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Improving collaborative problem solving skills in 7th grade junior high school students through science learning based on creative problem solving models

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ABSTRACT

Collaborative problem solving skills are one of the key skills of the 21st century. Students have difficulty working together to solve problems because studying the science appears to be cooperative and less geared towards having direct experience. There is a need for efforts to make studying the science meaningful. The aims of this research were to find out: 1) the differences in collaborative problem solving skills of junior high school students before and after the implementation of the creative problem solving (CPS) model, and 2) to improve collaborative problem solving skills through science learning based on the CPS model in 7th grade junior high school. This study was conducted at one of East Java's state junior high schools. A one group-pretest-posttest design was study method used. Purposive sampling with a sample size of 32 students was used for the sample selection technique. Using paired t-test and n-gain data analysis. The findings showed that (1) there was a difference before and after the implementation of the CPS model with paired t test results obtained -5,175 or 2,232 or 5,175, and (2) there was an improvement in collaborative problem-solving skills of junior high school students with 0.34 classified moderate n-gain tests. It can be inferred on the basis of the research results that the CPS model can improve collaborative problem-solving skills in junior high school students in class VII.

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INTRODUCTION

The Industrial Revolution (R.I.) 4.0 to the Society 5.0 transition era is one that the world is now dealing with in the twenty-first century. The 21st century has seen developments that highlight the significance of competence, one of which is collaborative problem solving skills (Triling & Fadel, 2009; Schwab, 2017). Hsumans must acquire science using the scientific method in order to solve the problems of the twenty-first century. Science education emphasizes the discovery process in addition to understanding knowledge in the form of concepts, facts, or principles (Tias, 2017; Voit, 2019).

Despite their differences in ability, students working together to solve an issue demonstrates the importance of collaborative problem solving techniques in the learning process (Mende, Proske, & Narciss, 2020; Fiore, Graesser, & Greiff, 2018). The ability to solve problems collaboratively and come to the best answers possible by drawing on the various perspectives and understandings of group members is a skill that can be learned (Ahonen & Harding, 2018; Le, Janssen & Wubbels, 2018).

The ability of students to solve problems collaboratively is now very limited. Observations made in June 2020 during science classes at a junior high school in East Java revealed that pupils prioritized individual traits when faced with challenging environmental pollution concerns. Aside from that, it was also evident that only a small number of groups were actively working. Low markers of knowledge, learning, and information sharing, as well as low student engagement in tests of collaborative problem-solving abilities, all support these findings. Due to the fact that science lessons are typically taught in groups with little opportunity for student participation in problem solving and are less focused on providing direct experience, students find it challenging to work together to solve difficulties (Darling-Hammond et al, 2019; Triyanto, 2019; Astutik, 2017; Hesse, 2015). This is consistent with the research findings of Alfin's (2019) and Chasanah (2019), which found that teachers solely evaluate cognitive skills without encouraging students to consider addressing issues, making the science learning process look boring and monotonous.

It is vital to make efforts to enhance students' collaborative problem-solving skills in light of the aforementioned exposure to the fact that there is a lack of such skills among students. One form of 21st century skill that is very vital to develop across the school environment and career world of work is collaborative problem solving skills (OECD, 2016). These abilities help people interact with others more easily, control social interactions and information exchange, develop communication skills, and solve problems more quickly because they involve collaborative problem-solving techniques in which each person pools their knowledge and skills. They also share various interpretations of problems and potential solutions (Rojas, et al, 2021; Graesser et al, 2018; Hattie & Donoghue, 2016).

Using a learning paradigm that requires students to actively ask questions and share ideas as well as studying in groups is one way to address the issues that are present (El-Sabagh, 2021; Wulandari, 2014). The alternative learning model used is creative problem solving (CPS). The reason for choosing the CPS model is that this learning model is not focused on the level of recognition, understanding and application of a science or information that has been obtained by students, but can also train students to be able to analyze a problem as well as how to solve it using creative ways (Le, Janssen & Wubbels; 2018; Syam, Ali & Palloan, 2018).

The CPS model for science instruction starts by providing students with challenges. Students formulate ideas based on literature reviews and use creative thinking to identify and solve challenges. As described by Mercier & Higgins (2014); Wismath & Orr (2015); Hidayatullah et al (2020) with reference to problem-solving-based collaborative learning students choose from among their ideas and thoughts to develop in order to solve challenges.

