

# The influence of the Investigation Through Cooperative Learning (ITCPS) learning-model on learning outcomes and collaborative skills of 7th grade students

Halifah Eka Sri Hartanti\*, Budi Utami, Daru Wahyuningsih

Department of Science Education, Faculty of Teacher Training and Education, Universitas Sebelas Maret, Ir. Sutami Street. 36A, Surakarta, 57126, Indonesia

\*Corresponding author, email: sr.halifah@student.uns.ac.id

## Article History

Received: 10 March 2026

Revised: 12 April 2026

Accepted: 9 May 2026

## Keywords

Collaboration skills

ITCPS learning model

Learning outcomes

## Abstract

21st century learning emphasizes learning outcomes and 4C skill such as collaboration. However, based on observations students' learning outcomes and skills still low. This study aims to determine effect of Investigation Through Cooperative Problem Solving (ITCPS) learning model on learning outcomes and collaboration skill of 7th grade students in junior high school in Surakarta. This study is a quantitative quasi-experimental design with a control class and a experimental class. The result of learning outcomes of knowledge sig.  $0.000 < 0.05$ , learning outcomes of skills sig.  $0.000 < 0.05$ , collaboration skills sig.  $0.000 < 0.05$ , learning outcomes on collaboration skills  $0.000 < 0.05$ . The ITCPS learning model has a positive influence on learning outcomes of knowledge and skills, but does not affect attitudes. The ITCPS model impacts science learning outcomes and collaboration skills because it integrates problem-solving activities with group work. Through ITCPS, students actively learn to identify problems, formulate problems, project investigations and develop solutions, present discussion, and evaluations.

**How to cite:** Hartanti, H. E. S., Utami, B. & Wahyuningsih, D. (2026). The influence of the Investigation Through Cooperative Learning (ITCPS) learning-model on learning outcomes and collaborative skills of 7th grade students. *Innovations in Science Education and Practice*, 3(2), 72-81.

## 1. Introduction

Learning has changes in form, methods, and objectives know as 21st century learning (Estigoy et al., 2025). 21st century learning is an instructional approach fundamentally grounded in the cultivation of essential skills such as innovation, self-development, information management, problem-solving, life and career skills. 21st century skills have emerged to keep pace with advancements in social, scientific, and technological fields (Kaya et al., 2023). All aspects needed to support the educational process such as quality, media, infrastructure, and technology. It is essential to prepare students by equipping them with 21st century skills (Rehman et al., 2024). Iyamuremye et al. (2025) reinforces the importance of empowering student with 21st century skills, it can improve peers interaction, problem-solving, collaborative inquiry, and software skills. The 21st century emphasizes fundamental learning such as critical thinking, communication, and collaboration (Naseer et al., 2025), problem-solving and creativity (Ma, 2026). Educator must develop 21st century skills with four competencies known as 4Cs: communication, critical thinking, creativity, and collaboration (Nahar & Machado, 2025).

Collaboration is a 21st-century skill that student need to master (Andersen & Rustad, 2022). Collaboration aims to find solution from a problem with engaging shared awareness skills and knowledge (Sum & Bădescu, 2023). Aspects of collaboration skills is working productively, respecting others, compromising, contributing each other, and sharing responsibly (Anggis, 2016). Students working in groups generate knowledge and achieve higher than those studying independent. Important to use student-centered learning to develop essential skills (Ningsih et al., 2025). Nahar & Machado (2025) show that collaboration is influential in learning, active collaboration make encourangin communication and collaboration with peers and teacher. Although that, teachers' insights and implementation of these skills are still limited (Ho & Le, 2026). Research by Fiharsono et al. (2025) learning activities in Morowali place students as passive recipients, sitting quietly, listening teacher. When the primary focus not for student, it consequently lower motivation and limited communicative skills (Zhang, 2025).

