Self-regulation in problem-based blended learning

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ABSTRACT

Self-regulation is pivotal for student success in the 21st-century learning landscape, enabling learners to effectively manage their academic goals and processes. This research investigates the impact of problem-based blended learning on students' self-regulation skills. A quasi-experimental design was employed, featuring a non-randomized control group. The experimental group was exposed to problem-based blended learning, while the control group experienced traditional face-to-face problem-based learning. The study involved 65 students from SMA Negeri 1 Prambanan, with self-regulation assessed through a closed questionnaire addressing nine key indicators. Data analysis revealed no significant difference in self-regulation between the control and experimental groups; however, the experimental group showed better outcomes. This group's higher performance in self-regulation was attributed to the flexible, interactive, and time-independent nature of blended learning, which fosters better time management, environmental structuring, and goal-setting among students. The findings underscore the potential of problem-based blended learning to enhance students' self-regulatory capacities, ultimately contributing to improved academic achievement and the development of essential 21st-century skills.

1. Introduction

Self-regulation plays a crucial role in 21st-century learning; It encompasses learners' beliefs about their ability to engage in appropriate actions, thoughts, feelings, and behaviors to pursue valuable academic goals [1]. In today's fast-paced and increasingly competitive academic environment, student self-regulation has become crucial in determining success. Self-regulation is evident in the learning process [2]. Self-regulation is important for monitoring and controlling studies to achieve the expected goals in learning [3], [4]. Developing self-regulation skills is essential for students, enabling them to engage in independent work and take charge of their motivation and educational pathway [5], [6]. Furthermore, self-regulation is linked to achieving desired learning outcomes and 21st-century skills, emphasizing the importance of learner responsibility in the learning process [7], [8]. Self-regulation is closely associated with developing various skills and competencies [9], [10]. Various studies have shown that self-regulated learning plays a significant role in academic achievement in different educational stages and is highly valued in the 21st-century workforce [11]–[15]. For instance, it has been found that self-regulation positively influences students' 21st-century skills, such as a positive attitude toward science and technology, critical thinking, and readiness for online learning [16]–[18]. Moreover, integrating self-regulation into the learning process is essential for developing professional competence and self-actualization among students in modern educational environments [19], [20]. Students' self-regulation can be learned by implementing a learning model in the class. Problem-based blended learning is a learning model that can be used to shape student self-regulation. Problem-based blended learning is a model that combines problem-based learning with blended learning (asynchronous and synchronous). Problem-based blended learning is a learning model that can be attempted to shape student self-regulation. Problem-based blended learning is a model that combines

problem-based learning with blended learning (asynchronous - synchronous). This is an effort to overcome the obstacles of problem-based learning and integration with digital literacy [21].

Blended learning is carried out through e-learning intermediaries to achieve far more optimal learning [22], [23]. Learning independence in blended learning can be seen in asynchronous times when students carry out independent learning activities outside of learning hours. Students must arrange how to study to understand the material, manage time, and determine the appropriate learning environment. Without a teacher, students are responsible for deciding what, why, where, when, and how learning should take place [11]. Effective blended learning can emerge because of the provision in self-regulation [24], [25]. Blended learning requires the ability to self-manage to achieve academic goals according to each student's pattern [24]–[26]. Stage Asynchronous can prepare students to understand the concept knowledge from the learning material. Learners can bring knowledge, conceptions, and habits that can influence their activities in the learning process [27], [28]. Thus, students need to be aware of the importance of self-regulation to display far more optimal learning outcomes [29]. To realize this, researchers conducted research using problem-based blended learning to measure students' self-regulated abilities. This research reveals the role of problem-based blended learning in student self-regulation. which later self-regulation can play a role in problem solving and student achievement.

2. Method

2.1. Research type and design

This quasi-experimental study used a nonrandomized control group design. The treatment design was given problem-based learning using blended learning (problem-based blended learning) as an experiment class and problem-based learning by face-to-face class as a control class. Blended learning is carried out in three meetings. Self-regulated measurements were carried out at the 3rd meeting using a closed questionnaire filled in by students with four answer choices (always, often, sometimes, and never). The nine indicators for self-regulated measurements are (1) Self-evaluation; (2) Goal setting and planning; (3) seeking information; (4) Keeping Records and monitoring; (5) Environmental structuring; (6) Self-consequences; (7) Self-learning; (8) Seeking and assisting; (9) Reviewing records [30], [31].

2.2. Population and Research Samples

The population in this study were students of class XI MIPA at SMA Negeri 1 Prambanan, which consisted of 4 classes. The sampling technique uses purposive sampling with criteria for the average score classes in the biology subjects at the end of the 2022/2023 odd semester assessment, which is identical or almost the same. The samples used in this study were class XI MIPA 1 with 34 students (experiment class) and XI MIPA 2 with 31 students (control class).

