

The Effect of Problem Posing Model on University Students' Creativity and Problem-Solving Skills

Fatimah Djafar¹

¹ IAIN Sultan Amai Gorontalo, Indonesia; e-mail: fatimahdjafar@iaingorontalo.ac.id

ARTICLE INFO

Keywords:

Creativity Skill;
Problem Posing Model;
Problem Solving Skill.

Article history:

Received 2021-09-17
Revised 2021-10-06
Accepted 2021-10-19

ABSTRACT

One of the goals of education is to prepare graduates to compete in a world of work that has undergone massive social and technological changes. For this reason, an ideal education should develop several skills that must be mastered in the 21st century, including problem-solving skills and creativity. This study aims to determine the impact of the problem-posing learning model on problem-solving & creativity skills in learning statistics. A quasi-experimental research design is used in this study involving 29 students. Data were collected using two questionnaires, namely problem-solving skills & creativity skills questionnaires. The data that has been collected is then analyzed quantitatively using SPSS 20.00 by running a t-test. The results showed that the problem-posing learning model was proven to have a significant positive impact on problem-solving and creative thinking skills compared to classes using conventional learning models.

This is an open access article under the [CC BY-NC-SA](#) license.



Corresponding Author:

Fatimah Djafar

IAIN Sultan Amai Gorontalo, Indonesia; e-mail: fatimahdjafar@iaingorontalo.ac.id

1. INTRODUCTION

One of the most critical aspects of human life is education. In general, education aims to prepare students to be able to live and survive in the future. In other words, education aims to produce a young generation who is superior and able to keep up with the dynamics of changing times. Education must strive to create an advanced generation with more professional, creative, and competent thinking than its predecessor generation (Helaluddin & Alamsyah, 2019; Yang et al., 2016).

Radical social and technological changes require every individual, especially the younger generation, to live in constant and rapid change. The presence of the industrial revolution 4.0 and society 5.0 also demands the education sector continues to innovate and improvise with these advances (Helaluddin, 2018). For this reason, it is very appropriate if other aspects are emphasized in educational goals other than the cognitive (knowledge) aspect. Some elements that are the goals of education today are 21st-century skills that students must master, including problem-solving and creativity skills (Leasa et al., 2021; Trilling & Fadel, 2009).

There are still many university graduates who do not have the knowledge and skills to compete in this era of industrial revolution 4.0 (Catarino et al., 2019). In other words, their ability to adapt to

these changes is prolonged. With these conditions, of course, universities must focus on the main competencies for students to be more complex than the previous ones. Hargreaves (2003) claims that there are four primary skills in the 21st century: flexibility, risk-taking, creativity, and innovation. The World Economic Forum also emphasized that the younger generation must master four primary skills called The Four Cs: critical thinking skills or problem-solving, creativity and innovation, collaboration, and communication (WEF, 2015; Helaluddin & Fransori).

Creative thinking skills play a very vital role in today's modern society. Kim & Song (2012) dan Badran (2007) claim that creative thinking is essential for business, research and development, arts, and science and technology. In fact, from the emergence of the wheel as a driving tool to the emergence of the latest microprocessors. For this reason, the true purpose of education is to create creative individuals (Fazylova & Rusol, 2016; Hargreaves, 2003).

The importance of developing creative thinking skills stems from the issue of a significant decline in human creativity, which has been identified since the 1990s (Kim, 2011; Kimbell, 2000; Newton & Newton, 2010). This decline was triggered by the assumption that creativity is an open topic in scientific research (Treffinger, 2009). This is based on the assumption that creativity has mystical origins (Ritter & Mostert, 2017). This assumption has been refuted after several recent studies, which have shown that more and more insights suggest that creative ideas emerge from the human brain (Sawyer, 2011). Creative thinking is highly dependent on fundamental cognitive processes such as working memory, creating new mental categories, and mentally manipulating objects (Scoot et al., 2004). In other words, creative thinking is closer to normative cognitive functions than individual innate talents. Creative thinking skills can emerge and develop with the practice process (Chen et al., 2019).