The Creative Problem Solving (CPS) learning paradigm has the benefits of making education more applicable and of preparing students to cope with and solve difficulties in real-world situations outside of the classroom (Siswadi *et al*, 2014; Treffinger & Isaksen, 2015; Yang et al, 2022). Also, the CPS model has the capacity to promote pupils' development of critical and creative thinking abilities (Amran, Kutty, & Surat, 2019) .

Based on the preceding description, it is intended that by applying the CPS model, junior high school students' cooperative problem-solving abilities will be enhanced in their study of science. This study's objectives were to: (1) Identify the differences between junior high school students' collaborative problem-solving abilities before and after the CPS learning model was implemented; and (2) Identify how junior high school students' collaborative problem-solving abilities improved as a result.

METHOD

Research Design

This research is a pre-experimental research with a one-group-pretest-posttest design. The design of this study is to control the variables and see the causation between the variables in the study using only one class as the experimental class (Gay, Mills & Airasian, 2012). One class was given a pretest and posttest to find out whether there were differences and an increase in students' collaborative problem solving skills in CPS-based science learning. The form of the research design is presented in **Figure 1.**

Class	Pretest	Treatment	Posttest
Exsperiment Class	O_1	X	O_2

Figure 1. Research Design

Information

X : The CPS learning paradigm is utilized in the treatment.

O_1 : The pre-test score of students' collaborative problem solving skills before the CPS learning paradigm was implemented.

O_2 : The post-test score of students' collaborative problem solving skills before the CPS learning paradigm was implemented.

Time and Place of Research

The research was carried out in even semesters, from February to March 2020. For the 2019–2020 academic year, class VII–A of the UPTD SMPN 10 Gresik, Gresik Regency, did the research.

Targets and Research Subjects

All class VII students at UPTD SMPN 10 Gresik for the 2019–2020 academic year comprised the research population. Employing purposive sampling to determine the sample. 32 students from class VII-A and a control group that received treatment using the CPS learning model made up the sample in this study (Gay, Mills & Airasian, 2012).

The learning model for creative problem solving (CPS) is the independent variable in this study. The ability of junior high school pupils to solve problems collaboratively is the dependent variable in this study. The study's control factors include the instructor, the subject matter, and the number of study hours.

Research Procedure

Three stages were included in the research efforts. An assessment of junior high school students' collaborative problem-solving skills was conducted as the initial step before the CPS model was used. The CPS model was used to carry out learning in the second step. The final step involved testing junior high school students' collaborative problem-solving abilities after using the CPS paradigm.

Data, Instruments, and Data Collection Techniques

The junior high school students' collaborative problem-solving abilities, the CPS learning model's implementation, and their replies served as the study's primary sources of data. The ability of junior high school students to work cooperatively to solve problems is assessed using a description test that includes a number of indicators, such as: task regulation (understanding and assessing the task being done is obtained from situations, data, or events), perspective taking (accepting and contributing to the task given), learning and knowledge building (making task completion strategies with mutual cooperation and compromise), participation, and task taking (actively involved in working with others implementing collaborative task completion strategies that have been created to get the right solution), and social regulation (reflecting on the process and results of task completion collaborative).

Using a learning observation sheet, the CPS learning model's syntactic implementation was evaluated. Two observers observe the learning process while completing a checklist (√) on the accompanying sheets. The observation sheet's scale is the Guttman scale, which has a "Yes" & "No" option (Arikunto, 2016). The CPS model syntax is used, and it includes the following steps: (1) objective finding (planning learning objectives); (2) fact finding (stating the facts of the problem); (3) problem finding (finding the essence of the problem presented); (4) idea finding (thinking of various types of ideas); (5) solution finding (screening ideas and determining appropriate alternative solutions); and (6) acceptance finding (accepting alternative solutions that are appropriate to the problem) (Griffin, 2015; Yang et al, 2022).

A student response survey was used to see how middle school students responded to science instruction based on the CPS model. A Likert scale with four scale options—very good, good, not good, and not good—was employed in this investigation. A Likert scale with a scale of four is preferable to one with a choice of three because it may represent variances in students' attitudes more effectively. Also, it challenges students to assess their attitudes toward the phenomena described in the tool so that they can avoid having neutral views when making decisions (Sumargo & Yuanita, 2014; Amran, Kutty, & Surat, 2019).

