

Student collaboration skills post-implementation of the WE-ARe model

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Abstract: Collaboration skills are fundamental to helping students face challenges in education and work. However, there is limited research on students' collaboration skills, particularly using a specific model. This present study aims to analyze the influence of the Warm-up, Exploring, Argumentation, Resume (WE-ARe) model on students' collaboration skills. We employed a quasi-experimental design with a Pre-test and Post-test Group Design. The sample was Islamic High School of Eleventh Grade Natural Science Program-2, totalling 28 people. The data was obtained through questionnaires, observation, and interview questions with instruments validated by experts and empirical processes. The *t*-test results show that the WE-ARe learning model significantly influences students' collaboration skills with a *t*-count of 47.753 (*sig.* 0.000). This finding indicates that the research hypothesis concerning differences in students' pre-test and post-test collaboration skills in the WE-ARe learning model was accepted, signifying that the WE-ARe learning model improves students' collaboration skills. It can be concluded that the WE-ARe model influences students' collaboration skills. This finding implies that the WE-ARe model can be an alternative innovative model in accommodating students' collaboration skills in learning.

Keywords: Collaboration skills; learning model; high school students; WE-ARe.

1. Introduction

The 21st-century skills development is pivotal in all scientific disciplines, including Biology (Ernawati & Sari, 2022). This century requires students' variety of skills to promote learning success and be competitive in their daily life (Amrianto et al., 2024). Accordingly, Science activities convey scientific steps with an iterative process in the form of student activities, such as completing projects and articulating ideas ensuring collaborations that lead to a deeper understanding of the material (Callahan et al., 2022). This is in line with the current demand that the quality of student learning processes and outcomes is directed at achieving high-level thinking abilities and collaboration skills in the industrial era of 4.0 (Hariadi et al., 2022). Thus, it is important that students not only possess conceptual knowledge, but also job skills and professional competencies they need in an ever-changing labour market (González-Cespón et al., 2024).

Collaboration skills are at the heart of education and working force. This skill is hence needed to prepare students to work together actively to achieve success and perform optimally (Sholihah et al., 2023). In this case, collaboration skills entail the skills of working together, active listening, being respectful, communicating ideas, working together, and compromising to achieve a goal (Munthe et al., 2023). Collaboration skills can also impact students' innovative thinking (Kim, 2019). Students who can think

critically, creatively, and collaboratively can reach good conclusions (Senisum et al., 2022) as they can generate new ideas (Zanden et al., 2020). Collaboration also teaches students to interact with peers, developing cognition and performance (Cheruvellil et al., 2020). Such skills can improve students' memory, in which they understand the meaning and concepts of learning as well as learning outcomes (Zahra et al., 2023). Students need to practice collaboration skills to increase their self-efficacy, and to further expand the opportunities to work with outside partners (Hur et al., 2020). Interactive discussions are useful in building collaboration between individuals and group (Nungu et al., 2023).

In practice, students in their study groups can engage in interactive problem-solving discussions to practice collaboration skills (Badriah et al., 2023). Problem-solving is a thinking process that stimulates them to respond to a problem and analyse it. While doing so, students can practise resolving problems, train individuals to collaborate procedurally and systematically (Hujatusnaini et al., 2022). Collaboration in heterogeneous groups calls for students' ability to work together positively in resolving learning problems, characterising their 21st-century skills (Rahardjanto et al., 2019). This demand indicates the need for an appropriate learning model that facilitates learning, which can empower students' collaboration skills in problem-solving and understanding concepts (Prajoko et al., 2023). Students' innovative ideas can emerge from the process of group discussion and collaboration (Wong et al., 2023).

Consequently, students' inability to collaborate becomes the impetus of behaviour tending to pursue individual achievement while ignoring the importance of social interaction (Le et al., 2017). Research shows that students experience problems with certain aspects of collaboration skills, especially in communicating, resolving conflicts effectively, and formulating and reporting collaboration results (Priyambodo et al., 2023). Students' collaboration skills are difficult to develop in such an environment, in which learning emphasises memory and understanding (Hasan & Pardjono, 2019). Learning how to collaborate is rarely considered an educational outcome (Liebech-Lien & Sjølie, 2021). Students become less productive when collaborating since it is difficult for them to accept differences and others' opinions, leaving unshared responsibilities in the group (Putri et al., 2021). Nevertheless, teachers have mostly focused on conventional teaching materials with little development of creativity in the learning process (Fikri & Rahmaniyyah, 2023). Little attention is given to the notion that creative thinking and collaboration skills can be developed through the proper implementation of learning methods, approaches, and models (Hendriyani et al., 2022).