Observation during the 2023 teaching assistance at junior high school in Surakarta showed that student collaboration was still low, as evidenced by many students being reluctant form groups, unwilling to form groups with certain student, and telling stories during group time. Discussions were rarely seen due to a lack of learning variation, never forming groups, and learning focused on the teacher and students listening. Thus, student collaboration skills at junior high school in Surakarta were categorized as lacking. Besides collaboration skill, the learning outcomes of 7th grade student were also relatively low, as indicated by score science final exam average 67 while the minimal score was 79. Therefore, a method is needed to has a positive effect on student learning outcomes and their collaboration skills (Koçoğlu & Kanadlı, 2025).

To improve learning outcomes and collaboration skills, student require a variety of learning models to avoid monotony (Radović & Seidel, 2025). The best model is a combined with practice to increase student engagement and understanding (Chen et al., 2025). The solution researchers can apply is the Investigation Through Cooperative Problem Solving (ITCPS) learning model. ITCPS is a learning model that combines cooperative learning and problem-solving models. Cooperative learning involves students collaborating with peers, supported by five elements in Johnson and Johnson's theory (Pretorius & de Beer, 2025). The five elements of Johnson & Johnson (2019) are positive interdependence, individual accountability, face-to-face promotive interactions, interpersonal and small group skills, and group processing. Problem-solving learning teaches students solve problems as a catalyst for critical thinking (Eticha et al., 2026). By adapting these two models, it is hoped that students will be able to work together to solve problems presented by the teacher (Utami, 2021).

Utami (2021) found that ITCPS can improve the social and affective aspects of chemistry learning. The five syntaxes of ITCPS consist of: 1) Identifying Problem, 2) Formulating Problem, 3) Investigation, 4) Explaining, and 5) Reflection. ITCPS has several advantages, including: 1) Students actively work together in groups, thereby increasing collaboration and interaction between students; 2) Practicing critical and creative thinking skills, thereby developing students' problem-solving abilities; 3) Through discussions, students can improve their understanding of concepts; 4) Increasing motivation and independence in learning; with the ITCPS learning model, students also practice independence and are responsible for the group learning process (Utami et al., 2021). Research by Utami et al. (2023) revealed that the ITCPS learning model can improve students' critical skills in understanding chemical equilibrium material. Prasadityo et al. (2023) argued in classification material, the ITCPS learning model can improve problem-solving skills. Another study revealed that science process skills can be improved with ITCPS, a case study of 8th grade students at SMPN 3 Surakarta (Zoraida et al., 2024).

Previous research has demonstrated the effectiveness of ITCPS in improving learning. However, it has not specifically examined its impact on learning outcomes and collaborative skills comprehensively in Surakarta. Therefore, this study aims to examine the influence of the investigation through cooperative problem-solving (ITCPS) learning model on learning outcomes and collaborative skills of seventh-grade students.

## 2. Method

This research is a quantitative quasi-experimental design study. This type research was chosen because it allows direct testing of two different classes to see the effect. The population of this study was all seventh-grade students of junior high school in Surakarta. Sampling used a cluster random sampling technique. Data collection techniques were carried out using test instrument and non-test instruments. The test instrument was used to data on the cognitive or knowledge aspects of science learning outcomes and was taken twice (pretest and posttest). The pre and post-test questions each consisted of 20 multiple-choice questions and 5 descriptive items about Earth and the Solar System material. The non-test instruments were in the form of questionnaires and observations. The questionnaire was used to data on the attitude aspect of learning outcomes, composed of 10 positive statements, 5 negative statements, and measured using a Likert scale. Likert scale is an analytical technique to measure the intensity of participants' responses regarding something (Huh & Gim, 2025). The Likert scale responses ranged from strongly disagree (STS) to strongly agree (SS) (Asogwa et al., 2025). Non-test observation instruments were conducted during the learning process to measure students' psychomotor and collaborative skills learning outcomes. The data used