Data Analysis Technique

In this study, descriptive and inferential statistical analysis was utilized to analyze the data. A descriptive analysis was utilized to compare the collaborative problem-solving abilities of junior high school pupils before and after CPS-based science instruction. The paired t-test and N-gain are the inferential methods used. A paired t-test was utilized to see whether there were any differences between junior high school pupils' prior and subsequent collaborative problem-solving abilities. The development of junior high school pupils' abilities to solve problems collaboratively is measured using the N-gain formula.

RESULT AND DISCUSSION

For this study, class VII-A, which had 32 students, served as the experimental class. Pretesting was done before using the CPS model. After applying the CPS model to the learning process, students are then given a posttest to complete. The average pre-test score was 54.01, with a standard deviation of 17.95, and the average post-test score was 69.84, with a standard deviation of 15.73, according to the results of the pretest. The students' pretest and posttest results were both normally distributed, with a homogeneous variance, according to analysis of the data.

Creative Problem Solving (CPS) Learning Model

The CPS model was used to conduct this study. Students who are learning utilizing the CPS model must work on difficulties in the form of problem-solving in heterogeneous groups. Pupils choose and develop ideas and thoughts they have in order to identify and solve challenges that have been presented through creative thinking. In this session, the teacher just performs the role of a facilitator, which entails that he only guides and accompanies the pupils in accordance with the learning flow.

Differences in Middle School Students' Collaborative Problem Solving Skills Before and After the Application of the Creative Problem Solving (CPS) Learning Model

The paired t-test can be performed after student pretest and posttest data analysis shows that both sets of data are normally distributed and have a homogeneous variance. The t-test findings are shown in **Table 1** below.

Table 1. Paired t-test results

	Paired differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
pretest - posttest	-15,83	17,12	3,03	-22,00	-9,661	-5,232	31	0,000

Table 1 shows that the significance value is 0.000 and the tcount value is -5.175, with a df value of 31, the ttable value is 2.040. Based on a significance value of 0.00 ≤ 0.05 and tcount -5.175 < –table -2.040, it can be interpreted that there is a difference after the application of the CPS learning model to collaborative problem solving skills of class VII-A students at UPTD SMPN 10 Gresik.

Students were disinterested in the learning process and less receptive to solving issues assigned by the teacher before the CPS model was applied to science education, even though these difficulties were all around them. Students continue to approach challenges in the same manner. This is consistent with the research of Sagita et al (2018); Yang et al, (2022), which shows that using traditional learning and evaluation methods that are solely focused on students' cognitive components will cause students to have a tendency to be passive and learning to be monotonous.

Using creative problem solving (CPS) learning paradigms, different solutions are provided for the learning issues encountered. Students appear passionate in participating in the learning process after CPS-based learning has been implemented, and students tend to be more engaged. Also, the creative problem-solving learning approach has the ability to increase students' responsiveness in problem-solving and their ability to offer more innovative alternatives than before. This is consistent with the findings of Syam, Ali & Palloan (2018); Jusmawati et al (2020); Murwaningsih & Fauziah (2020) study, which found that the CPS model not only helps students comprehend and gain insight into a subject, but also teaches them how to approach and solve problems in a more creative way.

Students can draw connections between the learning content and actual environmental situations that are experiencing pollution by applying the CPS learning model to scientific lessons on environmental pollution. This is so that students learn about practical completion as well as theoretical completion using the CPS learning model. According to research by Siswadi et al (2014); Muzaimah et al (2022), one benefit of the CPS learning model is that it can make the material students are studying more relevant by taking into account their immediate surroundings. One of the sources of student knowledge comes from the action of how actively a student interacts with the surrounding world when taken into account based on Piaget's social cognitive learning theory (Ardika et al (2014); Bord (2021).

Enhancing Pupils' Collaborative Problem-Solving Capabilities in Junior High

According to the indicators and recommendations in the collaborative issue solving abilities category, it is possible to assess students' levels of collaborative problem solving ability using the results of the pretest and posttest scores. Figure 2 displays the outcomes of averaging each indicator of students' ability to solve problems collaboratively from the results of the pretest and posttest.