In addition to creative thinking, another skill that should be a priority for college graduates is problem-solving skills. This skill is associated with gaining conceptual understanding, defining problems, and examining possible solutions that a person can do (Bahar & Aksut, 2020). Students who have problem-solving skills grow and develop as confident individuals and can think creatively and independently (Ozrecheroglu & Caganaga, 2018). These students can easily overcome problems that arise in everyday life.

To develop these two skills, lecturers must choose and use appropriate learning methods, especially in learning mathematics in universities. One method that can be used is problem-posing, a learning method for designing and adapting tasks effectively and demands high student cognition (Cai & Hwang, 2019). With a problem-posing approach, students are helped to develop their critical thinking skills to expand what they know and develop mathematical fluency (Rosli et al., 2014).

Several studies related to learning mathematics are related to problem-solving skills and creativity. Khalid et al. (2020) stated that collaborative learning increased students' creativity and problem-solving skills. Another study stated that general creativity and mathematical ability are very important for creative thinking skills in mathematics (Schoevers et al., 2020). In addition, the Numbered Heads Together (NHT) learning method has also proven effective in improving students' creative thinking skills (Lince, 2016).

From some relevant studies, it is still rare to find research that raises the theme of problem-posing approaches in learning statistics to improve creative thinking and problem-solving skills. It is still rare for researchers to focus on both skills in one learning process. For this reason, researchers are interested in exploring the impact of the problem-posing approach on these two skills. Thus, the formulation of the research problem is whether this problem-posing learning model can improve students' creative thinking and problem-solving skills.

2. METHODS

Design & Participants

Based on the suitability of the research objectives, this research is a quantitative research using a quasi-experimental design. This research design uses non-experimental, the same experimental conditions where the research subject is subjected to treatment (Gopalan et al., 2020; Ng et al., 2020).

The researcher used one group of students with 29 students using a one-group pretest-posttest design. The participants involved in this study were even semester (Semester II) students at the State Islamic Institute (IAIN) Gorontalo, Indonesia. The participants were prospective mathematics teacher students in the Mathematics Education Study Program who took a course in educational statistics. The study's participants' determination was carried out using a purposive sampling technique, namely selecting participants based on specific considerations.

Instruments

1. Creative Thinking Skills Test

One of the instruments used in this research is a test of creative thinking skills. This test is adapted from the creative thinking test developed by Bosch (2008), and Jatisunda et al. (2020) consist of four aspects of assessment: fluency, flexibility, originality, and elaboration. This test has the highest score of 4, and the lowest score is 0. The mathematical creative thinking skills test questions refer to educational statistical material designed to contain five questions in a description essay test. Before being used, this instrument is tested for reliability first to determine whether the tool is suitable for use. The test results show that this instrument has a reliability of 0.89 and is categorized as ideal for use.

2. Problem-Solving Skills Test

In addition to the instrument in the form of a test of mathematical creative thinking skills, this study also uses other instruments, namely a test of problem-solving skills. This test refers to the problem-solving skills test developed by Polya (1973) y designing three essay questions adapted to the educational statistics course. Four aspects are assessed in this skill test, namely: (1) understanding the known information, (2) understanding the information being asked, (3) the accuracy of problem-solving strategies, and (4) the accuracy of the model used. The scoring of problem-solving skills is based on the following benchmarks.

Table 1 Benchmarks for assessing problem-solving skills (Masduki et al., 2020).

Assessment Guidelines	Score
Not showing the overall ability	1
Shows only a small part of the ability	2
Shows most capabilities	3
Show all capabilities	4

As with the previous instrument, this problem-solving skill test is also tested for feasibility before being used. The test results show that this problem-solving skill test has a reliability of 0.79. that is, this instrument is feasible to be used to collect research data.

Data Analysis

The researchers used the same approach to analyse the data from the two questionnaires, both tests of mathematical creative thinking skills and problem-solving skills. Data analysis was carried out quantitatively using SPSS 20.00 software by running paired sample statistics, paired sample correlations, and paired sample tests. This test was conducted to see the difference between the pretest and posttest scores to determine the improvement of critical thinking and problem-solving skills.