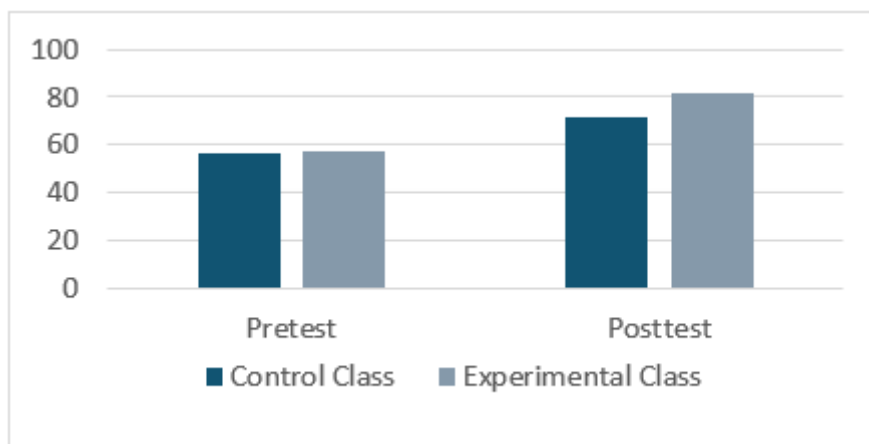
consisted of primary data obtained directly from respondents and secondary data from various literature.

The data analysis technique for this research uses SPSS 25 software. The techniques used for this research data analysis are descriptive analysis, inferential analysis, and report presentation. The normality test and homogeneity test are used to determine whether the population comes from normal and homogeneous data. The normality test was tested using the Kolmogorov Smirnov test with a significance level of  $\text{sig.} > 0.05$ . The homogeneity test used the Levene test with a significance level of  $\text{sig.} > 0.05$ . The hypothesis test used the Independent Sample T-Test and MANOVA tests.

### 3. Results and Discussion

#### 3.1. Cognitive Learning Outcomes

The average data cognitive learning outcomes can be seen in Figure 1.



**Figure 1. Average data pretest-posttest cognitive learning outcomes**

The average pretest-posttest scores in the experimental class were higher than those in the control class. The control class's average pretest score was 56.80 and posttest score was 71.96. The experimental class average pretest score was 57.32 and posttest score was 81.31. The collected data were subsequently tested for normality Kolmogorov Smirnov's test, the results presented in Table 1.

**Table 1. Normality test for cognitive learning outcomes**

Class	Sig.	Pretest		Posttest	
		sig.	conclusion	sig.	conclusion
Control	0.05	0.143	Normal	0.082	Normal
Experimental	0.05	0.079	Normal	0.302	Normal

Table 1 shows the cognitive learning outcomes data are above 0.05 sig., indicating normal distribution. The data then tested using the Levene's test for homogeneity. Results are show in Table 2.

**Table 2. Homogeneity test for cognitive learning outcomes**

Homogeneity test	A	Sig.	Conclusion
	0.05	0.143	data are homogeneous

Table 2 show a significance 0.143, greater than sig. 0.05, indicating data are homogeneous. The data were then hypothesized using independent sample t-test. Results are show in Table 3.

**Table 3. Hypothesis test for cognitive learning outcomes**

Hypothesis test	A	Sig.	Conclusion
	0.05	0.143	Has a significance diference

Table 3 show a significance  $0.000 < 0.05$ . This results conclude the ITCPS learning model influence significant for cognitive learning outcomes. Through the provision of pretest and posttest questions, students are encouraged to understand the material has been learned. In line with research by Utami et al., (2019) which states the ITCPS learning model helps students in understanding learning materials more deeply. Students are center of learning activities so effective learning model encourages active student involvement and improves educational outcomes (Du et al., 2025). Vaszkun & Szakács (2025) explained cognitive and habits significantly influence the effectiveness of online learning so students can create the right environment for teaching. The application syntax of science learning outcomes in cognitive aspect is described in Table 4.