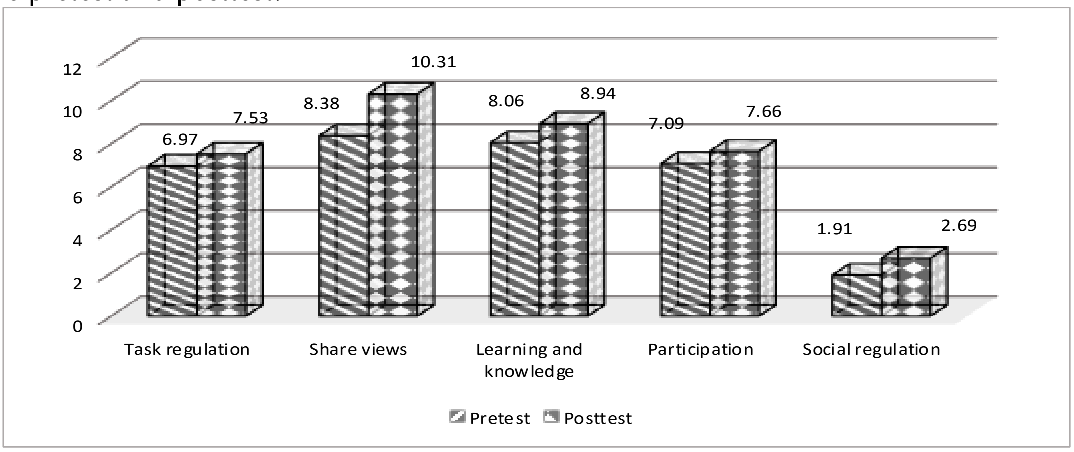

Figure 2. Diagram of the average indicator of students' collaborative problem solving skills

Figure 2 illustrates how the average values for the students' pretest and posttest scores differ. The task regulation indicator increased on average by 0.56; shared perspectives increased on average by 1.93; learning and knowledge building increased on average by 0.88; participation increased on average by 0.57; and social regulation increased on average by 0.78.

Figure 2's average pretest value illustrates how the students' abilities to solve problems cooperatively with their group members are still somewhat limited. This is due to the fact that pupils are still not accustomed to receiving instruction in problem-solving in groups where the questions provided are mutually sustainable. This is consistent with the OECD's (2016) findings from the TIMMS and PISA studies showing Indonesian pupils still have very limited and subpar collaborative problem-solving abilities.

The posttest's typical value is shown in Figure 2. It is clear that pupils' abilities to solve problems together have improved. According to study by Mercier and Higgins (2014), collaborative learning can enhance the ability to work with others to solve challenges. This is due to the fact that after selecting and creating their own solutions, students work in groups to discuss their ideas. An alternate, wise choice will be identified during the debate process to solve the issue, all group members will be able to use and accept it (Hidayatullah et al, 2020).

The N-gain score formula was used to determine the increase in students' collaborative problem solving abilities in accordance with the calculation of the average for each indicator of those abilities. The data analysis can be utilized to determine whether or not students' abilities to solve problems collaboratively have improved. Table 2 displays the findings of the examination of the data**.**

Table 2. N-Gain Score

XPretest	**XPosttest**	**Xmax**
54,01	69,84	100
N-Gain Score Calculation		
Xposttest - Xpretest	15,83	
Xmax-Xpretest	45,99	
N-*Gain*	0,34	
Kategori N-*Gain*	Moderate	

The average N-gain score, as shown in Table 2, is 0.34. (moderate category). This is due to the fact that students take collaborative problem-solving skills exams less seriously than they should, and because the time between the third learning session and the fourth session when the posttest is administered is far apart. The Covid-19 epidemic is to blame for the duration. Face-to-face instruction is being replaced by online instruction through Google Classroom and WhatsApp as a result of this problem. On tests of collaborative problem-solving skills, students only remember the order of several ways of working due to changes in techniques and media, which reduce learning effectiveness. The limitations that take place are in line with Piaget's hypothesis, which claims that pupils' knowledge and skill development depends on how often they interact with their environment (Amran, Kutty & Surat, 2019).

The N-gain score results show that the CPS learning model is capable of enhancing students' abilities to solve problems collaboratively. These findings are consistent with Lai, et al (2017); Alfin (2019) study on how collaborative problem solving abilities may be taught to students through problem solving based on practical experience. One of the syntaxes of the CPS model, idea discovery and solution finding, was used in this study to gather data on students' experience and practice in problem solving. Students learn idea-finding syntax to communicate with friends to recognize difficulties, and they learn solution-finding syntax to determine the best course of action to take (Jusmawati et al, 2020; Muzaimah et al, 2022). With the CPS model, peer interaction can inspire students to share their wisdom and knowledge. According to Laa et al. (2017); Yang et al. (2022) student engagement with teachers and peers who are seen as capable can lead to exciting and meaningful learning.