Procedure

Before the treatment begins, students are given a test first with an initial test consisting of 2 types, namely tests of creative thinking skills and problem-solving. Meanwhile, at the end of the lesson, a posttest was conducted using the same test as the pretest. The stages in learning problem-posing are as follows:

1. Lecturer delivers new material
2. Lecturers provide information to design solutions to the presented problems

3. Forming working groups consisting of 4 to 5 people per group. They work together online using the Zoom learning application and with the help of the WhatsApp application
4. Appoint one group to formulate the problem by drawing lots and presenting it via Zoom
5. Next, the lecturer uploads individual assignments via the Zoom application, and students formulate solutions
6. Lecturers ask students to send assignments that have been done through the chat menu in the Zoom application
7. The lecturer provides feedback on the student's assignments.

3. FINDINGS AND DISCUSSION

Data from both instruments, creative thinking skills and problem-solving skills, were analyzed using the SPSS application. The researcher ran a paired sample statistics test to see the average pretest and posttest scores on both skills.

Table 2 Paired Sample Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Creative thinking	Pretest	47.17	29	7.649	1.420
	Posttest	68.66	29	7.761	1.441
Problem solving	Pretest	19.41	29	3.407	.633
	Posttest	39.97	29	5.011	.930

From table 2 above, it can be explained that there are different average scores between creative thinking skills in the pretest and posttest. The average value of creative thinking skills with the problem-posing learning model in the pretest is 47.17, while the average value in the posttest is 68.66. Furthermore, the score of creative thinking skills obtained a standard deviation of 7,649 on the pretest and 7,761 on the pretest. In the second skill (problem-solving skills), the average score on the pretest was 19.41, while the average score on the posttest was 39.97. In addition, in this problem-solving skill, it is known that the standard deviation score is 3,407 in the pretest session and 5,011 in the posttest session.

Tabel 3 Paired Samples Correlations

		N	Correlation	Sig.
Creative thinking	Pretest-posttest	29	.770	.000
Problem solving	Pretest-posttest	29	.662	.000

Table 3 above shows that the correlation test between the two variables (pretest and posttest) on creative thinking skills produces several 0.770 with a probability value of (Sig.) = 0.000. Likewise, for problem-solving skills, the correlation test between pretest and posttest resulted in a score of 0.662 with a probability value of (Sig.) = 0.000. Thus, it can be concluded that the correlation between the two variables (pretest & posttest) of the two types of skills measured is significantly related. This is based on the provisions of Sig. < 0.005, then it is stated that there is a relationship or correlation between before and after learning using the problem-posing learning model.

Table 4 Paired Samples Test

	Paired Difference							Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	
Creative_Pretest-posttest	-21.483	5.228	.971	-23.471	-19.494	-22.129	28	.000
Prob. Solving_Pretest-posttest	-20.552	3.757	.698	-21.981	-19.123	-29.460	28	.000

Table 3 above shows that the correlation test between the two variables (pretest and posttest) on creative thinking skills produces several 0.770 with a probability value of (Sig.) = 0.000. Likewise, for problem-solving skills, the correlation test between pretest and posttest resulted in a score of 0.662 with a probability value of (Sig.) = 0.000. Thus, it can be concluded that the correlation between the two variables (pretest & posttest) of the two types of skills measured is significantly related. This is based on the provisions of Sig. < 0.005, then it is stated that there is a relationship or correlation between before and after learning using the problem-posing learning model.

From the research results above, it can be concluded that the problem-posing learning model can improve students' creativity and problem-solving skills. Both skills are considered essential because they are commonly needed today. Trilling & Fadel (2009) describes seven life skills that students, namely, must master: (a) critical thinking and problem solving, (b) communication, (c) collaboration, (d) computing and technology, (e) career, (f) cross-cultural, and (g) creativity and innovation. For this reason, the problem-posing learning model is considered appropriate to stimulate these two skills.