Concurrently, students' low ability to learn is due to less optimal learning models, methods, and learning media within the limited time applied in class. Such unsatisfactory implementation can also be attributed to teachers' limitations to innovate and learn creatively (Anwar et al., 2020). This includes the lack of periodic updates in the learning strategies and models practised by teachers to meet students' learning needs (Asmara et al., 2016). Hence, understanding the causes of ineffective collaboration, such as communication (Popov et al., 2012), can help teachers foster more successful and enjoyable collaborative learning experiences (Le et al., 2018). It can be said that the application of learning that optimises 4C skills for students is rarely carried out comprehensively because teachers still rely on the use of conventional learning with little innovation in learning (Andrian & Rusman, 2019; Aulia, 2022).

The WE-ARe (warm-up, exploring, argumentation, and resume phases) model is an innovative learning model that can accommodate students' learning needs to empower collaboration skills. It is an active learning design that starts from the warm-up, exploring, argumentation, and resume phases. This model is proven to increase self-confidence and generate positive energy in the learning environment, thereby encouraging student learning progress. The WE-ARe model has been proven in much research to influence student learning outcomes (Ainurhayati et al., 2023), metacognitive skills (Adiansyah, Muliana, et al., 2023), communication skills (Adiansyah, Asmah, et al., 2023; Amin et al.,

2024), digital literacy (Amin, Adiansyah, et al., 2023), and critical thinking ability (Amin, Karmila, et al., 2023). Despite these findings, research regarding the effect of WE-ARe on students' collaboration skills at school is currently limited. This present study thus aims to analyse the influence of the WE-ARe model on students' collaboration skills.

2. Materials and Methods

2.1 Types of research

This present study used a quasi-experimental research design. The independent variable was the WE-ARe model and the dependent variable was collaboration skills.

2.2 Research Subjects and Objects

This present study was carried out at Islamic High School 2 Watampone, Kabupaten Bone, Sulawesi Selatan in Grade Natural Science Program. The research period was Semester 2 of the 2022/2023 Academic Year. The population was 80 students of Eleventh Grade Natural Science Program at Islamic High School 2 Watampone with a sample of students of Eleventh Grade Natural Science Program-2 students, totalling 28 people. The research design was a Pre-test Post-test One Group Design.

2.3 Data Types and Sources

The primary data was obtained from collaboration skills, gathered through questionnaires, observation sheets, and questions. The instrument used had been validated both by experts and empirically. The results show that the instrument is valid and reliable.

2.4 Data collection technique

The data was collected through several steps detailed as follows: conducted a pre-test through questionnaires and essay questions; implemented a learning process as an experimental activity; carried out observations to collect data on the implementation of learning syntax and data collaboration skills; conducted a post-test at the last meeting in the forms of questionnaires and essay questions to measure the difference; and provided questionnaires for student responses on the experimental class using the WE-ARe model.

2.5 Data Analysis Techniques Data Analysis Techniques

The obtained data was analysed using a significance level of 5% with the help of SPSS. Prior to doing so, prerequisite tests were first carried out, namely the normality test and homogeneity test. The normality test used the One-Sample Kolmogorov-Smirnov test, and the Homogeneity test used Leven's Test of Equality of Error Variances. The research hypothesis is: there is a difference in the pre-test and post-test of students' Collaboration Skills using the WE-ARe Learning Model.

3. Results

The data collection was carried out through quasi-experimental research on Eleventh Grade Natural Science Program-2 at Islamic High School 2 Watampone, Sulawesi Selatan. The average collaboration skills of students using the WE-ARe model are presented in [Table 1](#).

Table 1. The average of Pre-test and Post-test scores in students' Collaboration Skill

No	Learning Model	Average		Difference
		Pre-test	Post-test	
1.	WE-Are learning model	32.00	89.57	57.57

The average shift in students' pre-test and post-test scores on collaboration skills with the WE-ARe learning model was 57.57. The difference is depicted in the [Figure 1](#).

Next, the normality test of collaboration skills data was carried out, and the results can be seen in Table 2.

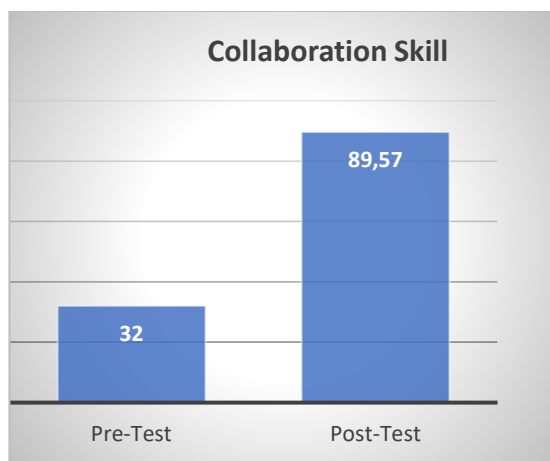


Figure 1. The graph shows the difference in students' scores between pre-test and post-test scores.

