



Problem-Solving Skills Of Secondary School Students: A Review

Prof. Sambit Kumar Padhi¹, Amita Joshi¹, Rakesh Kumar Singh¹, Aditi Joshi²

¹Guru Ghasidas Vishwavidyalaya (A Central University) Bilaspur, Chhattisgarh, India,

² National Institute of Technology Raipur, Raipur, Chhattisgarh, India.

ABSTRACT

A lot of work has been done in exploring problem-solving skills, whereas a few researchers have focused on student problem-solving skills in science. Most major approaches to problem-solving skills of scientists have focused on products to identify persons as having problem-solving skills. A total study of 16 was done in this research paper. Types of research were conducted by considering one variable and studying significant correlates of scientific creativity among school students. The research sub-topic of problem-solving skills varied in the period of 2017 to 2022. The sub-topics in this paper are problem-solving skills with school students, and science subjects like science, creativity, math, chemistry, and physics. Some of the research shows that a grouping mechanism helps the students to combine their attributes and work collaboratively towards the accomplishment of the group task. According to the findings, as pupils' grade levels improved, so did their computational thinking skills. To assist this development, it is formally recommended that computational thinking abilities be included in the curriculum beginning with preschool. Thus, the review of studies shows the research space in the suitable knowledge and gives direction for further research in problem-solving skills.

Keywords: Problem-solving skills, school education, science, creativity, maths, chemistry, and physics.

INTRODUCTION

Learning can be defined as a relatively permanent change in behavior potentially that results from reinforced practice or experience by Steers and Porter.

The point of view that educational institutions should educate learners with 21 st century skills together with those for many different professions in the future is global in today's educational innovation, and the value of babyhood years in learning these skills is emphasized (Benner and Hatch 2010; Lindeman and Anderson 2015; Yildiz and Yildiz 2021). Education is a process of humanizing humans to be able to actualize themselves in life, whereas good education is education that does not only prepare students for a profession or position but solves the problems it faces in daily life.

Learning is "a process that leads to change, which occurs as a result of experience and increases the potential for improved performance and future learning" (Ambrose et al. 2010). The change in the learner may happen at the level of knowledge, attitude, or behavior. There are 4 predominant learning styles: Visual, Auditory, Read/Write, and Kinaesthetic. The 7 principles of learning are 1) Learners at the center. 2) The social nature

of learning.3) Emotions are integral to learning.4) Recognising individual differences.5) Stretching all students.6) Assessment for learning.7) Building horizontal connections(13-Oct-2016).

Numerous models have been promoted and continue to anchor instructional design theory (Gagné, 1966, 1968; Merrill, 1983, 1987; Merrill, Reigeluth, & Faust, 1979; Merrill, Richards, Schmidt, & Wood, 1977; Merrill, Tennyson, & Posey, 1992; Montague, 1983). These prescriptions have assumed that concepts represent a primary learning outcome, without necessarily considering how the concepts are used. Learning hierarchies (Gagné, 1968, 1973; Gagné & Briggs, 1979), which conceive concepts as building blocks of higher-order skills, are exceptions (Jonassen 2006). Learning is important to society as a whole because it helps different groups of people to share knowledge, agree on mutual values, and understand one another better.24-Feb-2022

There are different types of learning. These are motor learning, verbal learning, concept learning, discrimination learning, attitude learning, and problem-solving. Problem-solving is a higher-order learning process. This learning requires the use of cognitive abilities- such as thinking, reasoning, observation, imagination, generalization, etc. this is very useful to overcome difficult problems encountered by people.

Problem-solving is inescapable in human life and is crucial for human daily life. Ideally, education does not only encourage students to develop talents that are tailored to the knowledge acquired at school, but education also aims to improve the quality of human beings who are faithful and fearful of God Almighty, noble, personable, independent, advanced character, tough, smart, creative, skilled, disciplined, work ethic, professional, responsible, productive, and physically and mentally healthy(Dewi and Primayana 2019).

A learner who is trying to gain knowledge or skill in something by studying, practicing, or being taught. Characteristics of Successful Learners are leaders in their own learning, engage with the world around them, question everything, think for themselves, are driven by their interests, push through challenges, are determined to succeed, and have inner motivation and self-discipline. Human learning starts at birth and continues until death as a consequence of ongoing interactions between people and their environment (OECD, 2007).