Learning with the problem-posing model is related to higher-order thinking skills (HOTS), which require logical arguments (Tok et al., 2013). This model is also assessed as a factor affecting a person's conceptual achievement and understanding (Hooker, 2017). For this reason, several researchers have suggested to educators to provide learning with this model with several considerations. One of them is that every individual has shown problem-solving behaviour early (Bahar & Aksüt, 2020). Each child has identified a problem situation and then investigated its causes and consequences. At the same time, these children create a thought process and choose the most appropriate solution.

Creativity skills are considered more significant when compared to aspects of knowledge alone. Creative thinking skills are more prominent among other thinking skills because of their increasingly important role in the labour market and personal and social life (Rosen et al., 2020; World Economic Forum, 2019). This is based on some literature that shows that students must be equipped with creative skills to overcome their life problems in various ways (Turkmen & Sertkahya, 2019).

Although creativity is closely related to contemporary social science, this skill is also described in the discipline of mathematics. Creative thinking skills in learning mathematics are used to solve problems measured from three aspects: fluency, flexibility, and novelty (Sanders, 2016). In addition, Leikin & Pitta-Pantazi (2013) mention that learning mathematics takes someone who faces mathematical problems creatively and that there is no solution to what he is learning.

Someone who thinks creatively can have several positive impacts on himself. A study states that someone creative tends to show confidence and increase academic achievement (Ernawati et al., 2019). Creative thinking can be an integral component of achieving success for himself and his group (Almeida et al., 2008). But more importantly, creative thinking skills are the ability to generate innovative ideas in constructing an original product that contains new concepts, methods, and systems (Chen et al., 2019).

Besides having an impact on increasing creative thinking skills, this study also states that the problem-posing approach also improves students' problem-solving skills. This skill type includes several activities such as understanding, selecting, distinguishing, determining, applying, and identifying (Rokhmat et al., 2019). In addition, some researchers also claim that problem-solving skills

consist of two primary levels, namely explicit problem solving and traditional problem solving (Docktor et al., 2015; Yuliati et al., 2018).

Problem-solving skills are a crucial component of maximum academic achievement, especially in the fields of Science, Technology, Engineering, and Mathematics (STEM) (Aurah et al., 2014). Thus, problem-solving skills should be considered an integral part of learning mathematics and should not be seen as an exercise performed by students at the end of each topic only (Hu et al., 2017). In mathematics learning, problem-solving skills place mathematical knowledge and skills at the highest level (Cai & Lester, 2010). When solving a problem, students not only use existing mathematical knowledge but also be able to develop it (Saygılı, 2017).

Problem-solving is also considered important because this skill is an important ability to encourage innovation and sustainable growth and development (Kim et al., 2018). Likewise, mathematical problem-solving skills are at the core of the mathematics curriculum (Blanco et al., 2013). This skill is considered important in education because it makes students individuals who can overcome everyday mathematical problems (Ozcan, 2015). For this reason, the findings in this study can provide additional evidence that today's teachers need to develop a variety of skills in addition to general math skills. Skills considered important and urgent to be taught to students are creative thinking skills and problem-solving skills.

CONCLUSION

From the study results, it can be concluded that the problem-posing learning model can improve students' creative thinking skills. In addition, the results of this study also support that the problem-posing learning model can improve other skills, namely problem-solving skills. There are differences in the average scores on the pretest and posttest for the two types of skills. This research involves a group of students conducting online learning with the help of the Zoom application. With the results of this study, it is hoped that it will become a reference and benchmark for developing creative thinking and problem-solving skills so that students can overcome the problems they will face later. It is expected that lecturers at universities, especially mathematics lecturers, use problem posing learning models to experience various mathematical problems to understand them and develop strategies for solving them. This research still involves relatively few participants considering the COVID-19 pandemic situation is still ongoing. For this reason, it is recommended for lecturers and researchers to use a problem-posing learning model with a larger number of participants in the future.