Table 2. The normality test of students' Collaboration Skill

	Test	Kolmogorov-Smirnov ^a		
		Statistic	Df	Sig.
Collaboration Skill	Pre-Test	.158	28	.073
	Post-Test	.164	28	.051

The results of the normality test on the collaboration skills obtained significant figures of 0.073 and 0.051 in the WE-ARe learning model. Both values are greater than 0.05, showing the Collaboration Skill data of students in the WE-ARe learning model class does not deviate from the normal distribution. Next, the homogeneity test of collaboration skills data was carried out, and the results can be seen in Table 3.

Table 3. The homogeneity test of students' Collaboration Skill

		Levene Statistic	df1	df2	Sig.
Collaboration Skill	Based on Mean	.123	1	54	.727
	Based on Median	.031	1	54	.860
	Based on the Median and with adjusted df	.031	1	53.457	.860
	Based on trimmed mean	.120	1	54	.731

The results of the homogeneity test on students' Collaboration Skill show a significance figure of more than 0.05, namely 0.727. This figure shows that the variants of the data are not different, meaning the data is homogeneous. At last, hypothesis testing of collaboration skills data was carried out. The research hypothesis is: *there is a difference in the pre-test and post-test of students' Collaboration Skills in the WE-ARe Learning Model*. The test results can be seen in Table 4. The results of the *t*-test on the influence of WE-ARe learning models on students' Collaboration Skills obtained a *t*-count of 47.753 with a significance of 0.000. The significance value is less than 0.05. The figures from the *t*-test results illustrate that H0: *there is no difference between the pre-test and post-test Collaboration Skills in the WE-ARe Learning Model* is **rejected**.

Table 4. Hypothesis test

No	Learning Model	Average			t-count	P value	N Gain
		Pre-test	Post-test	Difference			
1.	Learning Model WE-ARe	32.00	89.57	57.57	47.753	0.000	0.847

4. Discussion

Based on the findings, it is notable that the research hypothesis is accepted: *there is a difference in the pre-test and post-test of students' Collaboration Skills in the WE-ARe Learning Model*. This means that the WE-ARe Learning Model can improve students' Collaboration Skills. Learning activities in the WE-ARe model at the exploring stage successfully provided opportunities for students to collaborate and be active in problem-solving activities. This stage was proven to be able to accommodate students at various levels of academic ability to continue to actualise themselves in various construction and conceptualisation activities. The exploring stage in the WE-ARe learning model facilitates students' knowledge about cognitive models and develops their abilities to organise and control models in learning, thinking, solving problems, and collaborating.

Concurrently, collaborative problem solving is among the 21st century or 4C skills that are essential for successful learning and increased productivity in real work environments (Chiruguru, 2020; Erdoğan, 2019). Collaboration in a partnership/relationship in problem-solving is the key to achieving a highly effective learning process (Bryson, 2016). To continue to create a meaningful learning climate, students' independence and self-regulation skills are needed so that they can construct their knowledge optimally (Arjaya et al., 2023). A collaborative environment based on inclusion, openness, and support allows students to respond to problems and disagreements as they arise (Hussein, 2021).

Our observation results reveal that teachers gave feedback in the form of suggestions and questions rather than direct corrections. In turn, students would respond constructively. This improves students' collaboration skills as they discuss the content they are working on (Saldo & Walag, 2020). This finding follows the notion that in collaboration, students are trained to work together in groups, construct knowledge, participate in decision-making, find the right conclusions to solve problems, and increase control in the learning process (Rahayu et al., 2021). Further, students' constructive criticism of their friends' ideas and products – as well as feedback on group activities – also contribute to improving their critical thinking disposition (Bilici & Yilmaz, 2024; Ölmez, 2023). By practising collaboration skills, students can accept differences by respecting each other and prioritising the common good (Putri et al., 2021).

Students working in groups with different levels of knowledge interact and try to overcome and evaluate their shortcomings (Acharya & Sinha, 2018). In this case, collaborative skills can be strengthened by dividing the class into groups and assigning students to participate in discussion activities (Zahra et al., 2023). Students in one class are extensively diverse, but they also have a high potential for collaboration. This lends strong support to the notion that the collaborative combining of ideas and expertise is necessary for success in learning (Päivi et al., 2017). In particular, empowering collaboration skills can improve student learning outcomes by providing more information and a sense of security in their learning environment (Fuller et al., 2018).

