooperative learning model elaborated with project-based learning model can be applied to train teamwork skills, such as communication, leadership, negotiation, or team management (Karaahmetoğlu et al., 2019). This is evident from the results of research on student obstacles in learning programming languages, the highest percentage of which is the competence of working with classmates (collaboration) of 35% based on Effendi et al. (2019). The application of cooperative project-based learning models in programming courses has been carried out by several researchers including based on Melyanti et al. (2024). According to Hamburg et al. (2004), the subsequent sections of this article will detail the methodology, features, and outcomes of the application, offering a comprehensive analysis of its effectiveness in supporting a dynamic and engaging learning environment. The developed smart learning application serves as an invaluable tool for instructors by streamlining the process of providing practical modules (Andry, 2023). With user-friendly interfaces and comprehensive features, the application allows instructors to effortlessly create and share practical modules tailored to the Java programming course (Jazayeri, 2015). Additionally, the application incorporates a real-time room chat feature, facilitating seamless communication between team members and instructors. This feature not only enhances collaboration but also enables quick and effective communication, fostering an interactive learning environment (Keser et al., 2010). Furthermore, the application addresses the constraints of limited study time by offering the flexibility to access learning materials and engage in discussions at any time (Samarakoon et al., 2022). Meanwhile according to Adriyawati et al. (2020), this adaptability supports online monitoring, allowing instructors to keep track of students' progress and address queries promptly, overcoming the challenges posed by constrained learning durations.

In summary, the smart learning application is a multifaceted solution that eases the burden on instructors in delivering practical modules, fosters collaboration through real-time communication features, and accommodates the constraints of limited study time by enabling online monitoring. The application not only enhances the learning experience for students but also empowers instructors with efficient tools for managing and optimizing the cooperative project-based learning model in the Java programming course.

## Method

In the ever-evolving landscape of education, the integration of technology has become imperative to enhance learning experiences and outcomes. This research endeavors to explore the implementation of a Smart Learning environment within the context of Cooperative Project Based Learning (CPjBL) for the Java Programming course. The ADDIE (Analysis, Design, Development, Implementation, Evaluation) methodology serves as the foundational framework, guiding the systematic development and assessment of a digital platform tailored to the specific needs of the course (Lin et al., 2022).


**Figure 1**. The ADDIE development model

ADDIE model design is a pedagogical model that guides the construction of software and learning materials based on needs. This platform enables instructors to input pretest and post-test questions, group students based on their proficiency levels, and directly input grades, providing a comprehensive tool for tracking and evaluating student progress. Additionally, it empowers students to access their session portfolios, fostering a dynamic and interactive learning environment. This study aims to contribute valuable insights into the effectiveness of Smart Learning in tandem with CPBL, offering a potential model for optimizing programming education. The following are the stages of conducting research using the ADDIE development model, as depicted in Figure 1.

**Table 1**. ADDIE Table

| Analysis | Design | Development | Implementation | Evaluation |
|---|---|---|---|---|
| a. Needs Analysis<br>• Identify the learning needs and objectives for students in the Java Programming course.<br>• Review the existing curriculum and learning guidelines.<br>• Analyze the technological requirements and infrastructure needed for Smart Learning | a. System Design<br>• Design the structure of the Smart Learning application with features supporting CPBL.<br>• Design a user-friendly and intuitive interface.<br>• Incorporate the capability for instructors to input pretest and post-test questions | a. Implementation<br>• Develop the Smart Learning application with the designed features.<br>• Implement a mechanism for instructors to input grades and assess student performance.<br>• Develop a system for students to access and view their portfolios from completed sessions | a. Training<br>• Conduct training sessions for instructors to understand the integration of the application into teaching.<br>• Raise awareness among students about the use and benefits of the Smart Learning platform | a. User Feedback:<br>• Collect feedback from users (both students and instructors) regarding their experience with the Smart Learning platform.<br>• Assess the usability and effectiveness of the CPBL model. |
| b. Content Analysis<br>• Determine the content to be included in the Smart Learning platform.<br>• Identify suitable methods and strategies for Cooperative Project Based Learning (CPjBL). | b. Curriculum Integration:<br>• Define the learning content to be integrated into the platform.<br>• Design a system for grouping students based on pretest results (low, medium, high proficiency).<br>• Create a mechanism for instructors to input student grades for assessing the achievement of learning objectives | b. Content Development<br>• Develop project-based learning materials aligned with the course objectives.<br>• Ensure the application supports dynamic grouping based on pretest results.<br>• Regularly test the functionality and performance of the application. | b. Rollout<br>• Implement the Smart Learning application gradually based on the existing curriculum.<br>• Monitor the initial implementation for feedback and improvements. | b. Performance Data:<br>• Gather data on student learning outcomes from pretest and post-test results.<br>• Analyze the inputted grades to evaluate the achievement of expected competencies for each session. |
| | | | | c. Analysis and Adjustments:<br>• Analyze the collected data to evaluate the overall effectiveness of the Smart Learning approach.<br>• Implement necessary adjustments and improvements based on the evaluation results |