To establish the category level of each indication, the N-gain score is also calculated for each indicator. Table 3 lists the outcomes of computing the N-gain score for each indicator of group problem-solving abilities.

Table 3. N-gain score on indicators of collaborative problem solving skills

Indicator	Calculation of n-gain score					Category
	pretest	*posttest*	*posttest-pretest*	*X*max-*Xpretest*	*N-gain score*	
Task regulation	29,04	31,38	2,34	70,96	0,03	No upgrade
Share views	34,90	42,97	11,07	65,1	0,12	Low
Learning and knowledge	33,59	44,14	10,55	66,41	0,15	Low
Participation	29,56	38,54	8,98	70,44	0,13	Low
Social regulation	7,94	17,58	9,64	92,06	0,11	Low

Table 3 shows the outcomes of determining the n-gain category for each indicator. It is evident that task regulation, one of the measures of collaborative problem solving abilities, has not improved. Students don't make good use of their time, so they only have a few sources of information for their problem-solving assignments. Despite the fact that task regulation is a sign of collaborative problem solving abilities, which call for students to gather data relevant to tasks and use that data to solve issues sequentially. The information presented above backs up Rehalat's (2014); El-Sabagh (2021); Bord (2021) theory on the role of Gagne's learning theory in the learning process. According to Gagne's learning theory, students should have the chance to process knowledge into a description before applying it to a solution to a problem.

CONCLUSION AND SUGGESTION

Conclusion

The research was conducted by applying the creative problem solving (CPS) learning model in environmental pollution material. The results showed that (1) there were differences before and after the application of the CPS model with the results of the paired t test obtained $-5.175 \leq 2.232 \leq 5.175$, and (2) there was an increase in the collaborative problem solving skills of junior high school students with an n-gain result of 0.34 in the category currently. Thus it can be concluded that the CPS model can improve the collaborative problem solving skills of junior high school students in science learning.

Suggestion

Future research is expected to use the creative problem solving (CPS) learning model with the aim of improving students' collaborative problem solving skills on different materials. Problem-solving collaboration should be able to consider the division of heterogeneous groups to become collaborative partners in working on deeper collaborative problem-solving skills questions because the results obtained in this study are less effective if high-ability students directly get collaborative partners with low-ability students.

BIBLIOGRAPHY

Ahonen, A. K., & Harding, S.M. (2018). Assessing Online Collaborative Problem Solving Among School Children in Finland : A Case Study Using ATC21S TM in a National Context. *International Journal of Learning, Teaching and Educational Research*, *17*(2), 138–158. https://doi.org/10.26803/ijlter.17.2.9

Alfin, & Dkk. (2019). Development of Group Science Learning (GSL) Model to Improve the Skills of Collaborative Problem Solving , Science Process , and Self- Confidence of Primary Schools Teacher Candidates. *International Journal of Instruction*, *12*(1), 147–

164.

Amran, M.S., Kutty, F.M., & Surat, S. (2019). Creative Problem-Solving (CPS) Skills among University Students. *Creative Education,* 10(12): 3049-3058. DOI:10.4236/ce.2019.1012229.

Ardika, I. W. D., Sitawati, A. R., & Politeknik, N. K. S. (2014). Penerapan Teori Kognitif Piaget Dalam Pembelajaran Di Sekolah Sebagai Dasar Melaksanakan Revolusi Mental. *Soshum Jurnal Sosial Dan Humaniora*, *4*(2), 121–130.

Arikunto, S. (2016). *Dasar-dasar Evaluasi Pendidikan*. Jakarta: Bumi Aksara.

Astutik, S., Nur, M., & Susantini, E. (2017). *Validity Of Collaborative Creativity Model*. *The 3 International Conference on Research, and Implementation and Education of Mathemathics and Science, 1-6.*

Bord, G. (2021). Toward an understanding of when prior knowledge helps or hinders learning. *NPJ Science of Learning*, 6(24): 1-3. https://doi.org/10.1038/s41539-021-00103-w.