2.3. Data Analysis

Data analysis techniques consisted of analysis prerequisite tests: normality (Kolmogorov-Smirnov) and homogeneity (Levene's test). The hypothesis testing used the Mann-Whitney U Test—data tabulation on self-regulated aspects based on the categories listed in Table 1.

Table 1. Category of Self-Regulated

Interval	Category
$M < 61.03$	Low
$61.03 \leq X < 77.80$	Moderate
$X > 77.80$	High

3. Results and Discussion

Self-regulated data from 65 students were analyzed by prerequisite tests for normality (Kolmogorov-Smirnov) and homogeneity (Levene test) with a significant level of 5%. The results show that the self-regulated data is not normally distributed but is homogeneous (Table 2).

Table 2. The Result of Normality and Homogeneity Test

Test		Kolmogorov-Smirnov	Levene Statistic
		Sig.	***Sig.***
Self-Regulated	Experiment	.000	.358
	Control	.000	

Based on the prerequisite test results in Table 2, hypothesis testing was carried out non-parametrically using the Mann-Whitney U-Test. The results of the Mann-Whitney u-test are presented in Table 3.

Table 3. The Result of Mann-Whitney U-Test

Null Hypothesis	Test	Sig.	Decision
The distribution of Self-Regulated the same across categories of treatment class	Independent Samples Mann-Whitney U Test	.348	Retain the null hypothesis

Table 3 shows that self-regulation in the control and experimental classes showed no significant difference in the mean. So, it can be stated that problem-based blended learning does not affect self-regulation. However, despite no significant effect, the experimental class showed better results than the control class. Based on the grouping of self-regulated categories (shown in Fig. 1) indicates a difference in the percentage of self-regulated in the experimental, which is greater than in the control class.

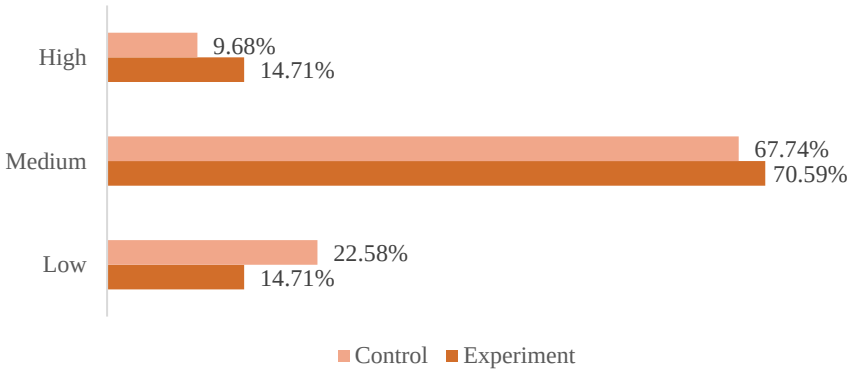
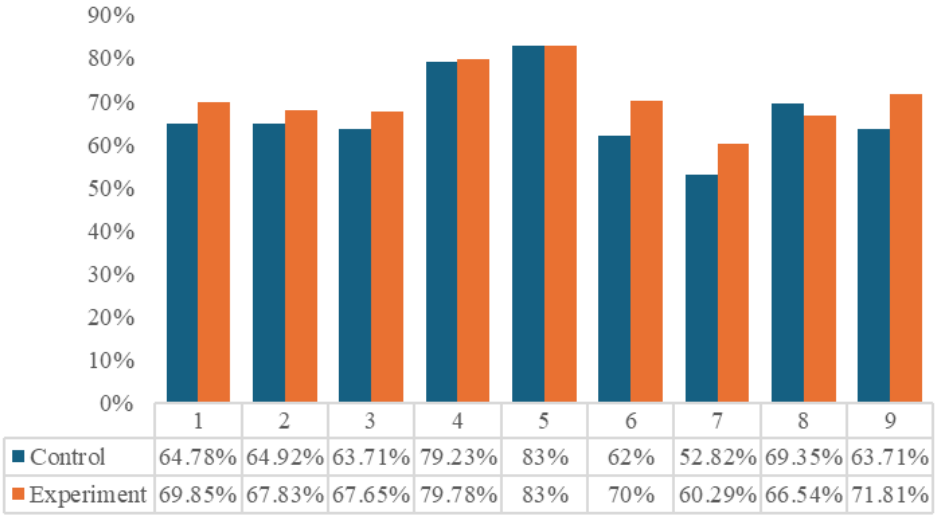