## Result and Discussion

Results should be clear and concise. The discussion should explore the significance of the results of the work, not repeat them. A combined Results and Discussion section is often appropriate. Avoid extensive citations and discussion of published literature.

In this study, system validation was conducted by involving IT experts who have experience in developing smart learning applications and systems. The validation method involves functional and technical analysis of the system, as well as evaluation against predefined criteria.

*Success Criteria*

Functionality: The extent to which the system supports smart learning environment and Cooperative Project Based Learning Model in Java Programming course.
Performance: The speed and response of the system in providing information and supporting user interaction.
Security: The level of security of the system against potential threats and other security risks.

*Validation Metrics*

Functionality: Percentage of core features implemented.
Percentage of success in supporting Cooperative Project Based Learning.
Performance: Average response time for each user action.
Number of concurrent users that the system can handle.
Security: The success of the system in detecting and preventing potential security threats.
Quality of data encryption used.

*Validation Formula*

Functionality:
Percentage of core features implemented (F) = (Number of core features implemented / Total core features) x 100%.
Percentage of success in supporting Cooperative Project Based Learning (C) = (Number of successful projects / Total projects conducted) x 100%.
Average response time (W) = (Number of response times for each user action / Number of user actions).
Number of concurrent users (U) = Number of concurrent users that the system can handle.

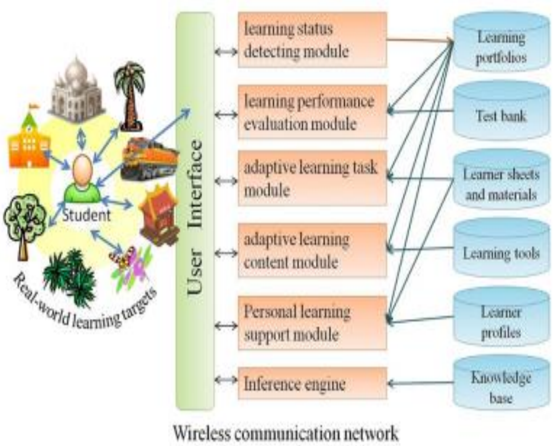


**Figure 2.** Framework of a smart learning environment

As for the display form group formation result display through smart learning application.