In regards to the teachers' roles, their responsibilities are not limited to the four walls of the classroom or the compensation received, but to the level of students' learning of the necessary skills and their application in their daily lives and in bridging their journey to success (Saldo & Walag, 2020). Hence, teachers' development of innovative learning that empowers collaboration skills is essential. Such endeavour aims to develop quality human resources in the form of independent individuals who are willing to create

prosperity, and equipped with skills useful for the changes and developments of the times (Aulia, 2022). These are the skills needed by students to face and adapt to social changes so that students can survive and compete well in life (Bakti et al., 2022).

Moreover, the improvement of learning quality by collaboration optimisation has a great opportunity to produce collaborative relationships between students to share burdens and responsibilities in planning, implementing, and evaluating processes, thereby synergising in achieving increased performance (Anwar et al., 2020). Collaboration allows groups to make better decisions than doing so individually as students will consider various points of view (Bialik & Fadel, 2015). The set of skills, experiences, and resources within a group can be used to support and empower each other and to encourage the development of each individual (Huang et al., 2018).

To achieve appropriate learning objectives, teacher contributions are needed in implementing effective learning (Zulkifli et al., 2022). Collaborative activities designed by teachers can facilitate the development of collaboration skills in students as demanded by society in the 21st century (Liebech-Lien & Sjølie, 2021). Collaboration is an interactive process in which students work together to achieve a common goal (Lai et al., 2017). Teachers need to build trust in students from the start so that interactive dialogue not only becomes a professional value for teachers but also improves student learning (Khoza, 2024). Collaboration skills are interpersonal arrangements that are more than just cooperation (Davidsen et al., 2020).

Engagement, effort, and persistence in challenging tasks are critical to successful performance outcomes; collaboration and increasing self-efficacy have an impact on performance on assigned tasks (Aikens & Kulacki, 2023). Students who are raised and educated in different environments will acquire different knowledge, cognitive processes, and value systems. Therefore, collaborative learning is likely to produce diverse and innovative ideas (Ramdani et al., 2022). Optimizing students' potential to master concepts requires the integration of appropriate learning strategies (Sigit et al., 2022).

At last, learning strategies can describe how students' will, motivation, and metacognition are realised in the form of real behaviour (Arjaya et al., 2023). Advances in science and technology in this era have increased the amount of information where it is necessary to continuously update individual knowledge and skills (Nijat, 2021). This ability can be empowered by using an effective and efficient learning model (Grooms et al., 2015). Fun learning can leave a deep impression and meaning for students. Each group needs to ensure the right collaboration strategy to solve the problems and tasks given (Van Leeuwen et al., 2023).

5. Conclusion

This present study affirms that the research hypothesis is accepted, in which *there are differences in students' pre-test and post-test collaboration skills using the WE-ARe learning model*. It thus can be concluded that there is an influence of the WE-ARe model on students' collaboration skills. These results are expected to add implications for increasing the body of knowledge related to teachers' innovative empowerment efforts in improving students' collaboration skills. Future researchers can conduct research using different dependent variables at various levels of education.