REFERENCES

- Almeida, L. S., Prieto, L. P., Ferrando, M., Oliveira, E., & Ferrandiz, C. (2008). Torrance test of creative thinking: The question of its construct validity. *Thinking Skills and Creativity*, 3, 53–58. <https://doi.org/10.1016/j.tsc.2008.03.003>
- Aurah, C. M., Cassady, J. C., & McConnell, T. J. (2014). Predicting problem solving ability from metacognition and self-efficacy beliefs on a cross validated sample. *British Journal of Education*, 2(1), 49–72.
- Badran, I. (2007). Enhancing creativity and innovation in engineering education. *European Journal of Engineering Education*, 32(5), 573–585. <https://doi.org/10.1080/03043790701433061>
- Bahar, M., & Aksüt, P. (2020). Investigation on the effects of activity-based science teaching practices in the acquisition of problem solving skills for 5-6 year old pre-school children. *Journal of Turkish Science Education*, 17(1), 22–39. <https://doi.org/10.36681/tused.2020.11>
- Blanco, L. J., Barona, E. G., & Carrasco, A. C. (2013). Cognition and affect in mathematics problem solving with perspective teachers. *Math Enthusiast*, 10(1), 335–364.
- Bosch, N. (2008). Rubric for creative thinking skills evaluation. KCCL.
- Cai, J., & Hwang, S. (2019). Learning to teach through mathematical problem posing: Theoretical considerations, methodology and directions for future research. *International Journal of Educational Research*, 102, 1–6. <https://doi.org/10.1016/j.ijer.2019.01.001>
- Cai, J., & Lester, F. (2010). Why is teaching with problem solving important to student learning?