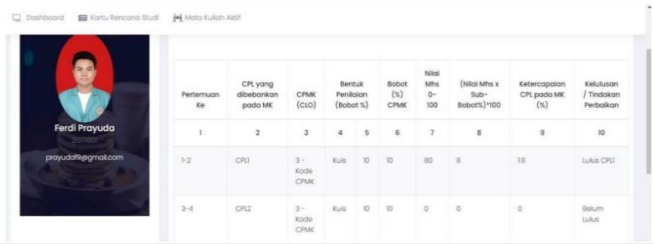

**Figure 3**. Group formation result display through smart learning application

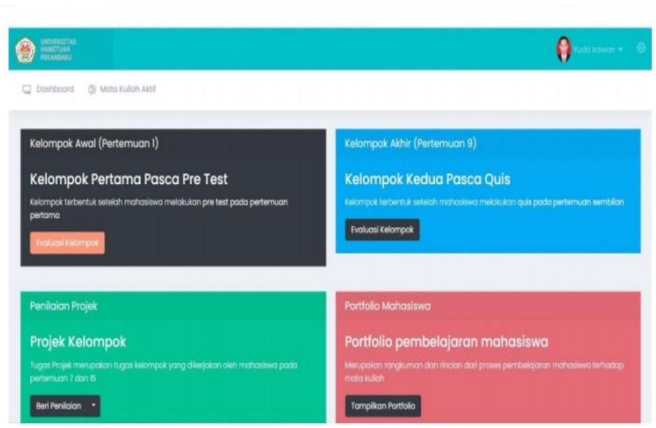


**Figure 4**. Menu display for lecturers in smart learning application

*Functionality (F)*

The assessment of functionality serves as a critical measure in evaluating the efficacy of the developed system. Functionality, often considered the cornerstone of any technological application, encapsulates the successful implementation of core features intended to enhance user experience and meet the specified objectives. In the context of our system, functionality is appraised by examining the extent to which essential features, integral to the seamless operation of the application, have been realized.

To quantify functionality, we employ a straightforward yet informative metric: the Percentage of Core Features Implemented (F). This calculation involves determining the ratio of implemented core features to the total number of core features, expressed as a percentage. A higher percentage indicates a more comprehensive implementation of essential functionalities, showcasing the system's ability to fulfill its intended purpose effectively.

**Table 2**. Assessment

| F | C | W | U |
|---|---|---|---|
| 85% | 75.62% | 3.5 Seconds | 47.5 users |

As for the results of the control class and experimental class for cognitive aspects in the use of the CPjBL learning model supported by this smart learning application can be seen in the table 3.

**Table 3**. Control and Experiment Class

| No | Control Class | | Experiment Class | |
|---|---|---|---|---|
| | Pretest | Posttest | Pretest | Posttest |
| 1 | 35.00 | 85.00 | 35.00 | 85.00 |
| 2 | 15.00 | 75.00 | 15.00 | 82.50 |
| 3 | 17.50 | 75.00 | 17.50 | 82.50 |
| 4 | 40.00 | 85.00 | 40.00 | 90.00 |
| 5 | 0.00 | 70.00 | 30.00 | 82.50 |
| 6 | 15.00 | 70.00 | 37.50 | 82.50 |
| 7 | 27.50 | 65.00 | 40.00 | 90.00 |
| 8 | 20.00 | 70.00 | 17.50 | 75.00 |
| 9 | 30.00 | 85.00 | 22.50 | 85.00 |
| 10 | 17.50 | 75.00 | 27.50 | 85.00 |
| 11 | 15.00 | 60.00 | 22.50 | 82.50 |
| 12 | 27.50 | 80.00 | 47.50 | 90.00 |
| 13 | 20.00 | 80.25 | 12.50 | 70.50 |
| 14 | 30.00 | 85.00 | 40.00 | 90.00 |
| 15 | 17.50 | 70.50 | 20.00 | 80.00 |
| 16 | 22.50 | 75.00 | 30.00 | 85.00 |
| 17 | 27.50 | 80.00 | 17.50 | 75.00 |
| 18 | 22.50 | 75.00 | 30.00 | 85.00 |
| 19 | 22.50 | 70.25 | 35.00 | 85.00 |
| 20 | 27.50 | 85.00 | 17.50 | 85.00 |
| 21 | 22.50 | 75.00 | 17.50 | 80.00 |
| 22 | 27.50 | 82.50 | 37.50 | 90.00 |
| 23 | | | 22.50 | 80.25 |
| 24 | | | 30.00 | 80.25 |
| 25 | | | 32.50 | 75.00 |
| 26 | | | 40.00 | 90.00 |
| 27 | | | 15.00 | 70.00 |
| 28 | | | 27.50 | 75.00 |
| 29 | | | 30.00 | 85.00 |
| 30 | | | 27.50 | 80.00 |
| Median | 22.73 | 76.07 | 27.63 | 82.45 |