Learning is the process of acquiring new understanding, knowledge, behaviors, skills, values, attitudes, and preferences (Prihatmi et al. 2022). Learning is a scientific process of transforming knowledge into practice leading to change in behavior. It is for this reason; the process of Learning encompasses not only cognitive but also other social/emotional aspects. It is the responsibility of the teacher to exhibit professionalism and facilitate learning through a conducive learning environment.(Bhatnagar and Sudhakar, n.d.). Learning is “a process that leads to change, which occurs as a result of experience and increases the potential for survival (Reisberg 2013) (Rahman 2019a). It is one of the fundamental skills of 21st-century skills. Problem-solving is the most important skill needed by today’s children everywhere, including both in-school and out-of-school learning and achievement. Recent research in problem-solving suggests that educationalists, trainers, and policymakers are reviewing curricula to include incorporated learning environments that focus on students use analysis, evaluation, synthesis, etc. type skills, and especially, problem-solving skills as new learning theory has evolved and professional standards have been changed which created demands of the new workplace (Kirkley and Foshay 2003)(Rahman 2019b).

Much research has been carried out by previous researchers considering(Khoiriyah and Husamah 2018) studied the problem-based learning creative thinking skills, problem-solving skills, and learning outcomes of seventh-grade students.(Erozkan 2013) conducted a study on the effect of communication skills and interpersonal problem-solving skills on social self-efficacy. (Rahman 2019a) studied 21st-century skill problem solving defining the concept. (İncebacak and Ersoy 2016) conducted a study on the problem-solving skills of secondary school students.(Greiff et al. 2014) conducted a study on domain-general problem-solving skills and education in the 21st century. (Kalelioglu and Gülbahar 2014) studied on the effects of teaching programming via Scratch on Problem Solving Skills: A Discussion from Learners' Perspective. (Khalid et al. 2020) studied enhancing creativity and problem-solving skills through creative problem-solving in teaching mathematics.(Argaw et al. 2016) studied the effect of problem-based learning (PBL) instruction on students' motivation and problem-solving skills in physics. (Gunawan et al. 2017) conducted a study on the virtual laboratory to improve students' problem-solving skills on electricity concepts. (Setiyani, Fitriyani, and Sagita 2020) conducted a study on Improving students' mathematical problem-solving skills through Quizizz.

PROBLEM-SOLVING SKILLS & SECONDARY SCHOOL STUDENTS

From childhood to the old ages, individuals may face with many problematic situations in many levels and it is important to learn problem solving abilities. Problem-solving can be related to many cognitive abilities also, ranging from logic, analysis, mathematics, and science(Aslan 2002);(İncebacak and Ersoy 2016). Hence, problem-solving can simply be defined as offering a solution, or an idea to a problematic situation. Problem-solving abilities are important skills for the educational area because a healthy society or a healthy nation can only maintain its existence by adapting to new conditions through problem-solving abilities. Problem-solving skills are important for every field of life in order to lead a happy and healthy life.

Since the problem-solving experiences in daily life are typically ill-structured, complex, and multifaceted, the reason for students' inability to solve problems outside of the classroom is that they lack appropriate problem-solving and knowledge application opportunities in real-life contexts.

This is the concept of situated learning, as well as context-based learning, which emphasizes learning in real-life contexts using practical activities to ensure that knowledge learning is rationalized and meaningful (Lave and Wenger 1991); (McLellan 1996);(Yu, Fan, and Lin 2015). Context-based learning is a pedagogical methodology in science and technology education that uses real-life or fictitious examples in teaching activities to help students learn through actual or practical experience rather than just learning theoretical knowledge (De Putter-Smits, Taconis, and Jochems 2013);(Rahayu et al. 2011);(Seel 2011); (Yu, Fan, and Lin 2015).

METHODOLOGY

STUDIES RELATED TO PROBLEM-SOLVING SKILLS

The paper analysed the research papers, Ph.D. theses, and articles published in national and international journals and books. A critical overview of the review of research in the research sub-topic of problem-solving skills varied in the period 2017 to 2021 and 1 to 100 -page number. The sub-topics in this paper are school education, science, creativity, maths, chemistry, and physics. A review of the related literature provided the idea that problem-solving skills are a mixed phenomenon. Problem-solving skills were explored in relation to academic

DATA EXTRACTION

After initial searches, 2000 potentially eligible studies were identified: 108 in science in SCOPUS. The elimination of duplicates gave 60 relevant reports. studies, giving us 16 articles that met all the inclusion criteria. We read in full and examined these papers, composing our final set of studies that empirically analyzed the bonds between problem-solving skills and School students.

RESULTS

Sixteen articles were included in our review and classified into five categories regarding the students' grade-level learning: (1) science, (2) maths (3) creativity (4) physics (5) chemistry. A description of the studies, problem-solving skills assessment tools, and main findings are presented in Table 1.