**Table 4. The application syntax ITCPS in cognitive learning outcomes aspect**

No.	Syntax	Explanation
	Identifying Problem	<p>Begins after the teacher opens the lesson with a greeting. The teacher conveys learning objectives and guides students to answer questions related to the Earth and Solar System.</p> <p>In Student Worksheet 1: the teacher displays a visual photo of a view of the city of Svalbard, Norway, covered in snow and in dim weather without sunlight. The problem identified by students was the occurrence of the polar night phenomenon in Svalbard. This phenomenon occurs because the sun does not rise during winter, lasting for two months from November to January.</p> <p>In Student Worksheet 2: the teacher displayed visual media in the form of a photograph of celestial objects in the form of the sun and planets that appear aligned. The problem identified by students was the occurrence of the planetary alignment phenomenon, due to the orbit of the planets around the sun. The only way to observe the planets is with the naked eye and a 10 cm telescope.</p> <p>In Student Worksheet 3: the teacher displayed a visual media in the form of a photograph of a half-sun and a sentence that read, "It is dangerous to look directly at a solar eclipse." The problem identified by students is that viewing a solar eclipse directly can be harmful to the eyes. A solar eclipse occurs during new moon phase when the earth, moon, and sun are aligned. Visuals help students understand the Earth and the Solar System by simplifying the complex concepts of how the universe works, how the Earth rotates, the difference between day and night, and the occurrence of solar and lunar eclipses.</p> <p>Learning begins with asking questions and observing, which becomes the gateway to learning. Problem identification is a crucial part of the ITCPS learning model because it is a crucial initial step. At this stage, students are encouraged to identify and understand the problems in each worksheet, improving student concentration, honing their explanation skills, and facilitating active student involvement in learning. In line with the Jilcha (2025) research, it positions the syntax problem identification and formulation as a crucial initial step in the systematic methodology of scientific research.</p>
	Formulating Problem	<p>Students are guided by the teacher to discuss in groups to formulate problems and provide hypotheses or tentative answers.</p> <p>The problem formulation that students found in Worksheet 1, which depicts the city of Svalbard, is "Why doesn't Svalbard experience daytime?" with the hypothesis "Svalbard doesn't experience daytime because it is close to the North Pole, and because of the Earth's rotation and revolution, the sun doesn't rise in the city during winter."</p> <p>The problem formulation that students found in Student Worksheet 2 was "How do we see celestial objects that are far from Earth?" with the hypothesis "how to view distant celestial objects using a telescope."</p> <p>The problem formulation identified by students in Student Worksheet 3 was "how to safely view a solar eclipse?" with the hypothesis "a solar eclipse can be observed safely using special protective equipment such as solar eclipse glasses."</p> <p>The activity of formulating problems and generating hypotheses is important because it enables students to understand the general outline of the material or learning they will be studying. To enable students to formulate problems, the teacher provides a basic explanation with a narrower focus on questions, and students will consider problem formulations that align with the direction of the questions posed by the teacher. Branchini et al. (2025) research added that hypothesis allow student to think beyond and stimulate their concentration. Formulating problem and generating hypothesis is a common practice in research.</p>
	Investigation	<p>In the investigation syntax, the teacher guides students to conduct experiments or investigations and then analyze the data obtained.</p> <p>In Student Worksheet 1, students conduct investigations by searching for information in textbooks, student handbooks, and other sources related to the polar night phenomenon in Svalbard. The data obtained is then analyzed and recorded in each group's Student Worksheet.</p> <p>In Student Worksheet 2, students conduct an experiment by making a simple telescope from a nearby object, namely PVC pipe (a plastic water pipe). After completing the simple telescope-making experiment, group members gathered information from various sources and then wrote it down on their worksheets.</p> <p>In Student Worksheet 3, students conducted an experiment making simple eclipse glasses using used cardboard and used X-ray photographs. An alternative for those without used X-ray photographs was to use black or white mica with a transparent black sticker.</p>