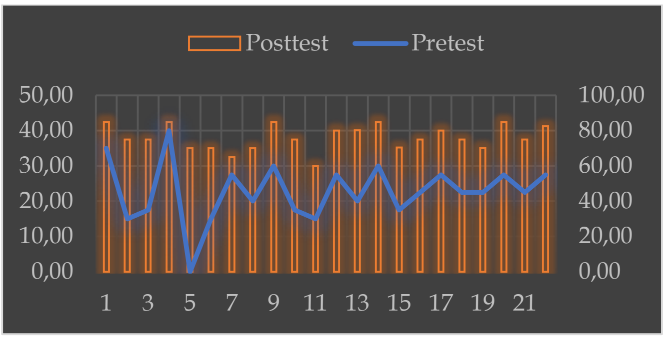


**Figure 5**. Control class

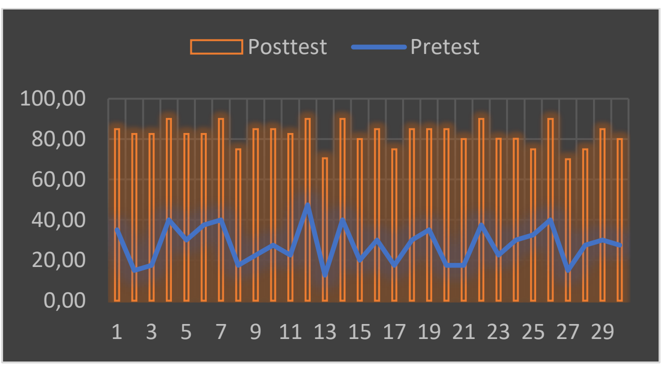


**Figure 6**. Experiment Class

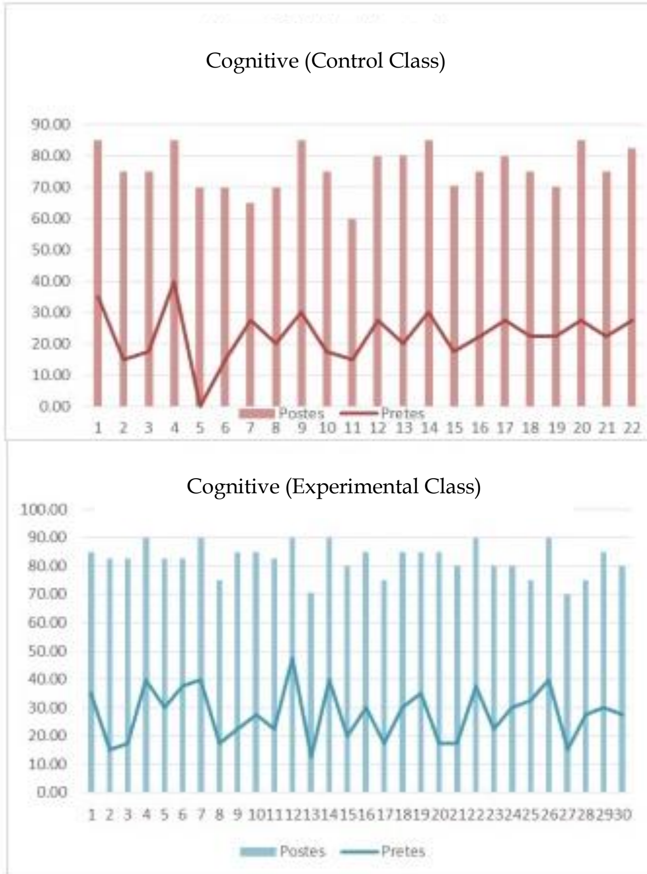


**Figure 7.** Cognitive scores of experimental and control classes

Functionality (F): The average functionality score is 85%, indicating a well-implemented set of core features as evaluated by the four experts. Cooperative Project Based Learning (C): The average success rate in supporting Cooperative Project Based Learning is 75.62%, demonstrating a commendable level of success with room for improvement. Average Response Time (W): The average response time is 3.5 seconds, signifying a relatively prompt system response to user actions. Number of Concurrent Users (U): The average capacity to handle concurrent users is 47.5, illustrating a reasonably robust system capacity.