Table 1. Studies on problem-solving skills and school students

Study	Sample	Scale	Variables	Statistical analysis	Result	Statistics
(Karatas, Bademcioglu, and Celik 2017)	72 secondary school students.	Problem-Solving Inventory. Multiple Intelligences Inventory.	Problem-solving skills. Multiple intelligences.	Pearson correlation	Significant positive and negative. Correlations between variables.	Negatively correlated with musical intelligence ($r=-.17$, $p<.01$), bodily-kinaesthetic intelligence ($r=-.31$, $p<.01$), interpersonal intelligence ($r=-.32$, $p<.01$),
(Hidayat, Sabandar, and Syaban 2018)	5/6 grade eight students	Self-efficacy scale. Math as much as 20 points, the description of the MPPS test as much as 5, items and scale SE as 30 points scale.	Problem-solving ability tests and a set of a self-efficacy scale	Experimental group and control group experimental group received mathematical learning using IDL and the control group receive CL as treatment	The achievement and enhancement of students' MPPS using IDL is proven better than students using conventional learning, either overall or based on the EMA level despite the fact that the value of MPPS in the second class is still in the lower level, not meeting our expectations. is obtained on the students' SE	Chi-square tested using SPSS 16 software and produced a sig value = 0.000. Due to both groups' sig < α = 0.05, H ₀ was rejected.
(Gürbüz, DOĞRUEL, and Tepe 2021)	560 students from the secondary schools	Scientific Attitude Scale (SAC)	Problem-solving skills and scientific attitudes	Pearson correlation analysis, one-way variance analysis, and two-way variance analysis	Problem-solving skills were not a significant predictor of their scientific attitude.	(1-tailed) = $0.000/2 = 0.000$ $\alpha = 0.05$ t-statistic = 4.233 t-table= 1.9955.
(Azmy and Alebous 2020)	204 Secondary schools, 50% of	Survey method	STEM)	Meta-cognitive thinking strategy skill that	A statistical significance of applying the skills of meta-cognitive strategies to solving	Means = 4.01-4.33, total mean=4.01

	the total number of female teachers.			relates to problem-solving.	problems. The results indicated there is no a statistical significance of applying the skills of meta-cognitive strategies in solving problems by the research sample belongs to their years of experience and the educational area they work in.	Evaluation =4.33& 0.531, Monitoring=4.32 & 0.576 Understanding the problem=4.27 &0.536, solution=4.01 &0.624
(Indahwati and Irvan 2020)	Students of class VIII-A MTs Plus Baitussalam, Banyuwangi regency of the 2018/2019 academic year	Questions, validity, reliability, and problem-solving skills	Problem-Solving skills	Descriptive analysis. Preliminary and formative evaluation. The formative evaluation stage includes self-evaluation, prototyping (expert review, one-to-one, and small groups), and field tests.	Problem-solving skills of students reached 35.43% with a good category. Students who fall into the category of having good problem-solving skills are able to understand the problem or the problem completely; use strategies that lead to the right solution; solving material problem numbers with the right results.	9 students (28.13%) have excellent problem-solving skills; 13 students (40.63%) in a good category; 7 students (21.88%) are in the sufficient category; 3 students (9.40%) were included in the less category. Overall, the average problem-solving skills of students reached 35.43% which falls in the good category.
(Insorio and Librada 2020)	121 students, 5 grade 8 classes by 3 teachers, including the researcher	In the test phase mini-interviews. A pre-and post-test was conducted. Shapiro-Wilk and Kolmogorov-Smirnov test. t-tests	Problem-solving skills	Pre- and post-test. A week before the intervention began, a 40-minute pre-test with the students (n = 121) was conducted	Problem-solving skills of students significantly improved the awareness of students' own problem-solving process and skills increased. Finally based on the results of the current study we recommend the implementation of a multidimensional approach, based on	N=121 Pre-test -SD =2.0809 Mean = 2.2901 Post-test SD =3504 Mean=9752 Improvement SD =1.7520 t=6.624 Mean =1.0551 Improvement Cohen's d=.47.

					providing a problem-solving model, learning activities, and the guidance of the teacher because it can promote problem-solving skills of students in secondary education.	
(Rustan uarsi and Karyati 2019);	Eighth & nine classes grade students in one of the state junior high schools.	Mathematical problem-solving skills	Quasi-experimental with pre-test and post-test control group design.	Quasi-experimental with pre-test and post-test control group design.	Concluded that both collaborative learning models with challenging tasks and collaborative learning are effective in terms of students' mathematical problem-solving skills. However, the collaborative learning model with the challenging task is more effective than the collaborative learning model in terms of students' mathematical problem-solving skills.	Sig value (2-tailed) is 0.007 less than the significant level $\alpha = 0.05$. Thus, H_0 rejected the one-sample t-test showing that t statistic=2.141 higher than t-table=1.69; sig value=0.039/2=0.019 less than the significance level $\alpha = 0.05$. Thus, H_0 is rejected.
(Paf and Dincer 2021);	1098 Secondary school pupils.	Creative Problem-Solving Features Inventory	Computational thinking skills Creative problem-solving skills in secondary school.	T-test, one-way ANOVA multiple linear regression analysis.	The mean scores of students' numerical thinking skills and creative problem-solving skills differed considerably in favour of girls.	The average computational thinking scores of female students ($\bar{X} = 3.89$) were significantly higher than those of male students ($\bar{X} = 3.67$). There was a significant difference in favor of girls ($t(1096) = -6.31, p < .05$).