Fig. 1. Percentage Self-Regulated based on criteria

Fig. 1 shows that the experimental class has a more significant percentage in the medium and high categories. These results are because the learning process using blended learning is not hampered by time, place, and situations that allow for higher-quality interactions between teachers and students [32]. A blended learning activity was implemented using "LMS Vigara Media Didik" SMA Negeri 1 Prambanan. Students feel a new atmosphere when discussing online. The discussion through "LMS Vigara Media Didik" is a new, unique experience for students because the LMS has only been used to collect assignments. Researchers provide variations of teaching materials presented in the LMS through videos and images. Blended learning makes students not only focused on activities in class, which are limited by time [33]. In this case, Blended learning helps students manage their time learning [34], [35], through asynchronous activities. The student's ability in learning management can trigger learning independence in students. Students can determine the appropriate place or environment to carry out learning. The time specified is not limited to creating more exploration related to the material presented. The learning environment and time management are essential for students to pay attention to. A responsive, proactive, and conducive learning atmosphere can support the continuity of the learning process [36], [37]. The ability of students to divert attention and time to focus more on tasks tends to produce better learning [38]. Several self-regulated aspects have percentage values above 60% (Fig. 2).

Based on Fig. 2, the lowest percentage of aspects in control and experimental classes is in the aspect of Self-learning (no 7). Self-learning enhances the learning experience and creates valuable skills [39], [40]. Self-learning is affected by several factors, including learning motivation, self-confidence, experience, and intelligence [41]–[43]. The involvement of students in the learning process can improve students' abilities, including the ability to gather information and write. Writing

ability can be identified in the process of extracting information that is arranged into a paragraph [44]. The summary of the information obtained can help students understand the material better [45]. Lack of self-confidence in writing and students' lack of knowledge regarding writing outlines, paraphrasing, and summarizing inhibit students' writing [46]. Less mastery of the material makes students confused about what they want to write [47]. Thus, students' readiness for problem-based blended learning is lacking, and the learning process may not necessarily go according to plan or purpose. Meanwhile, the highest aspect in control and experimental classes is environmental structuring (no 5, Fig. 2), or setting the environment and learning atmosphere to be more comfortable. The learning environment is essential because it will affect students' emotions, including interactions and attitudes closely related to academic achievement [48]. A good learning environment must be built so that character is formed and students can actively participate in learning [49]. A good learning environment can make it easier for students to concentrate and increase comfort in the learning process [50]. Conversely, a bad learning environment causes anxiety, tension, and boredom and frustrates students, hindering learning [51]. Using the LMS and implementing problem-based blended learning helps students determine their learning environment in asynchronous learning. Learning with LMS can create a flexible learning environment for implementing active learning for individuals and groups [52]. Students can interact with teachers and peers through online discussions by writing, reading, and responding to material-related posts [53]–[55]. A mix of online and face-to-face discussion opportunities can allow students to explore tentative ideas in a comfortable environment [56].



	1	2	3	4	5	6	7	8	9
Control	64.78%	64.92%	63.71%	79.23%	83%	62%	52.82%	69.35%	63.71%
Experiment	69.85%	67.83%	67.65%	79.78%	83%	70%	60.29%	66.54%	71.81%

Fig. 2. Percentage of Self-regulated aspects

Students can determine learning plans during an asynchronous session on problem-based blended learning. As in the Goal setting and planning aspect (aspect 2, Fig. 2), the experimental class has a more significant percentage than the control class. Learning planning, such as determining strategies and priorities, is an effective way to help students stay on track [57]. Learners who cannot assess strategy and time priorities tend to be unorganized [58]. Selectively choosing time priorities for learning can create effective learning patterns so that tasks and responsibilities can be realized to the fullest [59], likewise in determining learning strategies contained in the Self-Consequences aspect (aspect 6, Fig. 2). Success in the learning process is influenced by flexible strategies, such as knowing when and how to use learning strategies [60], [61]. Students can learn successfully if they can self-regulate and deeply process information in the learning process [62]. The involvement of students in the learning process can be increased with the support of problem-based learning models [63] and blended learning [64]. Through the problem-based learning model, students identify the characteristics of the problems according to the experiences of students, so they tend to give more value [65]. Especially in problem-based blended learning, teachers can further encourage student involvement in learning, starting with building student participation in asynchronous sessions.

The asynchronous activity begins with students watching the video presented in "LMS Vigara Media Educate." Then, students are directed to carry out online discussions that have been prepared. Online discussions are carried out by analyzing complex problems, causes of problems, and solutions that must be given [66]. This is in line with the syntax of the three problem-based learning models,