## Conclusion

The implementation of "Application to Support Smart Learning Environment in Co-operative Project-Based Learning Model on Java Programming Course" revealed promising results. With an average functionality score of 85%, the system demonstrated a commendable implementation of the core features, confirming its effectiveness in supporting the learning environment. Although the system's success rate in co-operative project-based learning reached 75.62%, there is still room for improvement. The average response time of 3.5 seconds demonstrates the system's fast response, providing a smooth user experience. In addition, the system demonstrated a strong capacity to handle concurrent users, with an average of 47.5. In conclusion, while this application shows striking advantages in functionality and user interaction, it is recommended to continue making refinements and targeted improvements to increase its effectiveness in supporting co-operative project-based learning in Java Programming Course.

**Acknowledgments**
Author thanks to all subject in most cases, sponsor and financial support acknowledgments.

**Author Contributions**
Our research group has been dedicated to enhancing learning outcomes and addressing societal challenges. Our primary research activities involve the development of innovative educational tools and methods to provide personalized learning experiences and to investigate the impact of technology on student engagement and academic achievement.

**Funding**
No funding was received.

**Conflicts of Interest**
The authors declare that they have no competing interests.

## References

Adriyawati, A., Utomo, E., Rahmawati, Y., & Mardiah, A. (2020). STEAM-Project-Based Learning Integration to Improve Elementary School Students' Scientific Literacy on Alternative Energy Learning. *Universal Journal of Educational Research*, *8*(5), 1863–1873. https://doi.org/10.13189/ujer.2020.080523

Agbo, F. J., & Oyelere, S. S. (2019). *Smart Mobile Learning Environment for Programming Education in Nigeria: Adaptivity and Context-Aware Features*. https://doi.org/10.1007/978-3-030-22868-2_71

Ahmad, K., & Gestwicki, P. (2013). Studio-based learning and app inventor for android in an introductory CS course for non-majors. *Proceeding of the 44th ACM Technical Symposium on Computer Science Education*, 287–292. https://doi.org/10.1145/2445196.2445286

Andry, A. B. (2023). Pentingnya Pendidikan Inklusif: Menciptakan Lingkungan Belajar Yang Ramah Bagi Semua Siswa. *Jurnal Kajian Pendidikan Dan Psikologi*, *1*(1), 12–19. https://doi.org/10.61397/jkpp.v1i1.10

Azzouz, A., & HAMOU, M. (2022). *A Crowdsourcing Mobile Application and Interactive Learning Analytics Dashboard to enhance Project-Based Learning supported by technology.* Retrieved from http://dspace.univ-tiaret.dz/handle/123456789/5546http://dspace.univ-tiaret.dz/bitstream/123456789/5546/1/TH.M.INF.FR.2022.01.pdf

Ding, Q., & Cao, S. (2017). RECT: A Cloud-Based Learning Tool for Graduate Software Engineering Practice Courses With Remote Tutor Support. *IEEE Access*, *5*, 2262–2271. https://doi.org/10.1109/ACCESS.2017.2664070

Effendi, D., & Wahidy, D. A. (2019). Pemanfaatan Teknologi Dalam Proses Pembelajaran Menuju Pembelajaran Abad 21. *Prosiding Seminar Nasional Pendidikan Program Pascasarjana Universitas Pgri Palembang*, 125–129. Retrieved from https://jurnal.univpgri-palembang.ac.id/index.php/Prosidingpps/article/view/2977/2799