	After completion, students gathered information from various sources and wrote it down on their worksheets. At this stage, students also analyzed and concluded the results of their investigations obtained from various sources, both inside and outside the classroom. The teacher guided students in preparing a final report, which can be found in the worksheets. In line with Radharani et al. (2025) research, syntax investigation is important because develops students' scientific literacy indicators, interpretation scientific evidence and data to Student Worksheet.
Explaining	Students are accountable for what they have learned during the investigation. The results of investigation or experiment are oral presented on class. In the first worksheet, students present the results of their case study investigation of Polar Night in Svalbard. In the second worksheet, students present the results of their simple telescope design. In the third worksheet, students present the results of their simple eclipse glasses design. Groups that do not present are allowed to ask questions related to the material. Each group is given a quota of three questions and three possible answers. All students presenting have the same right to answer questions from other groups. Groups not presenting have the right to listen and ask questions carefully and are obligated to do so. Explaining syntax is important because it provides the basis and practice for students in sentence construction, makes it easier to understand research results, increases confidence when answering questions, and improves learning outcomes and collaboration skills. In line with Jitpaisarnwattana (2025) research, oral presentation able to increase posttest score, language proficiency, and fluent pronoun.
Reflection	In the reflection syntax, the teacher provides confirmation to students regarding the material they have learned. The teacher explains the correct concepts and corrects any misconceptions that arise. This aims to ensure that students understand the material accurately and prevent misconceptions. The application of reflection can improve students' understanding of the subject, achieve significant learning outcomes, and help students reflect on and understand the Earth and Solar System material previously studied. The Selimi et al. (2025) research added, reflection is important because this syntax emphasize the importance of listening teacher explanation, evaluating students perspective, improving teamwork skills, and completing tasks more efficiently.

### 3.2. Psychomotor Learning Outcomes

Data collection was conducted through observation of students. There was one observer who assisted the researcher during the research. Students received 1 point for each skill with a total of 20 points. The average score of the control class was 51.07, the experimental class was 59.03. With a difference of 7.96 points, the control class was higher. The psychomotor aspect is divided into 5 aspects, namely imitation, manipulation, precision, articulation, and naturalization. The score of the imitation aspect of the control class was 59.12, experimental class was 69.79. The value of the manipulation aspect of the control class was 63.8, experimental class was 70.83. The value of the articulation aspect of the control class was 34.89, experimental class was 42.45. The value of the naturalization aspect of the control class was 42.7, experimental class was 51.82. The data were then tested for normality using the Shapiro-Wilk test. The normality test is shown in Table 5.

**Table 5. Normality test for psychomotor learning outcomes**

Class	Sig.	Posttest	Conclusion
		sig.	
Control	0.05	0.160	Normal
Experimental	0.05	0.137	Normal

Table 5 shows that the psychomotor science learning outcomes for both the control and experimental classes were above the 0.05 sign, indicating a normal distribution. The data then tested for homogeneity using the Levene's test. The results are shown in Table 6.

**Table 6. Homogeneity test for psychomotor learning outcomes**

Homogeneity test	A	Sig.	Conclusion
	0.05	0.547	data are homogeneous

Table 6 has a significance level of 0.547. A homogeneity test value above 0.05 indicates that the data are homogeneous. The data were then hypothesized using an independent sample t-test. The results test are shown in Table 7.

**Table 7. Hypothesis test for cognitive learning outcomes**

Hypothesis test	A	Sig.	Conclusion
	0.05	0.000	Has a significance difference

Table 7 show a significance level of  $0.000 < 0.05$ , so ITCPS learning model has a significant effect on psychomotor science learning outcomes. Psychomotor learning outcomes are found in syntax of Investigation and Explanation. These psychomotor science learning outcomes encompass five aspects: imitation, manipulation, precision, articulation, and naturalization (Ginting, 2023).