namely student inquiry guidance, in which students investigate the topic of the problem and then explore it to obtain relevant information [65]. The teacher is a facilitator and guides students individually and in groups [67]. The role of the teacher in this investigation is in line with the aspect of seeking social assistance (aspect 8, Fig. 2), in which students seek help from teachers and classmates. The percentage of aspect 8 in the experimental class is lower than in the control class. Investigation of problems in the experimental class is far more optimal because of asynchronous activities. Asynchronous activities allow students to search for information to solve problems without a time limit [68]. This aligns with seeking information (aspect 3, Fig. 2), where the experimental class has a more significant percentage than the control class. In the control class, information seeking is limited only to implementing learning in class, so students' exploration time is less, and students' focus on problems is reduced. In problem-based blended learning, asynchronous activity can support the students to prepare to join in class [35], [55], [69], [70] so activities in class are more effective. Student's focus on the problems presented can be known through follow-up learning carried out by students. The follow-up aligns with the fourth problem-based learning syntax: developing and presenting the work after the discussion ends. In the Keeping Records and Monitoring aspect (aspect 4, Fig. 2), students synchronously work on material-related assignments (face to face in class) and present in a presentation. The percentage of these aspects in the control and experimental classes is not much different and is relatively high, above 70%. This indicates that the students were interested in the learning activities design compiled. High interest in the learning process affects students' understanding [71], [72]. This understanding makes it easier for students to carry out aspects of self-evaluation or self-evaluation (aspect 1, Fig. 2) to review material that has been previously studied [34], [54], [73]. If problem-based blended learning is often used in the biology learning process, it can further encourage students to self-regulate in the learning process. Researchers believe it will positively impact cognitive, affective, and psychomotor, including 21st-century skills.

4. Conclusion

Problem-based blended learning has not shown a significant effect on self-regulation. However, based on the grouping of self-regulation categories, the experimental class has a more substantial percentage than the control class. Problem-based blended learning helps students create independent learning, demonstrated through asynchronous learning, which encourages students to determine the learning environment, time priorities, and study planning and look for information related to the problem to be analyzed. Asynchronous activities make synchronous activities more efficient. In the future, problem-based blended learning must be used continuously to form self-regulation abilities. The study suggests that the blended learning approach, which integrates asynchronous and synchronous activities, enhances students' ability to manage their learning environments and time, leading to more effective and independent learning experiences. These findings underscore the potential of blended learning to foster critical 21st-century skills, such as self-regulation, critical thinking, and adaptability, essential for academic success and professional competence.

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References

[1] H. Bembenutty, "New directions for self-regulation of learning in postsecondary education," *New Dir. Teach. Learn.*, vol. 2011, no. 126, pp. 117–124, Jun. 2011, doi: 10.1002/tl.450.

[2] I. M. Van Eekelen, H. P. A. Boshuizen, and J. D. Vermunt, "Self-regulation in Higher Education Teacher Learning," *High. Educ.*, vol. 50, no. 3, pp. 447–471, Oct. 2005, doi: 10.1007/s10734-004-6362-0.

[3] F. O'Dwyer and J. Runnels, "Bringing Learner Self-Regulation Practices Forward," *Studies in Self-Access Learning Journal*. pp. 404–422, 01-Dec-2014, doi: 10.37237/050408.

[4] J. Pange, "Self regulated learning strategies in groups of learners," *Tiltai*. pp. 169–182, 14-Apr-2021, doi: 10.15181/tbb.v66i1.785.

[5] I. Tosuncuoglu, "The Interconnection of Motivation and Self Regulated Learning Among University Level EFL Students," *English Lang. Teach.*, vol. 12, no. 4, pp. 105–114, Mar. 2019, doi: 10.5539/elt.v12n4p105.

[6] T. G. Fomina, E. V. Filippova, and V. I. Morosanova, "Longitudinal Study of the Relationship Between Conscious Self-Regulation, School Engagement and Student Academic Achievement," *Psychol. Sci. Educ.*, vol. 26, no. 5, pp. 30–42, 2021, doi: 10.17759/pse.2021260503.

[7] M. S. Andrade, "Curricular Elements for Learner Success—21st Century Skills," *J. Educ. Train. Stud.*, vol. 4, no. 8, pp. 143–149, Jul. 2016, doi: 10.11114/jets.v4i8.1743.

[8] J. M. Russell, C. Baik, A. T. Ryan, and E. Molloy, "Fostering self-regulated learning in higher education: Making self-regulation visible," *Act. Learn. High. Educ.*, vol. 23, no. 2, pp. 97–113, Jul. 2022, doi: 10.1177/1469787420982378.

[9] K. Wilson and A. Narayan, "Relationships among individual task self-efficacy, self-regulated learning strategy use and academic performance in a computer-supported collaborative learning environment," *Educ. Psychol.*, vol. 36, no. 2, pp. 236–253, Feb. 2016, doi: 10.1080/01443410.2014.926312.

[10] J. Li, H. Ye, Y. Tang, Z. Zhou, and X. Hu, "What Are the Effects of Self-Regulation Phases and Strategies for Chinese Students? A Meta-Analysis of Two Decades Research of the Association Between Self-Regulation and Academic Performance," *Frontiers in Psychology*, vol. 9. p. 2434, 18-Dec-2018, doi: 10.3389/fpsyg.2018.02434.