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6. References

- Acharya, A., & Sinha, D. A. (2018). Mixed Strategy for Collaborative Group Formation and Its Learning Outcomes. *Journal of Educational Technology Systems*, 46(4), 440–462. <https://doi.org/10.1177/0047239517749246>
- Adiansyah, R., Asmah, S., Amin, A. M., Rosmawati, Asfat, M. L., & Suadmi. (2023). Penerapan Model Pembelajaran WE-ARe (Warm-up, Exploring, Argumentation, Resume) terhadap Communication Skills Siswa. *Jurnal Biology Science and Education*, 12(2), 132–141. <https://doi.org/10.33477/bs.v12i2.5667>
- Adiansyah, R., Muliana, Amin, A. M., Asfat, M. L., & Sunusi, S. A. (2023). Pengaruh Model WE-ARe terhadap Metacognitive Skills. *Jurnal Biotek Volume*, 11(2), 158–169. <https://doi.org/10.24252/jb.v11i2.42447>
- Aikens, M. L., & Kulacki, A. R. (2023). Identifying Group Work Experiences That Increase Students' Self-Efficacy for Quantitative Biology Tasks. *CBE Life Sciences Education*, 22(2), 1–20. <https://doi.org/10.1187/cbe.22-04-0076>
- Ainurhayati, Amin, A. M., & Muna, L. (2023). Pengembangan Lembar Kerja Siswa (LKS) Berbasis Model Pembelajaran WE-ARe (Warm-Up, Exploring, Argumentation, Resume) dalam Memfasilitasi Peningkatan Hasil Belajar Kognitif Siswa Kelas XI Di SMA Negeri 6 Kota Ternate. *Jurnal Biology Science and Education*, 12(2), 107–120. <https://doi.org/10.33477/bs.v12i2.5638>
- Amin, A. M., Adiansyah, R., & Hujjatusnaini, N. (2023). The Contribution of Communication and Digital Literacy Skills to Critical Thinking. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, 11(3), 697–712. <https://doi.org/10.24815/jpsi.v11i3.30838>
- Amin, A. M., Adiansyah, R., Mustami, M. K., Yani, A., Hujjatusnaini, N., & Ahmed, M. A. (2024). The Influence of We-Are (Warm-Up, Exploring, Argumentation, Resume) Model Integrated With 21St-Century Skills on Prospective Biology Teachers' Communication Skills. *Jurnal Pendidikan IPA Indonesia*, 13(1), 12–28. <https://doi.org/10.15294/jpii.v13i1.47911>
- Amin, A. M., Karmila, F., Laode, Z. A., Hujjatusnaini, N., Adiansyah, R., & Abbas, S. (2023). The Implementation of WE-ARe Learning Model toward the Critical Thinking of Pre-service Biology Teachers. *Advances in Biological Sciences Research*. https://doi.org/10.2991/978-94-6463-166-1_50
- Amrianto, Rohman, F., Dharmawan, A., & Sari, M. S. (2024). Development of a 4C skills Evaluation Instrument for Biology: A Validity and Reliability Study on Indonesian High School Students Learning. *International Journal of Innovative Research and Scientific Studies*, 7(2), 701–717. <https://doi.org/10.53894/ijirss.v7i2.2873>
- Andrian, Y., & Rusman. (2019). Implementasi Pembelajaran Abad ke-21 dalam Kurikulum 2013. *Jurnal Penelitian Ilmu Pendidikan*, 12, 14–23. <https://doi.org/10.21831/jpipfip.v12i1.20116>
- Anwar, K., Asari, S., Husniah, R., & Asmara, C. H. (2020). Students' Perceptions of Collaborative Team Teaching and Student Achievement Motivation. *International Journal of Instruction*, 14(1), 325–344. <https://doi.org/10.29333/IJI.2021.14119A>
- Arjaya, I. B. A., Hermawan, I. M. S., Ekayanti, N. W., & Paraniti, A. A. I. (2023). Metacognitive Contribution to Biology Pre-Service Teacher's Digital Literacy and Self-Regulated Learning During Online Learning. *International Journal of Instruction*, 16(1), 455–468. <https://doi.org/10.29333/iji.2023.16125a>
- Asmara, C. H., Anwar, K., & Ribeh, M. (2016). EFL Learners' Perception toward an

- Outdoor Learning Program. *International Journal of Education and Literacy Studies*, 4(2), 74–81. <https://doi.org/10.7575/aiac.ijels.v.4n.2p.74>
- Aulia, E. (2022). Effects of 21st Century Learning on the Development of Critical Thinking, Creativity, Communication, and Collaboration Skills. *Journal of Nonformal Education*, 8(1), 46–53. <https://journal.unnes.ac.id/nju/index.php/jne>
- Badriah, L., Mahanal, S., Lukiati, B., & Saptasari, M. (2023). Collaborative Mind Mapping-Assisted RICOSRE to Promote Students' Problem-Solving Skills. *Participatory Educational Research*, 10(4), 166–180. <https://doi.org/10.17275/per.23.65.10.4>
- Bakti, A. M. P., Kristina, D., & Sumardi, S. (2022). An Academic Self-Efficacy as a Predictor of Senior High School Students' Participation in English Debate Club. *AL-ISHLAH: Jurnal Pendidikan*, 14(3), 2625–2636. <https://doi.org/10.35445/alishlah.v14i3.1771>
- Bialik, M., & Fadel, C. (2015). *Skills for the 21st Century: What Should Student Learn?* Center for Curriculum Redesign. https://www.researchgate.net/publication/318681750_Skills_for_the_21st_Century_What_Should_Students_Learn/link/597762f0aca27203ecbdd8c8/download?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19
- Bilici, S., & Yilmaz, R. M. (2024). The Effects of Using Collaborative Digital Storytelling on Academic Achievement and Skill Development in Biology Education. *Education and Information Technologies*, 29, 20243–20266. <https://doi.org/10.1007/s10639-024-12638-7>
- Bryson, C. (2016). Engagement Through Partnership: Students as Partners in Learning and teaching in Higher Education. *International Journal for Academic Development*, 21(1), 84–86. <https://doi.org/10.1080/1360144x.2016.1124966>
- Callahan, K. P., Peterson, C. N., Martinez-Vaz, B. M., Huisinga, K. L., Galport, N., Koletar, C., Eddy, R. M., Provost, J. J., Bell, J. K., & Bell, E. (2022). External Collaboration Results in Student Learning Gains and Positive STEM Attitudes in CUREs. *CBE Life Sciences Education*, 21(4), 1–11. <https://doi.org/10.1187/cbe.21-06-0167>
- Cheruvellil, K. S., Palma-Dow, A. D., & Smith, K. A. (2020). Strategies to Promote Effective Student Research Teams in Undergraduate Biology Labs. *The American Biology Teacher*, 82(1), 18–27. <https://doi.org/10.1525/abt.2020.82.1.18>
- Chiruguru, S. B. (2020). The Essential Skills of 21st Century Classroom (4Cs). In *Shingania University* (Issue March, pp. 1–13). <https://doi.org/10.13140/RG.2.2.36190.59201>
- Davidson, J., Ryberg, T., & Bernhard, J. (2020). “Everything Comes Together”: Students' Collaborative Development of a Professional Dialogic Practice in a Architecture and Design Education. *Thinking Skills and Creativity*, 37(100678). <https://doi.org/10.1016/j.tsc.2020.100678>
- Erdoğan, V. (2019). Integrating 4C Skills of 21st Century into 4 Language Skills in EFL Classes. *International Journal of Education and Research*, 7(11), 113–127. www.ijern.com
- Ernawati, E., & Sari, T. M. (2022). Implementation of Free Inquiry Approach Based on Blended Learning on Creative Thinking and Student Collaboration Skills. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 8(3), 216–225. <https://doi.org/10.22219/jpbi.v8i3.22254>
- Fikri, A. A., & Rahmaniyyah, A. (2023). Development of E-modules Based on Science Literacy and Islamic Values in Ecosystem Materials. *Research and Development in Education (RaDEn)*, 3(2), 58–67. <https://doi.org/10.22219/raden.v3i2.23326>
- Fuller, B., Liu, Y., Bajaba, S., Marler, L., & Pratt, J. (2018). Examining how the personality, self-efficacy, and anticipatory cognitions of potential entrepreneurs shape their entrepreneurial intentions. *Personality and Individual Differences*, 125,