First, imitation aspect. Students prepare the tools and materials needed for the simple telescope and eclipse glasses project. Students imitate the teacher who has given the previous example. (Shen et al (2025) argues imitation is observing others, then doing imitation. Second, aspect of manipulation. Is done when students draw the design of the simple telescope and eclipse glasses project. The use of project media improves conceptual understanding through practice. Milenković et al (2025) argues that manipulatives are physical objects to help students visualize abstract concepts to solve complex problems. Third, aspect of precision presenting the results of the simple telescope and eclipse glasses design, problem formulation, hypotheses, project design innovation, and presenting the work. Msuya & Abdala (2025) revealed that effective oral presentations improve self-confidence, sharing and collaboration, create a relaxed and supportive learning environment. Fourth, aspect of articulation presenting information on these final product results and communicating it to other groups. Presentations train students' eye contact, body language, speech quality, support effective communication skills, speaking confidence, and increase students' motivation in learning (Karagöl et al., 2025).

Research by Utami et al (2019) on the Investigation Through Cooperative Problem Solving (ITCPS) learning model has five main syntax steps: identifying problem, formulation problem, investigation, explanation, and reflection. The ITCPS learning model encourages students to actively conduct experiments and collaborate, be enthusiastic, observe, and take notes. These activities are in accordance with psychomotor aspect indicators such as project design skills, accuracy, and problem solving. So that psychomotor aspect learning outcomes develop using cooperative and problem-solving-based learning models. Consistent with research by Akkaya & Mirzeoğlu (2024) which states that cooperative learning models are more effective in academic learning and skills in sports learning. Arrieta-Cohen et al (2024) added that problem-solving-based learning models show significant improvements in test scores, problem solving, collaboration, communication, and critical thinking.

### 3.3. Collaboration skill

Collaboration skills data were collected using student observation sheets. Students received 1 point for each collaboration skill with a total of 20 points filled in by the observer. Collaboration skills data obtained an average value of 51.34 for the control class and 81.02 for the experimental class. Furthermore, the data were distributed frequency based on each aspect. First, collaboration aspect for control class are 51.04 and 90.36 for the experimental class. Second, responsibility aspect for control class was 60.62 and 87.75 for the experimental class. Third, compromise aspect for control class was 47.91 and 89.58 for the experimental class. Fourth, communication aspect for the control class was 58.59 and experimental class was 63.80. Fifth, flexibility aspect for control class was 39.84 and experimental class are 79.42. In all aspects, the experimental class's value was higher than the control class. Furthermore, the data were tested for normality using the Shapiro-Wilk test. The results can be seen in Table 8.

**Table 8. Normality test for collaboration skills**

Class	Sig.	Posttest	Conclusion
		sig.	
Control	0.05	0.101	Normal
Experimental	0.05	0.114	Normal

Table 8 shows that the collaboration skills data is above the 0.05 sig., indicating a normal distribution. The data were then tested for homogeneity using the Levene's test. The results of the homogeneity test are shown in Table 9.

**Table 9. Homogeneity test for collaboration skills**

Homogeneity test	A	Sig.	Conclusion
	0.05	0.567	data are homogeneous

In Table 9, the collaboration skills have a significance level of 0.567. A value above 0.05 indicates that the data are homogeneous. The data were then tested for hypotheses using an independent sample t-test, as shown in Table 10.

**Table 10. Hypothesis test for collaboration skills**

Hypothesis test	A	Sig.	Conclusion
	0.05	0.000	Has a significance difference

Table 10 shows a significance level of 0.000. This value is less than 0.05, so the test results conclude that the ITCPS learning model has a significant effect on collaboration skills. The application of various models significantly increases competence, develops skills, decision-making, and critical thinking (Eskiyurt & Özkan, 2024). Collaborative learning also supports the development of cognitive, affective learning outcomes, the development of metacognitive, social, and collaborative skills (Rumiantsev et al., 2023).