[11] D. Ramdass and B. J. Zimmerman, "Developing Self-Regulation Skills: The Important Role of Homework," *J. Adv. Acad.*, vol. 22, no. 2, pp. 194–218, Feb. 2011, doi: 10.1177/1932202X1102200202.

[12] S. O. Adodo, "Effect of Mind-Mapping as a Self-Regulated Learning Strategy on Students' Achievement in Basic Science and Technology," *Mediterr. J. Soc. Sci.*, vol. 4, no. 6, pp. 163–172, Jul. 2013, doi: 10.5901/mjss.2013.v4n6p163.

[13] S. G. Paris and A. H. Paris, "Classroom Applications of Research on Self-Regulated Learning," *Educ. Psychol.*, vol. 36, no. 2, pp. 89–101, Jun. 2001, doi: 10.1207/S15326985EP3602_4.

[14] A. Fadillah, D. Nopitasari, W. Bilda, S. A. Immawati, and S. Raharjo, "Analysis Of Student Learning Independence On Blended Learning Model," *Kreano, J. Mat. Kreat.*, vol. 13, no. 2, pp. 308–318, Nov. 2022, doi: 10.15294/kreano.v13i2.38512.

[15] S. Xiao, K. Yao, and T. Wang, "The Relationships of Self-regulated Learning and Academic Achievement in University Students," *SHS Web Conf.*, vol. 60, p. 01003, Jan. 2019, doi: 10.1051/shsconf/20196001003.

[16] K. Karatas and I. Arpaci, "The Role of Self-directed Learning, Metacognition, and 21st Century Skills Predicting the Readiness for Online Learning," *Contemp. Educ. Technol.*, vol. 13, no. 3, p. ep300, Mar. 2021, doi: 10.30935/cedtech/10786.

[17] S.-R. Xu and S.-N. Zhou, "The effect of students' attitude towards science, technology, engineering, and mathematics on 21st century learning skills: A structural equation model," *J. Balt. Sci. Educ.*, vol. 21, no. 4, pp. 706–719, Aug. 2022, doi: 10.33225/jbse/22.21.706.

[18] A. KuloĞLu and V. Karabekmez, "The Relationship Between 21st-century Teacher Skills and Critical Thinking Skills of Classroom Teacher," *Int. J. Psychol. Educ. Stud.*, vol. 9, no. 1, pp. 91–101, Mar. 2022, doi: 10.52380/ijpes.2022.9.1.551.

[19] S. V. Karkina, L. T. Fajzrahmanova, and A. V. Gluzman, "Subject-Oriented Approach in the Professional Formation of the Future Music Teacher," *J. Hist. Cult. Art Res.*, vol. 6, no. 4, p. 1071, Sep. 2017, doi: 10.7596/taksad.v6i4.1120.

[20] I. Okhrimenko, R. Perkatyi, H. Topchii, Y. Andrusyshyn, and A. Ponomarenko, "Level of Self-Educational Competence of Cadets of Higher Educational Institutions with Specific Training Environment," *Rev. Rom. pentru Educ. Multidimens.*, vol. 14, no. 3, pp. 66–87, Sep. 2022, doi: 10.18662/rrem/14.3/598.

[21] A. A. Tawfik, J. J. Gishbaugher, J. Gatewood, and T. L. Arrington, "How K-12 Teachers Adapt Problem-Based Learning Over Time," *Interdiscip. J. Probl. Learn.*, vol. 15, no. 1, Aug. 2021, doi: 10.14434/ijpbl.v15i1.29662.

[22] R. Fenech, P. Baguant, and I. Abdelwahed, "Blended learning: An experiment on student attitudes," *Int. J. Web-Based Learn. Teach. Technol.*, vol. 16, no. 6, pp. 1–12, Jun. 2021, doi: 10.4018/IJWLTT.20211101.oa13.

[23] A. Kristanto, M. Mustaji, and A. Mariono, "The Development of Instructional Materials E-Learning Based On Blended Learning," *Int. Educ. Stud.*, vol. 10, no. 7, pp. 10–17, Jun. 2017, doi: 10.5539/ies.v10n7p10.

[24] L. Anthonysamy, K. Ah Choo, and H. Soon Hin, "Investigating self-regulated learning strategies for digital learning relevancy," *Malaysian J. Learn. Instr.*, vol. 18, no. 1, pp. 29–64, 2021, doi: 10.32890/mjli2021.18.1.2.

[25] J. A. Greene, D. Z. Copeland, V. M. Deekens, and S. B. Yu, "Beyond knowledge: Examining digital literacy's role in the acquisition of understanding in science," *Comput. Educ.*, vol. 117, pp. 141–159, Feb. 2018, doi: 10.1016/j.compedu.2017.10.003.