- 120–125. <https://doi.org/10.1016/j.paid.2018.01.005>
- González-Cespón, J. L., Alonso-Rodríguez, J. A., Rodríguez-Barcia, S., Gallego, P. P., & Pino-Juste, M. R. (2024). Enhancing Employability Skills of Biology Graduates through an Interdisciplinary Project-Based Service Learning Experience with Engineering and Translation Undergraduate Students. *Education Sciences*, 14(1), 95. <https://doi.org/10.3390/educsci14010095>
- Grooms, J., Enderle, P., & Sampson, V. (2015). Coordinating Scientific Argumentation and the Next Generation Science Standards through Argument Driven Inquiry What Is Scientific Argumentation and Why Is It important in Science? *Science Education*, 24(1), 45–50. <https://eric.ed.gov/?id=EJ1069981>
- Hariadi, B., Jatmiko, B., Sunarto, M. J. D., Prahani, B. K., Sagirani, T., Amelia, T., & Lemantara, J. (2022). Higher Order Thinking Skills Based Learning Outcomes Improvement with Blended Web Mobile Learning Model. *International Journal of Instruction*, 15(2), 565–578. <https://doi.org/10.29333/iji.2022.15231a>
- Hasan, A., & Pardjono, P. (2019). The Correlation of Higher Order Thinking Skills and Work Readiness of Vocational High School Students. *Jurnal Pendidikan Teknologi Dan Kejuruan*, 25(1), 52–61. <https://doi.org/10.21831/jptk.v25i1.19118>
- Hendriyani, M. E., Rifqiawati, I., & Lestari, D. (2022). Online Learning Videos to Develop Creative Thinking Skills of Students. *Research and Development in Education*, 2(2), 67–75. <https://doi.org/10.22219/raden.v2i2.20035>
- Huang, C. C., Hsu, H. C., Yang, L. Y., Chen, C. H., Yang, Y. Y., Chang, C. C., Chuang, C. L., Lee, W. S., Lee, F. Y., & Hwang, S. J. (2018). Peer-Assisted Learning Model Enhances Clinical Clerk's Procedural Skills. *Journal of the Chinese Medical Association*, 81(8), 747–753. <https://doi.org/10.1016/j.jcma.2017.06.028>
- Hujjatusnaini, N., Corebima, A. D., Prawiro, S. R., & Gofur, A. (2022). The Effect of Blended Project-Based Learning Integrated With 21st-Century Skills on Pre-Service Biology Teachers' Higher-Order Thinking Skills. *Jurnal Pendidikan IPA Indonesia*, 11(1), 104–118. <https://doi.org/10.15294/jpii.v11i1.27148>
- Hur, J. W., Shen, Y. W., & Cho, M. H. (2020). Impact of Intercultural Online Collaboration Project for Pre-Service Teachers. *Technology, Pedagogy and Education*, 29(1), 1–17. <https://doi.org/10.1080/1475939X.2020.1716841>
- Hussein, B. (2021). Addressing Collaboration Challenges in Project-Based Learning: The Student's Perspective. *Education Sciences*, 11(434), 1–20. <https://doi.org/10.3390/educsci11080434>
- Khoza, H. C. (2024). Dialogue with Students as a Valuable Tool in Teacher Inquiry for Professional Development : A Self-Study of a Novice Science Teacher Educator Learning about Student Interaction in Biology classrooms. *Journal of the Scholarship of Teaching and Learning*, 24(1), 44–57. <https://doi.org/10.14434/josotl.v24i1.35486>
- Kim, K. H. (2019). Demystifying Creativity: What Creativity Isn't and Is? *Roeper Review*, 41(12), 119–128. <https://doi.org/10.1080/02783193.2019.1585397>
- Lai, E., DiCerbo, K., & Foltz, P. (2017). Skills for Today: Collaboration. *Executive Development*, 3(4), 6–12. https://www.researchgate.net/publication/350922642_Skills_for_Today_What_We_Know_about_Teaching_and_Assessing_Collaboration
- Le, H, Janssen, J., & Wubbels, T. (2017). Collaborative Learning Practices: Teacher and Student Perceived Obstacles to Effective Student Collaboration. *Cambridge Journal of Education*, 48(1), 103–122. <https://doi.org/10.1080/0305764X.2016.1259389>
- Le, Ha, Janssen, J., & Wubbels, T. (2018). Collaborative Learning Practices: Teacher and Student Perceived Obstacles to Effective Student Collaboration. *Cambridge Journal of Education*, 48(1), 103–122. <https://doi.org/10.1080/0305764X.2016.1259389>
- Liebeck-Lien, B., & Sjølie, E. (2021). Teachers' Conceptions and Uses of Student Collaboration in the Classroom. *Educational Research*, 63(2), 212–228. <https://doi.org/10.1080/00131881.2020.1839354>