- National Council of Teachers of Mathematics.
- Catarino, P., Vasco, P., Lopes, J., Silva, H., & Morais, E. (2019). Cooperative learning on promoting creative thinking and mathematical creativity in higher education. *REICE. Revista Iberoamericana Sobre Calidad, Eficacia y Cambio En Educacion*, 17(3), 5–22.
- Chen, S. Y., Lai, C. F., Lai, Y. H., & Su, Y. S. (2019). Effect of project based learning on development of students' creative thinking. *The International Journal of Electrical Engineering and Education*, 1, 1–19. <https://doi.org/10.1177/0020720919846808>
- Docktor, J. L., Strand, N. E., Mestre, J. P., & Ross, B. H. (2015). Conceptual problem solving in high school physics. *Physical Review Special Topics-Physics Education Research*, 11(2).
- Dwi Wiwik Ernawati, M., Damris, M., A. Asrial, & Muhaimin, M. (2019). Development of creative thinking skill instruments for chemistry student teachers in Indonesia. *International Journal of Online and Biomedical Engineering*, 15(14), 21–30. <https://doi.org/10.3991/ijoe.v15i14.11354>
- Fazylova, S., & Rusol, I. (2016). Development of creativity in schoolchildren through art. *Czech-Polish Historical and Pedagogical Journal*, 8(2), 112–123. <https://doi.org/10.5817/cphpj-2016-0023>
- Gopalan, M., Rosunger, K., & Ahn, J. B. (2020). Use of quasi-experimental reserach design in education research: Growth, promise, and challeges. *Review of Research in Education*, 44, 1–13. <https://doi.org/10.3102/0091732X20903302>
- Hargreaves, H. (2003). *Teaching in the knowledge society*. Teacher College Press.
- Helaluddin, H. (2018). Redesain kurikulum pendidikan tinggi islam: Strategi dalam menyongsong era reolusi industri 4.0. *Jurnal Mudarrisuna: Media Kajian Pendidikan Agama Islam*, 8(2), 258–277. <https://doi.org/10.22373/jm.v8i2.3224>
- Helaluddin, H., & Alamsyah, A. (2019). Kajian konseptual tentang social-emotional learning (sel) dalam pembelajaran bahasa. *Al-Ishlah: Jurnal Pendidikan*, 11(1), 1–16.
- Helaluddin, H., & Fransori, A. (2019). Integrasi the four cs dalam pembelajaran bahasa. *Eduhumaniora: Jurnal Pendidikan Dasar*, 11(2), 95–106. ejournal.upi.edu/index.php/eduhumaniora
- Hooker, C. (2017). A proposed universal model of problem solving for design, science and cognate fields. *New Ideas in Psychology*, 47, 41–48. <https://doi.org/https://doi.org/10.1016/J.NEWIDEAPSYCH.2017.05.001>
- Hu, R., Xiaohui, S., & Shieh, C. J. (2017). A study on the application of creative problem solving teaching to statistics teaching. *EURASIA: Journal of Mathematics, Science and Technology*, 13(7), 3139–3149. <https://doi.org/10.12973/eurasia.2017.00708a>
- Jatisunda, M. G., Suciawati, V., & Nahdi, D. S. (2020). Discovery learning with scaffolding to promote mathematical creative thinking ability and self-efficacy. *Al-Jabar: Jurnal Pendidikan Matematika*, 11(2), 351–370. <https://doi.org/10.24042/ajpm.v11i2.6903>
- Khalid, M., Saad, S., Abdul Hamid, S. R., Ridhuan Abdullah, M., Ibrahim, H., & Shahrill, M. (2020). Enhancing creativity and problem solving skills through creative problem solving in teaching mathematics. *Creativity Studies*, 13(2), 270–291. <https://doi.org/10.3846/cs.2020.11027>
- Kim, J. Y., Choi, D. S., Sung, C. S., & Park, J. Y. (2018). The role of problem solving ability on innovative behavior and opportunity recognition in university students. *Journal of Open Innovation: Technology, Market, and Complexity*, 4(1), 1–13. <https://doi.org/10.1186/s40852-018-0085-4>
- Kim, K. H. (2011). The creativity crisis: The decrease in creative thinking scores on the torrance tests of creative thinking. *Creativity Research Journal*, 23(4), 285–295. <https://doi.org/10.1080/10400419.2011.627805>
- Kim, S. H., & Song, K. S. (2012). The effects of thinking style based cooperative learning on group creativity. *Creative Education*, 3, 20–24. <https://doi.org/10.4236/ce.2012.38B005>
- Kimbell, R. (2000). Creativity in crisis. *Journal of Design and Technology Education*, 5(3), 206–211.
- Leasa, M., Batlolona, J. R., & Talakua, M. (2021). Elementary students' creative thinking skills in science in the Maluku Islands, Indonesia. *Creativity Studies*, 14(1), 74–89. <https://doi.org/10.3846/cs.2021.11244>
- Leikin, R., & Pitta-Pantazi, D. (2013). Creativity and mathematics education: The state of the art. *ZDM*, 45, 159–166. <https://doi.org/10.1007/s11858-012-0459-1>