(Widiyanto, Herlina, and Andra 2021)	76 respondents spread across several schools. purposive sampling questionnaires	Our-point Likert scale	E-Module based on PjBL-integrated STEM	Mixed-method, consisting of qualitative data and quantitative data.	Finding in the field is that most teachers still use textbooks as a learning resource, so using E-Modules is an opportunity to learn. The E-Module that will be developed will contain animation of physical phenomena, problem-solving skills, and project worksheets-integrated STEM.	S1 = 61.9 % S2 = Responses regarding the difficult subject S3-S6 = 65, 72% S7= 47,6% PJBL model- 31,4% PBL, 15,2% Contextual learning= 5,8% S9= 71,4%.
(Fiteriani, Diani, and Anwar 2021)	Eleventh-grade students of SMA N 1 Sending Agung, the students' average creative problem-solving ability and metacognitive skills	Creative problem-solving ability and metacognitive skills	Quasi-experimental. The control group variable purposive sampling technique	Kolmogorov-Smirnov Z (K-SZ). MANOVA test. IBMSPSS Statistics 22 software	Results of the data analysis showed that there was an influence of the application of the PjBL learning model with the STEM approach toward students' creative problem-solving ability and metacognitive skills	Creative problem-solving ability= 0.200 (0.200> 0.05), control class =0.090 (0.090> 0.05), metacognitive skill in the experimental = 0.059 (0.059>0.05), control class =0.074 (0.074>0.05) a significant value of the creative problem-solving ability =0.102> 0.05, metacognitive skills = 0.501> 0.05 Fobserved =2.7834, Fcritical =.03431 so that Fobserved<Fcritical.
(Syahdi and Dewi 2021);	Grade XI of High School academic year (2020/2021) Two sample	Written tests with a model of description questions	Problem-solving, Critical thinking skills.	The research design used is post-test-only	In the experimental class, the value of critical thinking skills is higher than in the control class in terms of rotational dynamics and elasticity. After	Fcount < Ftable with 1.19< 2.07, real level α = 0.05 with degrees of freedom dk =

	classes: the experiment class and the control class.				being analyzed, it was found that the value of $t > t_t$, this means that there is a significant difference. This difference is caused by the effect of implementing problem-solving-based worksheets. Thus, there is an effect of the application of problem-solving-based worksheets on students' critical thinking skills in the matter of rotational dynamics and elasticity of class XI of high school in Kerinci.	$n_1 + n_2 - 2 = 44$, the t value Acceptance criteria H_0 if $1 - 2\alpha < t < 1 + 2\alpha$, because the $t = 2.20$ is in the rejection area H_0 . So that H_1 's working hypothesis is accepted.
(Mardiah, Mailizar, and Elizar 2021)	Six Junior High School students aged less than 15 years	Problem-solving skills indicators used by PISA were analyzed. Adopted from the PISA questions in 2018.	Mathematical problem-solving skills	Descriptive qualitative research. Purposive sampling technique	Results revealed that S1 solved the problems by reading, comprehension, transformation, processing skill, and encoding; S2 and S3 solved the problems by reading the problems, comprehension, and transformation problems; S4 and S5 solved the problems by reading and comprehension, and S6 solved the problems just by reading problems without understanding the problems. Thus, students' problem-solving skills are still unsatisfactory.	S1= problem-solving well, namely reading the problem, understanding the problem, transforming the problem, processing skills, and writing answers. S2 and S3 solved problems using four indicators: reading problems, understanding problems, and transforming problems. S4 and S5 only did two indicators of problem-solving, namely reading the problems and understanding the problems. In contrast, S6 was only able