- Munthe, R. N. S., Agustin, A. S., Putri, Z. A., Kundariati, M., Anggur, M. R. I., Fadilla, N. B., Nurhawa, W. O., Susilo, H., Ibrohim, I., & Sudrajat, A. K. (2023). Implementation of Problem-Based Learning Model Through Lesson Study for Improving Prospective Biology Teachers' Communication and Collaboration Skills. *AIP Conference Proceedings*, 2569(020031). <https://doi.org/10.1063/5.0112404>
- Nijat, D. U. S. (2021). Project-Based Learning in Biology Lessons. *International Nowruz Conference on Scientific Research March 18-21, Karabagh, Azerbaijan*, 470–410. https://www.researchgate.net/publication/362239737_PROJECT-BASED_LEARNING_IN_BIOLOGY_LESSONS
- Nungu, L., Mukama, E., & Nsabayeze, E. (2023). Online Collaborative Learning and Cognitive Presence in Mathematics and Science Education. Case Study of University of Rwanda, college of Education. *Education and Information Technologies*, 28(9), 10865–10884. <https://doi.org/10.1007/s10639-023-11607-w>
- Ölmez, E. (2023). *Dijital Öykülemenin Lise Öğrencilerinin İngilizce Yazma Becerilerine Ve Yabancı Dil Kaygı Düzeylerine Etkisi*. Eğitim Bilimleri Ana Bilim Dalı. <https://openaccess.hacettepe.edu.tr/xmlui/handle/11655/29593>
- Päivi, H., Järvelä, S., Mäkitalo-Siegl, K., Ahonen, A., Näykki, P., & Valtonen, T. (2017). Preparing Teacher-Students for Twenty-First-Century Learning Practices (PREP 21): a Framework for Enhancing Collaborative Problem-Solving and Strategic Learning Skills. *Teachers and Teaching*, 23(1). <https://doi.org/DOI:10.1080/13540602.2016.1203772>
- Popov, V., Brinkman, D., Biemans, H. J. A., Mulder, M., Kuznetsov, A., & Noroozi, O. (2012). Multicultural Student Group Work in Higher Education. *International Journal of Intercultural Relations*, 36(2), 302–317.
- Prajoko, S., Sukmawati, I., Pamungkas, S. J., Permadani, K. G., Alamsyah, M. R. N., & Darmawan, E. (2023). Asynchronous Project-based Learning: Is it Effective in Biology Learning Process? *Jurnal Pendidikan Biologi*, 16(1), 37–46. <https://doi.org/10.21009/biosferjpb.29742>
- Priyambodo, P., Paidi, Wilujeng, I., & Djukri. (2023). Phenomenological Studies: Strategies for Improving Indonesian Pre-Service Teacher Collaboration Skills. *Pegem Journal of Education and Instruction*, 13(3), 350–361. <https://doi.org/10.47750/pegegog.13.03.35>
- Putri, R. K., Bukit, N., & Simanjuntak, M. P. (2021). The Effect of Project Based Learning Model's on Critical Thinking Skills, Creative Thinking Skills, Collaboration Skills, & Communication Skills (4C) Physics in Senior High School. *Advances in Social Science, Education and Humanities Research*, 591, 323–330. <https://doi.org/10.2991/assehr.k.211110.103>
- Rahardjanto, A., Husamah, & Fauzi, A. (2019). Hybrid-PjBL: Learning Outcomes, Creative Thinking Skills, and Learning Motivation of Preservice Teacher. *International Journal of Instruction*, 12(2), 179–192. <https://doi.org/10.29333/iji.2019.12212a>
- Rahayu, S. M., Rosidin, U., & Herlina, K. (2021). Development of Collaboration and Communication Skills Assessment Tools Based on Project Based Learning in Improving High School Students the Soft Skills . *Proceedings of the International Conference on Educational Assessment and Policy (ICEAP 2020)*, 545(Iceap 2020), 163–166. <https://doi.org/10.2991/assehr.k.210423.082>
- Ramdani, D., Susilo, H., Suhadi, & Sueb. (2022). The Effectiveness of Collaborative Learning on Critical Thinking, Creative Thinking, and Metacognitive Skill Ability: Meta-Analysis on Biological Learning. *European Journal of Educational Research*, 11(3), 1607–1628. <https://doi.org/10.12973/eu-jer.11.3.1607>
- Saldo, I. J. P., & Walag, A. M. P. (2020). Utilizing Problem-Based and Project-Based Learning in Developing Students' Communication and Collaboration Skills in Physics. *American Journal of Educational Research*, 8(5), 232–237.