- Lince, R. (2016). Creative thinking ability to increase student mathematical of junior high school by applying models numbered heads together. *Journal of Education and Practice*, 7(6), 206–212.
- Masduki, Kholid, M. N., & Khotimah, R. P. (2020). Exploring students' problem-solving ability and response towards metacognitive strategy in mathematics learning. *Universal Journal of Educational Research*, 8(8), 3698–3703. <https://doi.org/10.13189/ujer.2020.080849>
- Newton, L. D., & Newton, D. P. (2010). What teachers see as creative incidents in elementary science lessons. *International Journal of Science Education*, 32(15), 1989–2005. <https://doi.org/10.1080/09500690903233249>
- Ng, S. F., Azlan, M. A. K., Kamal, A. N. A., & Manion, A. (2020). A quai-experiment on using guided mobile learning interventions in esl classrooms: Time use and academic performance. *Education and Information Technologies*, 1–14. <https://doi.org/10.1007/S10639-020-10191-7>
- Ozcan, Z. C. (2015). The relationship between mathematical problem-solving skills and self-regulated learning through homework behaviours, motivation, and metacognition. *International Journal of Mathematical Education in Science and Technology*, 47(3), 408–420. <https://doi.org/10.1080/0020739X.2015.1080313>
- Ozrecberoglu, N., & Caganaga, C. K. (2018). Making it count: Strategies for improving problem-solving skills in mathematics for students and teachers' classroom management. *Eurasia Journal of Mathematics, Science and Technology Education*, 14(4), 1253–1261. <https://doi.org/10.29333/ejmste/82536>
- Polya, G. (1973). *How to solve it: A new aspect of mathematical method*. Princeton University Press.
- Ritter, S. M., & Mostert, N. (2017). Enhancement of creative thinking skills using a cognitive-based creativity training. *Journal of Cognitive Enhancement*, 1, 243–253. <https://doi.org/10.1007/s41465-016-0002-3>
- Rokhmat, J., Marzuki Marzuki, Wahyusi, W., & Putrie, S. D. (2019). A strategy of scaffolding development to increase students' problem-solving abilities: The case of physics learning with causalitic-thinking approach. *Journal of Turkish Science Education*, 16(4), 569–579. <https://doi.org/10.36681/tused.2020.8>
- Rosen, Y., Stoffler, K., & Simmering, V. (2020). Imagine: Design for creative thinking, learning and assessment in schools. *Journal of Intelligence*, 8(16), 1–20. <https://doi.org/10.3390/jintelligence8020016>
- Rosli, R., Capraro, M. M., & Capraro, R. M. (2014). The effects of problem posing on student mathematical learning: A meta-analysis. *International Education Studies*, 7(13), 227–241. <https://doi.org/10.5539/ies.v7n13p227>
- Sanders, S. (2016). Critical and creative thinkers in mathematics classrooms. *Journal of Student Engagement: Education Matters*, 6(1), 19–27.
- Sawyer, K. (2011). The cognitive neuroscience of creativity: A critical review. *Creativity Research Journal*, 23(2), 137–154. <https://doi.org/10.1080/10400419.2011.571191>
- Saygili, S. (2017). Examining the problem solving skills and the strategies used by high school students in solving non-routine problems. *E-International Journal of Educational Research*, 8(2), 91–114. <https://doi.org/10.19160/ijer.321075>
- Schoevers, E. M., Kroesbergen, E. H., & Kattou, M. (2020). Mathematical creativity: A combination of domain-general creative and domain-specific mathematical skills. *Journal of Creative Behavior*, 54(2), 242–252. <https://doi.org/10.1002/jocb.361>
- Scoot, G., Lerittz, L. E., & Mumford, M. D. (2004). Types of creativity training: Approach and their effectiveness. *Journal of Creative Behavior*, 38(3), 149–179. <https://doi.org/10.1080/10400410409534549>
- Tok, T. N., Tok, S., & Dolapcioglu, S. D. (2013). The perception levels of the novice teachers' problem-solving skills. *World Conference on Educational Science WCES*, 415–420.
- Treffinger, D. J. (2009). Myth 5: creativity is too difficult to measure. *Gifted Child Quarterly*. <https://doi.org/10.1177/0077/0016986209346829>
- Trilling, B., & Fadel, C. H. (2009). *21st century skills: Learning for life in our times*. John Wiley & Sons,

Inc.

- Turkmen, H., & Sertkahya, M. (2019). Creative thinking skills analyzes of vocational high school. *Journal of Educational and Instructional Studies*, 5(1), 74–84.
- World Economic Forum. (2019). The future of jobs report 2018. Centre for The New Economy and Society, WEF.
- Yang, K. K., Lee, L., Hong, Z., & Lin, H. (2016). Investigation of effective strategies for developing creative science thinking. *International Journal of Science Education*, 38(13), 2133–2151. <https://doi.org/10.1080/09500693.2016.1230685>
- Yuliati, L., Riantoni, C., & Mufti, N. (2018). Problem solving skills on direct current electricity through inquiry-based learning with phet simulations. *International Journal of Instruction*, 11(4), 123–138. <https://doi.org/10.12973/iji.2018.1149a>

This page is intentionally left blank