[26] L. Anthonysamy, A.-C. Koo, and S.-H. Hew, "Self-regulated learning strategies and non-academic outcomes in higher education blended learning environments: A one decade review," *Educ. Inf. Technol.*, vol. 25, no. 5, pp. 3677–3704, Sep. 2020, doi: 10.1007/s10639-020-10134-2.

[27] D. L. Butler and S. C. Cartier, "Advancing Research and Practice about Self-Regulated Learning," in *Handbook of Self-Regulation of Learning and Performance*, Routledge, 2017, pp. 352–369. doi: 10.4324/9781315697048-23

[28] S. Järvelä, H. Järvenoja, J. Malmberg, J. Isohätälä, and M. Sobocinski, "How do types of interaction and phases of self-regulated learning set a stage for collaborative engagement?," *Learn. Instr.*, vol. 43, pp. 39–51, Jun. 2016, doi: 10.1016/j.learninstruc.2016.01.005.

[29] A. Efklides, "Interactions of Metacognition With Motivation and Affect in Self-Regulated Learning: The MASRL Model," *Educ. Psychol.*, vol. 46, no. 1, pp. 6–25, Jan. 2011, doi: 10.1080/00461520.2011.538645.

[30] B. Cahyanto and M. Afifulloh, "Instrumen Self-Asessment Berbasis Self-Regulated Learning untuk Penilaian Keterampilan Dasar Mengajar Mahasiswa," *J. Pendidik. Teor. Penelitian, dan Pengemb.*, vol. 6, no. 3, p. 345, Mar. 2021, doi: 10.17977/jptpp.v6i3.14608.

[31] N. Purdie, J. Hattie, and G. Douglas, "Student conceptions of learning and their use of self-regulated learning strategies: A cross-cultural comparison.," *J. Educ. Psychol.*, vol. 88, no. 1, pp. 87–100, Mar. 1996, doi: 10.1037/0022-0663.88.1.87.

[32] N. Kamarni and H. Rahadian, "Blended Learning in Improving Self-Regulated Learning and Student Quality in Islamic Microeconomic Course," in *The 3rd International Conference on Educational Development and Quality Assurance (ICED-QA 2020)*, 2021, pp. 550–556, doi: 10.2991/assehr.k.210202.095.

[33] E. R. Mulyaningrum and R. C. Rachmawati, "The effectiveness of blended learning on plant development structure lectures," *J. Bioedukatika*, vol. 8, no. 1, pp. 7–14, Feb. 2020, doi: 10.26555/bioedukatika.v8i1.11427.

[34] K. Ting and M. Chao, "The Application of Self-Regulated Strategies to Blended Learning," *English Lang. Teach.*, vol. 6, no. 7, pp. 26–32, Jun. 2013, doi: 10.5539/elt.v6n7p26.

[35] M. F. Saifuddin, "E-Learning dalam Persepsi Mahasiswa," *J. VARIDIKA*, vol. 29, no. 2, pp. 102–109, Jan. 2018, doi: 10.23917/varidika.v29i2.5637.

[36] D. Bylieva, J.-C. Hong, V. Lobatyuk, and T. Nam, "Self-Regulation in E-Learning Environment," *Educ. Sci.*, vol. 11, no. 12, pp. 1–23, Dec. 2021, doi: 10.3390/educsci11120785.

[37] Y. Gambo and M. Z. Shakir, "Review on self-regulated learning in smart learning environment," *Smart Learn. Environ.*, vol. 8, no. 12, pp. 1–14, Dec. 2021, doi: 10.1186/s40561-021-00157-8.

[38] D. Wicks *et al.*, "An Evaluation of Low Versus High-Collaboration in Online Learning," *Online Learn.*, vol. 19, no. 4, Jun. 2015, doi: 10.24059/olj.v19i4.552.

[39] U. Kose and A. Arslan, "Optimization of self-learning in Computer Engineering courses: An intelligent software system supported by Artificial Neural Network and Vortex Optimization Algorithm," *Comput. Appl. Eng. Educ.*, vol. 25, no. 1, pp. 142–156, Jan. 2017, doi: 10.1002/cae.21787.

[40] S.-H. Liu, "Effects of Self-Perceptions on Self-Learning among Teacher Education Students," *Int. Educ. Stud.*, vol. 8, no. 10, pp. 63–71, Sep. 2015, doi: 10.5539/ies.v8n10p63.

[41] A.-M. Cazan and B.-A. Schiopca, "Self-directed Learning, Personality Traits and Academic Achievement," *Procedia - Soc. Behav. Sci.*, vol. 127, pp. 640–644, Apr. 2014, doi: 10.1016/j.sbspro.2014.03.327.

[42] S. Lang, "Key factors influencing the maintenance of adult learners' literacy skills levels: A follow-up study of three participant cohorts of the literacy programme in Cambodia," *Int. Rev. Educ.*, vol. 67, no. 5, pp. 611–636, Oct. 2021, doi: 10.1007/s11159-021-09913-x.