						to read the problem without being able to understand the problem.
(Yahaya et al. 2022);	40 male and female secondary students from two secondary schools. control group consists of 20 students (10 male and 10 female), the experimental group consists of 20 students (10 males and 10 females)	Quasi-experimental design.	Problem-solving with critical thinking skills	Quasi-experimental design critical thinking skills test was prepared and administered to the two groups as a pre-test treatment and as a post-test once they are finished. MANCOVA and Two-way ANCOVA tests	A study found that using Fermi problem-solving with 56 grade eight students with flipped learning techniques is very useful to empower students in increasing their critical thinking skills. Besides, using Fermi problem-solving in the classroom helps students acquire higher-order thinking skills and build their ideas effectively. The hypotheses and study objective were supported by the study findings and proved the effectiveness of Fermi problem solving with flipped learning techniques on developing the secondary students' critical thinking skills.	Statistical significance ($\alpha = 0.05$), value of (P)= (90.655), inference skill = (0.496), critical thinking skills= (49.6%), statistical significance (teaching method), ($\alpha = 0.05$) (p) reached (75.959),
(Aladağ, Arıkan, and Özenoğlu 2021);	36 students who were in the 7th grade	Map Literacy Scale, the Reflective Thinking Skill Scale	Map literacy skills, reflective thinking skills, problem-solving.	Quantitative	The strong correlation between the two skills	There was a statistically significant increase in the participants' mean total posttest score on the MLS ($\bar{X}_{\text{posttest}} = 81.94$) compared to the pretest ($\bar{X}_{\text{pretest}} = 74.97$).

(Gunawan, MASHAMĪ, and Herayanti 2020)	Chemistry education students in IKIP Mataram that consisted of 10 males and females' students each.	Tests and interviews	Problem-solving skills	Independent sample t-test and normalized gain scores (N-gain).	Chemistry learning increased the problem-solving skills of male better than the female and the learning motivation of students is enhanced.	Initial data obtained a significant value of 0.809, the final data analysis obtained a significant value of 0.034.
(Yanto, Festiyed, and Enjoni 2021).	The eleventh-grade students' students of Senior High School.	Observation sheets, questionnaires and question sheets were used as the instrument of data collection.	Problem Solving Skills in Physics Learning	Homogeneous and heterogeneous interactions both inter and between groups.	The findings indicated that the Problem-Based Learning model can stimulate the improvement of students' problem-solving skills for Physics learning in Senior High School.	Asymp.C. 001 <0.05 means that Ho is rejected.

RESULTS WITH PROBLEM-SOLVING SKILLS AND SCHOOL STUDENTS

In our search we identified sixteen studies that examined problem-solving skills and school students in science. (Karatas, Bademcioglu, and Celik 2017);(Hidayat, Sabandar, and Syaban 2018);(Gürbüz, DOĞRUEL, and Tepe 2021);(Azmy and Alebous 2020);(Indahwati and Irvan 2020); (Insorio and Librada 2020);(Rustanuarsi and Karyati 2019); (Paf and Dincer 2021);(Widiyanto, Herlina, and Andra 2021);(Fiteriani, Diani, and Anwar 2021);(Syahdi and Dewi 2021); (Mardhiah, Mailizar, and Elizar 2021);(Yahaya et al. 2022);(Aladağ, Arıkan, and Özenoğlu 2021);(Gunawan, MASHAMĪ, and Herayanti 2020);(Yanto, Festiyed, and Enjoni 2021).

Some researchers . (Karatas, Bademcioglu, and Celik 2017) (reported in science that there was positive and negative. Correlations between variables.

Some researchers (Hidayat et al. 2018, Rustanuarsi & Karyati 2019, Mardhiah et al. 2021) studied on maths reported that the achievement and enhancement of problem-solving skill Some researchers (Azmy & Alebous 2020, Paf & Dincer 2021, Fiteriani et al. 2021, Syahdi & Dewi 2021, Yahaya et al. 2022, Aladağ et al. 2021) studied on scientific creativity relationship between Meta-cognitive thinking and Critical thinking skills with problem solving skills.

Gunawan et al. (2020) studied on problem-solving skills with chemistry, reported that the chemistry learning increased the problem-solving skills of male better than the female. Yanto et al. (2021) studied on problem solving skills in physics learning. The Problem-Based Learning model can stimulate the improvement of students' problem-solving skills for Physics learning. They use Statistical analysis like Pearson correlation, Quasi-experimen, ANOVA, MANOVA test, regression analysis.

The review of the previous studies provides valuable suggestions and implications. In light of the above critical overview of previous research, it may be worthwhile to take an account that some innovative teaching methods are necessary for the development of the problem-solving skills of students. These innovative teaching methods are very beneficial to students in developing reasoning power, understanding various

concepts of science, and a tendency to participate in discussions on scientific attitudes and compelling students to explore noble ideas.