Chasanah, A.N. (2019). Cognitive Growth Learning Model to Improve the Students' Critical Thinking Skills. *Journal of Research and Advances in Mathematics Education*, 4(2): 112-123. DOI:10.23917/jramathedu.v4i2.8127.

Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2019). Implications for educational practice of the science of learning and development. *Applied Developmental Science*, 1–44. doi:10.1080/10888691.2018.1537791.

El-Sabagh, H.A. (2021). Adaptive e-learning environment based on learning styles and its impact on development students' engagement. *International Journal of Educational Technology in Higher Education*, 18(3): 123-136.https://doi.org/10.1186/s41239-021-00289-4.

Fiore, S. M., Graesser, A., & Greiff, S. (2018). Collaborative problem-solving education for the twenty-first-century workforce. *Nature Human Behaviour*, 2(6), 367–369. doi:10.1038/s41562-018-0363-y.

Gay, L. R., Mills, G. E., & Airasian, P. (2012). *Educational Research Competencies For Analysis And Application* (10th ed.). Ashland: Pearson Education.

Graesser, A., Fiore, S.M., Friesse, M.N., & Hesse, F.W. (2018). Advancing the Science of Collaborative Problem Solving. Advancing the Science of Collaborative Problem Solving. *Psychological Science in the Public Interest*, 19(2): 59-92. https://doi.org/10.1177/1529100618808244.

Griffin, & E. Care. (2015). *Assessment and Teaching of 21st Century Skills (pp. 37-56).* New York: Springer.

Hattie, J.A.C. & Donoghue, G.M. (2016). Learning strategies: a synthesis and conceptual model. *NPJ Science of Learning*, 2(3): 13-26. doi:10.1038/npjscilearn.2016.13.

Hesse, I. (2015). A Framework for Teachable Collaborative Problem Solving Skills. *In Springer*. https://doi.org/10.1007/978-94-017-9395-7

Hidayatullah, R., Ariyanto, S.R., Muhaji., Mubarok, H., Yohannes, A. (2020). Collaborative Problem Based Learning: An Analysis of Problem Solving Skills in Vocational Schools. *IJORER: International Journal of Recent Educational Research*, 1(3): 209-217. DOI:10.46245/ijorer.v1i3.62.

Jusmawati, Satriawati,Irman, R., Rahman, A., Arsyad, N. (2020). Developing Worksheets Through Creative Problem Solving (CPS) Model to Improve Students' Creative Thinking for the Class V of SDTunas Bangsa Makassar. Daya Matematis: *Jurnal Inovasi Pendidikan Matematika*, 8(3): 200-204. https://doi.org/10.26858/jdm.v8i3.16609.

Laa, N., Winata, H., & Meilani, R. I. (2017). Pengaruh model pembelajaran creative problem solving terhadap minat belajar siswa. *Jurnal Pendidikan Manajemen Perkantoran*, *2*(2), 139–148.

Lai, E. R., DiCerbo, K. E., dan Foltz, P. (2017). *Skills for Today: What We Know about Teaching and Assessing Collaboration*. Tersedia di https://www.pearson.com/.../Collaboration-White-Paper_FIN. Pada tanggal 18 Mei 2019, 14.30 WIB. 50hlm.

Le, H., 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.

Mende, S., Proske, A., & Narciss, S. (2020). Individual preparation for collaborative learning: Systematic review and synthesis. *Educational Psychologist*, 56(1), 29–53. doi:10.1080/00461520.2020.1828086.

Mercier, E., & Higgins, S. (2014). Creating joint representations of collaborative problem solving with multi-touch technology. *Journal of Computer Assisted Learning Published*, 497–510. https://doi.org/10.1111/jcal.12052

Murwaningsih, T., & Fauziah, M. (2020). The Effectiveness of Creative Problem Solving (CPS) Learning Model on Divergent Thinking Skills. *International Journal of Science and Applied Science,* 4(1): 78-90. DOI: https://doi.org/10.20961/ijsascs.v4i1.49460.

Muzaimah, Gani, A., Pada, A.U.T., Rahmayani, R.F.I., Syukri, M., Yusrizal. (2022). Implementation of Creative Problem Solving Model to Improve Students' Critical Thinking Skills in Chemistry Lessons. *JTK: Jurnal Tadris Kimiya*, 7(2): 227-244. DOI: https://doi.org/10.15575/jtk.v7i2.21262.