[43] M. T. A. Simarmata, G.-G. Lee, H. Ajicahyadi, and K.-J. Wang, "Determinant factors of distance self-learning performance on computer programming language education - a concept map approach," *Education and Information Technologies*. 22-Aug-2023, doi: 10.1007/s10639-023-12142-4.

[44] Syamsuarni, Jufrizal, and Y. Rozimela, "Collaborative Paragraph Writing in Students' Writing Skill," in *the Advances in Social Science, Education and Humanities Research: Proceedings of the Eighth International Conference on English Language and Teaching (ICOELT-8 2020)*, 2021, doi: 10.2991/assehr.k.210914.029.

[45] Krishnaveni P and Balasundaram S R, "Summarizing Learning Materials Using Graph Based Multi-Document Summarization," *Int. J. Web-Based Learn. Teach. Technol.*, vol. 16, no. 5, pp. 39–57, Sep. 2021, doi: 10.4018/IJWLTT.20210901.oa3.

[46] H. Al Fadda, "Difficulties in Academic Writing: From the Perspective of King Saud University Postgraduate Students," *English Lang. Teach.*, vol. 5, no. 3, pp. 123–130, Feb. 2012, doi: 10.5539/elt.v5n3p123.

[47] J. Elander, K. Harrington, L. Norton, H. Robinson, and P. Reddy, "Complex skills and academic writing: a review of evidence about the types of learning required to meet core assessment criteria," *Assess. Eval. High. Educ.*, vol. 31, no. 1, pp. 71–90, Feb. 2006, doi: 10.1080/02602930500262379.

[48] C. L. Rucinski, J. L. Brown, and J. T. Downer, "Teacher–child relationships, classroom climate, and children's social-emotional and academic development.," *J. Educ. Psychol.*, vol. 110, no. 7, pp. 992–1004, Oct. 2018, doi: 10.1037/edu0000240.

[49] H. Çalışkan, "An Investigation into the Organization Levels of Social Studies Teachers with regard to Constructivist Learning Environments in Terms of Several Variables," *J. Soc. Stud. Educ. Res.*, vol. 6, no. 1, pp. 49–83, May 2015, doi: 10.17499/jsser.00913.

[50] E. Ibem, O. Alagbe, and A. Owoseni, "A study of students' perception of the learning environment : Case study of department of architecture, Covenant University, Ota Ogun State," in *the International Technology, Education and Development Conference, Valencia, Spain*, 2017, pp. 6275–6286, doi: 10.21125/inted.2017.1455.

[51] M. K. Mustami, "The relationship between self-adjustment, social support from peers, and self-regulation with learning outcomes among high school students in biology," *Pertanika J. Sci. Humanit.*, vol. 27, no. 2, pp. 925–935, 2019.

[52] B. Ayçiçek and T. Yanpar Yelken, "The Effect of Flipped Classroom Model on Students' Classroom Engagement in Teaching English," *Int. J. Instr.*, vol. 11, no. 2, pp. 385–398, Apr. 2018, doi: 10.12973/iji.2018.11226a.

[53] A. A. Koehler, Z. Cheng, H. Fiock, S. Janakiraman, and H. Wang, "Asynchronous Online Discussions During Case-Based Learning: A Problem-Solving Process," *Online Learn.*, vol. 24, no. 4, pp. 64–92, Dec. 2020, doi: 10.24059/olj.v24i4.2332.

[54] L. Yu-Ling, "The integration of technology and aesthetics when student teachers undertake blended learning in adolescent psychology: An interdisciplinary approach," *Educ. Res. Rev.*, vol. 9, no. 20, pp. 1002–1012, Oct. 2014, doi: 10.5897/ERR2014.1874.

[55] M. K. Chowdhury and F. B. P. Behak, "Implementing Blended Learning in Bangladeshi Universities: Challenges and Opportunities from Student Perspectives," *Utamax J. Ultim. Res. Trends Educ.*, vol. 4, no. 2, pp. 168–185, Aug. 2022, doi: 10.31849/utamax.v4i2.8182.

[56] K. Callis-Duehl, R. Idsardi, E. A. Humphrey, and R. D. Gougis, "Missed Opportunities for Science Learning: Unacknowledged Unscientific Arguments in Asynchronous Online and Face-to-Face Discussions," *J. Sci. Educ. Technol.*, vol. 27, no. 1, pp. 86–98, Feb. 2018, doi: 10.1007/s10956-017-9710-4.

[57] I. A. Ajayi, "School Plants Planning and Students' Learning Outcomes in South West Nigerian Secondary Schools," *Int. J. Educ. Sci.*, vol. 02, no. 01, pp. 47–53, Apr. 2010, doi: 10.31901/24566322.2010/02.01.06.