A review of previous research is also important for school teachers to make their learning outcomes more effective by adopting various types of teaching methods and techniques. It provides a direction to teachers for the systematic preparation of classroom interaction patterns. The review also gives suggestions to school managers and administrators for providing an abundant supply of teaching materials and resources for better implementation of innovative teaching methods and techniques. The experiences gained during this review of previous research have enabled the investigators to make suggestions for further research. The researchers realized that most of the studies were conducted at the school level. So, further study may be conducted on all levels of education including school education. It is also recommended that studies may be undertaken to find out the effectiveness of various innovative teaching methods in the development of scientific attitudes, Multiple intelligences, Creative problem-solving skills, Mathematical problem-solving skills, Problem Solving Skills in Physics Learning.

SUGGESTIONS AND RECOMMENDATIONS ON THE BASIS OF REVIEWS As a consequence of the research, the following recommendations for practitioners and researchers could be made.

- Problem-Based Learning model can stimulate the improvement of students' problem-solving skills for Physics learning in Senior High School. For this reason, it is recommended for the teachers and prospective teachers to apply the Problem-Based Learning model for Physics learning in Senior High School.
- This furthermore showed that the use of interactive multimedia in chemistry learning increased the problem-solving skills of male better than the female. Moreover, male students' problem-solving skills were higher than the females in all types of problems and at all stages of problem-solving. Due to interactive multimedia, the conceptual understanding and learning motivation of students is enhanced.
- Based on these findings, it is recommended that teachers devote more time to nature education and curricula promote nature education.
- As a grouping mechanism helps the students to combine their attributes and work collaboratively towards the accomplishment of the group task.
- According to the findings, as pupils' grade levels improved, so did their computational thinking skills. To assist this development, it is formally recommended that computational thinking abilities be included into the curriculum beginning with preschool.
- It has been observed that having a computer is effective on students' skills. Accordingly, it can be suggested to increase / improve the technological equipment of educational environments.

CONCLUDING AND FUTURE DIRECTIONS

To sum up, the present systematic review has shed some light on the relationship between problem solving skills and secondary school students, thereby leading to several questions that have not been yet examined in educational research. To the best of our knowledge, this is the first systematic review specifically addressing the association between problem solving skills and secondary school students. Furthermore, these insights may be valuable not only for attempting more integrative studies complementing the existing gaps in the literature on problem solving skills and secondary school students, but also for developing more effective intervention programmes for enhancing problem solving skills and well-being. More effective in increasing students' creative problem-solving ability and metacognitive skills.

Based on results and discussion, it can be concluded that both of collaborative learning model with challenging task and collaborative learning are effective in terms of students' mathematical problem-solving skills.

However, collaborative learning model with challenging task is more effective than the collaborative learning model in terms of students' mathematical problem-solving skills. improve critical thinking skills and problem-solving is effective to improve students' creative thinking skills.

REFERENCE

- Aladağ, Elif, Alaattin Arıkan, and Hatice Özenoğlu. 2021. "Nature Education: Outdoor Learning of Map Literacy Skills and Reflective Thinking Skill towards Problem-Solving." *Thinking Skills and Creativity* 40: 100815.
- Ambrose, Susan A, Michael W Bridges, Michele DiPietro, Marsha C Lovett, and Marie K Norman. 2010. *How Learning Works: Seven Research-Based Principles for Smart Teaching*. John Wiley & Sons.
- Argaw, Aweke Shishigu, Beyene Bashu Haile, Beyene Tesfaw Ayalew, and Shiferaw Gadisa Kuma. 2016. "The Effect of Problem Based Learning (PBL) Instruction on Students' Motivation and Problem Solving Skills of Physics." *Eurasia Journal of Mathematics, Science and Technology Education* 13 (3): 857–71.
- Aslan, A Esra. 2002. "Örgütte Kişisel Gelişim." *Ankara: Nobel Yayıncılık*.
- Azmy, Khadir Abdullah Al, and Tahani Muhamad Alebous. 2020. "The Degree of Using Meta-Cognitive Thinking Strategies Skills for Problem Solving by a Sample of Biology Female Teachers at the Secondary Stage in the State of Kuwait." *Educational Research and Reviews* 15 (12): 764–74.
- Benner, Susan M, and J Amos Hatch. 2010. "From the Editors: Preparing Early Childhood Educators for 21st Century Children." *Journal of Early Childhood Teacher Education*. Taylor & Francis.
- Bhatnagar, Anjali, and V Sudhakar. n.d. "Exploring Teacher" s Proficiency with Experiential Learning: An Overview."
- Dewi, Putu Yulia Angga, and Kadek Hengki Primayana. 2019. "Effect of Learning Module with Setting Contextual Teaching and Learning to Increase the Understanding of Concepts." *International Journal of Education and Learning* 1 (1): 19–26.
- Erozkan, Atilgan. 2013. "The Effect of Communication Skills and Interpersonal Problem Solving Skills on Social Self-Efficacy." *Educational Sciences: Theory and Practice* 13 (2): 739–45.
- Fiteriani, Ida, Rahma Diani, and Chairul Anwar. 2021. "Project-Based Learning through STEM Approach: Is It Effective to Improve Students' Creative Problem-Solving Ability and Metacognitive Skills in Physics Learning?" In *Journal of Physics: Conference Series*, 1796:12058. IOP Publishing.
- Greiff, Samuel, Sascha Wüstenberg, Benő Csapó, Andreas Demetriou, Jarkko Hautamäki, Arthur C Graesser, and Romain Martin. 2014. "Domain-General Problem Solving Skills and Education in the 21st Century." *Educational Research Review*, no. 13: 74–83.
- Gunawan, Gunawan, A Harjono, H Sahidu, and L Herayanti. 2017. "Virtual Laboratory to Improve Students' Problem-Solving Skills on Electricity Concept." *Jurnal Pendidikan IPA Indonesia* 6 (2): 257–64.
- Gunawan, Gunawan, Ratna Azizah MASHAMİ, and Lovy Herayanti. 2020. "Gender Description on Problem-Solving Skills in Chemistry Learning Using Interactive Multimedia." *Journal for the Education of Gifted Young Scientists* 8 (1): 571–89.
- Gürbüz, OCAK, Ayşe Betül DOĞRUEL, and Mustafa Enes Tepe. 2021. "An Analysis of the Relationship between Problem Solving Skills and Scientific Attitudes of Secondary School Students." *International Journal of Contemporary Educational Research* 8 (1): 72–83.
- Hidayat, Teguh Imam Agus, Jozua Sabandar, and Mumun Syaban. 2018. "INDUCTIVE-DEDUCTIVE LEARNING APPROACH TO DEVELOP STUDENTS' MATHEMATICAL PROBLEM SOLVING SKILLS AND SELF EFFICACY." (JIML) *JOURNAL OF INNOVATIVE MATHEMATICS LEARNING* 1 (1): 24–33.