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, *3*, 275–285. https://doi.org/10.1016/j.susoc.2022.05.004

Hamburg, I., Hersh, M., Gavota, M., & Lazea, M. (2004). Open web- based learning environments and knowledge forums to support people with special needs. *Interactive Technology and Smart Education*, *1*(3), 205–216. https://doi.org/10.1108/17415650480000024

Hutchins, N. M., Biswas, G., Zhang, N., Snyder, C., Lédeczi, Á., & Maróti, M. (2020). Domain-Specific Modeling Languages in Computer-Based Learning Environments: a Systematic Approach to Support Science Learning through Computational Modeling. *International Journal of Artificial Intelligence in Education*, *30*(4), 537–580. https://doi.org/10.1007/s40593-020-00209-z

Jazayeri, M. (2015). Combining Mastery Learning with Project-Based Learning in a First Programming Course: An Experience Report. *2015 IEEE/ACM 37th IEEE International Conference on Software Engineering*, 315–318. https://doi.org/10.1109/ICSE.2015.163

Johnson, D. W., Johnson, R. T., & Smith, K. A. (2014). Cooperative Learning: Improving University Instruction by Basing Practice on Validated Theory. *Journal of Excellence in College Teaching*, *25*(4), 85–118. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10180297

Karaahmetoğlu, K., & Korkmaz, Ö. (2019). The effect of project-based arduino educational robot applications on students' computational thinking skills and their perception of Basic Stem skill levels. *Participatory Educational Research*, *6*(2), 1–14.

https://doi.org/10.17275/per.19.8.6.2

Keser, H., & Karahoca, D. (2010). Designing a project management e-course by using project based learning. *Procedia - Social and Behavioral Sciences*, *2*(2), 5744–5754. https://doi.org/10.1016/j.sbspro.2010.03.938

Lin, P.-C., Hou, H.-T., & Chang, K.-E. (2022). The development of a collaborative problem solving environment that integrates a scaffolding mind tool and simulation-based learning: an analysis of learners' performance and their cognitive process in discussion. *Interactive Learning Environments*, *30*(7), 1273–1290. https://doi.org/10.1080/10494820.2020.1719163

Liu, H., Warner, T., Iklé, M., & Mittal, S. (2020). Harness big data by iCycle: intelligent computer-supported hybrid collaborative learning environment. *International Journal of Smart Technology and Learning*, *2*(1), 31. https://doi.org/10.1504/IJSMARTTL.2020.109488

Nurbekova, Z., Grinshkun, V., Aimicheva, G., Nurbekov, B., & Tuenbaeva, K. (2020). Project-Based Learning Approach for Teaching Mobile Application Development Using Visualization Technology. *International Journal of Emerging Technologies in Learning (iJET)*, *15*(08), 130. https://doi.org/10.3991/ijet.v15i08.12335

Nykänen, O., & Ala-Rantala, M. (1998). A Design for a Hypermedia-based Learning Environment. *Education and Information Technologies*, *3*(3), 277–290. https://doi.org/10.1023/A:1009653700008

Samarakoon, U., Manathunga, K., & Imbulpitiya, A. (2022). Theory or Practice: Student Perspective on Project Based Learning Versus Module Based Learning to Improve Technical Skills Among IT Undergraduates. In *Student Perspective on Project Based Learning Versus Module Based Learning to Improve Technical Skills Among IT Undergraduates* (pp. 968–979). https://doi.org/10.1007/978-3-030-93907-6_103

Sancho-Thomas, P., Fuentes-Fernández, R., & Fernández-Manjón, B. (2009). Learning teamwork skills in university programming courses. *Computers & Education*, *53*(2), 517–531. https://doi.org/10.1016/j.compedu.2009.03.010

Tan, P.-H., Ting, C.-Y., & Ling, S.-W. (2009). Learning Difficulties in Programming Courses: Undergraduates' Perspective and Perception. *2009 International Conference on Computer Technology and Development*, 42–46. https://doi.org/10.1109/ICCTD.2009.188