[58] F. G. Karaoğlan Yılmaz, "The relationship between metacognitive awareness and online information searching strategies," *Pegem Eğitim ve Öğretim Derg.*, vol. 6, no. 4, pp. 447–468, Nov. 2016, doi: 10.14527/pegegog.2016.022.

[59] J. Blegur, M. R. P. Wasak, and M. Souisa, "The correlation between time management and student learning outcomes in physical education," *Facta Univ. Ser. Phys. Educ. Sport*, vol. 17, no. 2, pp. 289–298, Nov. 2019, doi: 10.22190/FUPES190702027B.

[60] J. Lee, J. Husman, S. B. Green, and S. K. Brem, "Development and validation of the persistent academic possible selves scale for adolescents (PAPSS)," *Learn. Individ. Differ.*, vol. 52, pp. 19–28, Dec. 2016, doi: 10.1016/j.lindif.2016.09.005.

[61] H. Astleitner, "Multidimensional engagement in learning-an integrated instructional design approach," *J. Instr. Res.*, vol. 7, no. 1, Aug. 2018, doi: 10.9743/JIR.2018.1.

[62] M. Wijnen, S. M. M. Loyens, G. Smeets, M. Kroeze, and H. van der Molen, "Comparing problem-based learning students to students in a lecture-based curriculum: learning strategies and the relation with self-study time," *Eur. J. Psychol. Educ.*, vol. 32, no. 3, pp. 431–447, Jul. 2017, doi: 10.1007/s10212-016-0296-7.

[63] R. A. Tarmizi, M. A. A. Tarmizi, N. I. Lojinin, and M. Z. Mokhtar, "Problem-based learning: engaging students in acquisition of mathematical competency," *Procedia - Soc. Behav. Sci.*, vol. 2, no. 2, pp. 4683–4688, 2010, doi: 10.1016/j.sbspro.2010.03.750.

[64] D. M. Leidl, L. Ritchie, and N. Moslemi, "Blended learning in undergraduate nursing education – A scoping review," *Nurse Educ. Today*, vol. 86, p. 104318, Mar. 2020, doi: 10.1016/j.nedt.2019.104318.

[65] N. Sockalingam and H. G. Schmidt, "Characteristics of Problems for Problem-Based Learning: The Students' Perspective," *Interdiscip. J. Probl. Learn.*, vol. 5, no. 1, Mar. 2011, doi: 10.7771/1541-5015.1135.

[66] S.-Y. Wu, H.-T. Hou, W.-Y. Hwang, and E. Z.-F. Liu, "Analysis of Learning Behavior in Problem-Solving-Based and Project-Based Discussion Activities within the Seamless Online Learning Integrated Discussion (SOLID) System," *J. Educ. Comput. Res.*, vol. 49, no. 1, pp. 61–82, Jul. 2013, doi: 10.2190/EC.49.1.c.

[67] G. P. R. Dewi and M. H. Santosa, "Students' perception on the facilitation strategies provided by teachers in asynchronous online discussion," *LLT J. A J. Lang. Lang. Teach.*, vol. 25, no. 1, pp. 160–170, May 2022, doi: 10.24071/llt.v25i1.3579.

[68] A. A. Koehler, Z. Cheng, H. Fiock, S. Janakiraman, and H. Wang, "Asynchronous Online Discussions During Case-Based Learning: A Problem-Solving Process," *Online Learn.*, vol. 24, no. 4, Dec. 2020, doi: 10.24059/olj.v24i4.2332.

[69] M. A. Ashraf, S. M. Tsegay, and Y. Meijia, "Blended Learning for Diverse Classrooms: Qualitative Experimental Study With In-Service Teachers," *SAGE Open*, vol. 11, no. 3, p. 215824402110306, Jul. 2021, doi: 10.1177/21582440211030623.

[70] K.-A. Berga *et al.*, "Blended learning versus face-to-face learning in an undergraduate nursing health assessment course: A quasi-experimental study," *Nurse Educ. Today*, vol. 96, p. 104622, Jan. 2021, doi: 10.1016/j.nedt.2020.104622.

[71] R. Heckman, C. S. Ã˜sterlund, and J. Saltz, "Blended Learning at the Boundary: Designing a New Internship," *Online Learn.*, vol. 19, no. 3, Feb. 2015, doi: 10.24059/olj.v19i3.671.

[72] B. R. Stockwell, M. S. Stockwell, M. Cennamo, and E. Jiang, "Blended Learning Improves Science Education," *Cell*, vol. 162, no. 5, pp. 933–936, Aug. 2015, doi: 10.1016/j.cell.2015.08.009.

[73] C. M. Tang and L. Y. Chaw, "Digital Literacy: A Prerequisite for Effective Learning in a Blended Learning Environment?.," *Electron. J. E-learning*, vol. 14, no. 1, pp. 54–65, 2016.