OECD. (2016). *Results from PISA 2015*. Washington : OECD Publishing, 1–8. https://www.oecd.org/pisa/innovation/collaborative-problem-solving/.

Rehalat, A. (2014). Model pembelajaran pemrosesan informasi. *JPIS, Jurnal Pendidikan Ilmu Sosial*, *23*(2), 1–11.

Rojas, M., Nussbaum, M., Chiuminatto, P., Guerrero, O., Greiff, S., Krieger, F., & Van Der Westhuizen, L. (2021). Assessing collaborative problem-solving skills among elementary school students. *Computers & Education*, 175, 104313. doi:10.1016/j.compedu.2021.104313.

Sagita, I., Medriati, R., & Purwanto, A. (2018). Penerapan Creative Problem Solving Model untuk Meningkatkan Kemampuan Pemecahan Masalah Fisika Siswa Kelas XI MIA 4 MAN 2 Kota Bengkulu. *Jurnal Kumparan Fisika*, *1*(3), 1–6.

Schwab, K. (2017). *The Fourth Industrial Revolution*. New York: World Economic Forum.

Siswadi, I. B. I. P., Abadi, I. B. G. S., Agung, I. G., & Negara, O. (2014). Pengaruh Model Pembelajaran Creative Problem (Cps) Solving Berbantuan Media Grafis Terhadap Hasil Belajar IPA Siswa Kelas V Sd Gugus Vi Pangeran Diponogoro Denpasar Barat Tahun Ajaran 2013 / 2014. *Jurnal Mimbar PGSD Universitas Pendidikan Ganesha*, *2*(1).

Sumargo, E., & Yuanita, L. (2014). Penerapan Media Laboratorium Virtual (Phet) Pada Materi Laju Reaksi Dengan Model Pengajaran Langsung. *Unesa Journal of Chemical Education*, *3*(1), 119–133.

Syam, F. A., Ali, M. S., & Palloan, P. (2018). Penerapan Model Pembelajaran Creative Problem Solving Terhadap Keterampilan Berpikir Kreatif Dalam Pembelajaran Fisika Peserta Didik SMA 2 Bulukumba. *Seminar Nasional Fisika 2018 Program Pascasarjana Universitas Negeri Makassar*, 1–4.

Tias, I. W. U. (2017). Penerapan Model Penemuan Terbimbing Untuk Meningkatkan Hasil Belajar Ipa Siswa Sekolah Dasar. *Jurnal Riset Pedagogik UNS*, *1*(1), 50–60.

Treffinger, D. J., & Isaksen, S. G. (2005). Creative Problem Solving: The History, Development, and Implications for Gifted Education and Talent Development. *Gifted Child Quarterly*, 49(4), 342–353. doi:10.1177/001698620504900407.

Triling, B., & Fadel, C. (2009). 21st Century Skills: Learning for Life in Our Times. *21St Century Skill*, (Book), 48. https://www.wiley.com/en-us/21st+Century+Skills%3A+Learning+for+Life+in+Our+Times-p-9781118157060.

Triyanto. (2019). Understanding student participation within a group learning. *South African Journal of Education*, 39(2): 1-8. https://doi.org/10.15700/saje.v39n2a1629.

Voit, E.O. (2019) Perspective: Dimensions of the scientific method. *PLoS Comput Biol* 15(9): e1007279. https://doi.org/10.1371/journal.pcbi.1007279

Wismath, Shelly L. and Orr, Doug (2015) Collaborative Learning in Problem Solving: A Case Study in Metacognitive Learning. *The Canadian Journal for the Scholarship of Teaching and Learning*, 6(3): 56-74. http://ir.lib.uwo.ca/cjsotl_rcacea/vol6/iss3/10.

Wulandari, A.Y. (2014). Pengaruh Pembelajaran Kooperatif Student Team Achievement Division (STAD) dan Group Investigation (GI) Ditinjau dari Aktivitas Belajar. *Jurnal Pena Sains*, 1(2): 36-45. DOI: https://doi.org/10.21107/jps.v1i2.1337.

Yang, W., Green, A.E., Chen, Q., Kenett, Y.N., Sun, J., Wei, D., Qiu, J. (2022). Creative problem solving in knowledge-rich contexts. *Trends in Cognitive Sciences*, 26(10): 849-859. https://doi.org/10.1016/j.tics.2022.06.012.

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