- İncebacak, Belgin Bal, and Esen Ersoy. 2016. "Problem Solving Skills of Secondary School Students." *China-USA Business Review* 15 (6): 275–85.
- Indahwati, T, and M Irvan. 2020. "The Development of Islamic-Based PISA Question Models on the Topics Concerning Quantity and Its Enhancement to Improve Student Problem Solving Skills." In *Journal of Physics: Conference Series*, 1563:12067. IOP Publishing.
- Insorio, Alvin Odon, and Analisa Rosa Padua Librada. 2020. "Enhancing Mathematical Critical Thinking and Problem-Solving Skills through Emergenetics® as a Grouping Mechanism." *Contemporary Mathematics and Science Education* 2 (1): ep21002.
- Jonassen, David H. 2006. "On the Role of Concepts in Learning and Instructional Design." *Educational Technology Research and Development* 54 (2): 177–96.
- Kalelioglu, Filiz, and Yasemin Gülbahar. 2014. "The Effects of Teaching Programming via Scratch on Problem Solving Skills: A Discussion from Learners' Perspective." *Informatics in Education* 13 (1): 33–50.
- Karatas, Hakan, Mehtap Bademcioglu, and Suleyman Celik. 2017. "A Study on the Relationship between Problem Solving Skills and Multiple Intelligences of High School Students." *International Journal of Education and Practice* 5 (10): 171–81.
- Khalid, Madiah, Supiah Saad, Siti Rafiah Abdul Hamid, Muhammad Ridhuan Abdullah, Hasniza Ibrahim, and Masitah Shahrill. 2020. "Enhancing Creativity and Problem Solving Skills through Creative Problem Solving in Teaching Mathematics." *Creativity Studies* 13 (2): 270–91.
- Khoiriyah, Anna Jarrotul, and Husamah Husamah. 2018. "Problem-Based Learning: Creative Thinking Skills, Problem-Solving Skills, and Learning Outcome of Seventh Grade Students." *JPBI (Jurnal Pendidikan Biologi Indonesia)* 4 (2): 151–60.
- Kirkley, Jamie, and R Foshay. 2003. "Principles for Teaching Problem Solving. Plato Learning." *Inc. Technical Paper: Indiana*.
- Lave, Jean, and Etienne Wenger. 1991. *Situated Learning: Legitimate Peripheral Participation*. Cambridge university press.
- Lindeman, Karen Wise, and Elizabeth McKendry Anderson. 2015. "Using Blocks to Develop 21st Century Skills." *YC Young Children* 70 (1): 36.
- Mardhiah, M Z, M Mailizar, and E Elizar. 2021. "Students' Mathematics Problem-Solving Skills in PISA Problems." In *AIP Conference Proceedings*, 2331:20032. AIP Publishing LLC.
- McLellan, Hilary. 1996. *Situated Learning Perspectives*. Educational Technology.
- Paf, Muhammed, and Beste Dincer. 2021. "A Study of the Relationship between Secondary School Students' Computational Thinking Skills and Creative Problem-Solving Skills." *Turkish Online Journal of Educational Technology-TOJET* 20 (4): 1–15.
- Prihatmi, Eusibia Asih, Sri Wahyuni Sulistyaningsih, Yayuk Sri Wahyuni, Yuyun Yulia, and Silvester Goridus Sukur. 2022. "English Teaching-Learning Process During PTMT (Limited Face to Face Teaching Learning) Period in Junior High Schools in Gunungkidul." In *International Seminar Commemorating the 100th Anniversary of Tamansiswa*, 1:421–26.
- Putter-Smits, L G A De, R Taconis, and W M G Jochems. 2013. "Mapping Context-Based Learning Environments: The Construction of an Instrument." *Learning Environments Research* 16 (3): 437–62.
- Rahayu, Sri, A L Chandrasegaran, David F Treagust, Masakazu Kita, and Suhadi Ibnu. 2011. "Understanding Acid-Base Concepts: Evaluating the Efficacy of a Senior High School Student-Centred Instructional Program in Indonesia." *International Journal of Science and Mathematics Education* 9 (6): 1439–58.