- <https://doi.org/10.12691/education-8-5-1>
- Senisum, M., Susilo, H., Suwono, H., & Ibrohim. (2022). GIRESiMCo: A Learning Model to Scaffold Students' Science Process Skills and Biology Cognitive Learning Outcomes. *Education Sciences*, 12(228), 1–14. <https://doi.org/10.3390/educsci12040228>
- Sholihah, M., Zubaidah, S., Mahanal, S., & Listyorini, D. (2023). Biology Students' Collaboration Skills in the Pandemic Era. *AIP Conference Proceedings*, 2569(020028), 1–7. <https://doi.org/10.1063/5.0112432>
- Sigit, D. V., Ristanto, R. H., & Mufida, S. N. (2022). Integration of Project-Based E-Learning with STEAM: An Innovative Solution to Learn Ecological Concept. *International Journal of Instruction*, 15(3), 23–40. <https://doi.org/10.29333/iji.2022.1532a>
- Van Leeuwen, A., Hornstra, L., & Flunger, B. (2023). Need Supportive Collaborative Learning: are Teachers Necessary or do Students Support Each Other's Basic Psychological Needs? *Educational Studies*, 49(1), 131–146. <https://doi.org/10.1080/03055698.2020.1835613>
- Wong, B., Chiu, Y. L. T., Murray, Ó. M., Horsburgh, J., & Copsey-Blake, M. (2023). 'Biology is Easy, Physics is Hard': Student Perceptions of the Ideal and the Typical Student Across STEM Higher Education. *International Studies in Sociology of Education*, 32(1), 118–139. <https://doi.org/10.1080/09620214.2022.2122532>
- Zahra, F., Wanah, H. N., Zubaidah, S., Mahanal, S., & Arsih, F. (2023). The Correlation Between Argumentation Skills, Collaboration Skills and Biology Learning Outcomes in High School. *AIP Conference Proceedings*, 2569(020015), 1–7. <https://doi.org/10.1063/5.0112394>
- Zanden, P. J. A., van der, Meijer, P. C., & Beghetto, R. A. (2020). A Review Study about Creativity in Adolescence: Where is the Social Context? *Thinking Skills and Creativity*, 38(100702). <https://doi.org/10.1016/j.tsc.2020.100702>
- Zulkifli, Z., Satria, E., Supriyadi, A., & Santosa, T. A. (2022). Meta-analysis: The Effectiveness of the Integrated STEM Technology Pedagogical Content Knowledge Learning Model on the 21st Century Skills of High School Students in the Science Department. *International Journal of Education and Literature*, 1(2), 68–76. <https://doi.org/10.55606/ijel.v1i2.32>