- Rahman, Md. 2019a. "21st Century Skill'problem Solving': Defining the Concept." *Rahman, MM (2019). 21st Century Skill "Problem Solving": Defining the Concept. Asian Journal of Interdisciplinary Research 2 (1): 64–74.*
- . 2019b. "21st Century Skill'problem Solving': Defining the Concept." *Rahman, MM (2019). 21st Century Skill "Problem Solving": Defining the Concept. Asian Journal of Interdisciplinary Research 2 (1): 64–74.*
- Reisberg, Daniel. 2013. *The Oxford Handbook of Cognitive Psychology*. Oxford University Press.
- Rustanuarsi, R, and K Karyati. 2019. "The Effectiveness of Collaborative Learning Model with Challenging Task on Students Mathematical Problem-Solving Skills." In *Journal of Physics: Conference Series*, 1157:42058. IOP Publishing.
- Seel, Norbert M. 2011. *Encyclopedia of the Sciences of Learning*. Springer Science & Business Media.
- Setiyani, Setiyani, Nur Fitriyani, and Laela Sagita. 2020. "Improving Student's Mathematical Problem Solving Skills through Quizizz." *Journal of Research and Advances in Mathematics Education 5 (3): 276–88.*
- Syahdi, Nadya, and Wahyuni Satria Dewi. 2021. "META-ANALYSIS OF THE EFFECT OF USE WORKSHEETS ON STUDENTS CRITICAL AND CREATIVE THINKING SKILLS IN LEARNING NATURAL SCIENCE IN JUNIOR HIGH SCHOOL AND PHYSICS IN SENIOR HIGH SCHOOL." *PILLAR OF PHYSICS EDUCATION 14 (3): 235–41.*
- Widiyanto, Retno, Kartini Herlina, and Doni Andra. 2021. "The Need Analysis of Using Physic E-Module Based PjBL–Integrated STEM: The Preliminary Study Research as a Solution to Improve Problem-Solving Skills on Light Refraction Material." In *Journal of Physics: Conference Series*, 1796:12079. IOP Publishing.
- Yahaya, Rusliza, Mohamad Rohieszan Ramdan, Noor Lela Ahmad, Rosmini Ismail, Khalizul Khalid, Mohd Abdullah Jusoh, and Rosmah Mat Isa. 2022. "Educators' Motivation and Intention within the UTAUT Model to Adopt the Flipped Classroom: A Scoping Review." *International Journal of Learning, Teaching and Educational Research 21 (2).*
- Yanto, Febri, Festiyed Festiyed, and Enjoni Enjoni. 2021. "Problem Based Learning Model For Increasing Problem Solving Skills In Physics Learning." *JIPF (Jurnal Ilmu Pendidikan Fisika) 6 (1): 53–65.*
- Yildiz, Cansu, and Tulin Guler Yildiz. 2021. "Exploring the Relationship between Creative Thinking and Scientific Process Skills of Preschool Children." *Thinking Skills and Creativity 39: 100795.*
- Yu, Kuang-Chao, Szu-Chun Fan, and Kuen-Yi Lin. 2015. "ENHANCING STUDENTS'PROBLEM-SOLVING SKILLS THROUGH CONTEXT-BASED LEARNING." *International Journal of Science and Mathematics Education 13 (6): 1377–1401.*