Collaborative skills assessment is carried out when working in groups on LKPD projects. LKPD 1 students analyze readings about the city of Svalbard, students are guided to analyze maps, rotations and the revolution of the earth. Student Worksheet 2 students are given a project to make a simple telescope, connect pipes and install lenses. The teacher guides students on how to observe celestial objects simply. Student Worksheet 3 students make simple eclipse glasses from used cardboard and are given lenses from black mica. The teacher guides students on how to observe a solar eclipse with simple eclipse glasses. Collaboration skills assessment is carried out using observation sheets. Ritoša et al. (2023) stated that observations carried out by observers (external observers) are used more often than surveys. Observations are used in a structured manner to assess and evaluate student learning and learning outcomes (Weston et al., 2023).

Research has shown that the ITCPS learning model positively impacts the ability to collaborate, solve problems, assist other members, and express ideas more quickly, leading to solutions. According to Ginting (2023) research, collaboration allows students to interact, exchange differing perspectives, seek clarification, and engage in discussions about their ideas.

### 3.4. Relationship between learning outcomes and collaboration

The data on science learning outcomes in the cognitive, attitude, and skills and collaboration aspects were then tested using MANOVA. The MANOVA test results are shown in Table 11.

**Table 11. MANOVA test for learning outcomes and collaboration skills**

Manova test	A	Sig.	Conclusion
	0.05	0.000	Has a significance difference

The Table 11 shows a significance value of 0.000. The test results conclude that the ITCPS learning model has a significant effect on science learning outcomes in the psychomotor aspect. To achieve optimal learning, students are required to develop the 4C skills: communication, critical thinking, collaboration, and creativity (Cheng & Weatherly, 2025).

Communication is defined as the process of creating and maintaining relationships with others using verbal and nonverbal actions effectively. Critical thinking is a higher-order thinking process for overcoming challenges. Collaboration involves shared effort and responsibility, flexibility in compromise, shared responsibility, and valuing individual contributions. Creativity encourages individuals to engage in creative thinking to create or improve products, analyze, and continuously evaluate ideas (Cheng & Weatherly, 2025). The 4Cs are currently considered key skills (Rapti & Sapounidis, 2024). It is important to have 21st-century skills as essential intellectual competencies (Herlinawati et al., 2024).

#### 4. Conclusion

The results of the research and analysis concluded that 1) The ITCPS learning model has an effect on learning outcomes in the knowledge and skills domains, but does not have an effect on learning outcomes in the attitude domain; 2) The ITCPS learning model has an effect on students' collaboration skills; 3) The ITCPS learning model as a whole has a significant effect on science learning outcomes and collaboration skills. The ITCPS learning model is a developmental learning model that has not been widely used in education. This learning model is recommended for use in the learning process of the latest curriculum, to improve learning outcomes and collaborative skill in 21st century skills, that emphasizes students as the main focus of learning.

#### Author Contributions

All authors have equal contributions to the paper. All the authors have read and approved the final manuscript.

#### Funding

No funding support was received.

#### Declaration of Conflicting Interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

#### References

- Akkaya, E. E., & Mirzeoğlu, A. D. (2024). The Effect of Cooperative Learning Model on Academic Learning Time and Acquiring Volleyball Knowledge and Skills. *Egitim ve Bilim*, 49(220), 83–108. <https://doi.org/10.15390/EB.2024.13111>
- Andersen, R., & Rustad, M. (2022). Using Minecraft as an Educational Tool for Supporting Collaboration as a 21st Century Skill. *Computers and Education Open*, 3(100094). <https://doi.org/10.1016/j.caeo.2022.100094>
- Anggis, E. V. (2016). Penerapan Model Kooperatif JIGSAW berbasis Lesson Study untuk Meningkatkan Keterampilan Kolaboratif dan Hasil Belajar Kognitif Pendekatan dan Jenis Penelitian. *Proceeding Biology Education Conference*, 13(1), 493–497.
- Arrieta-Cohen, M. C., Torres-Arizal, L. A., & Gómez-Yepes, R. L. (2024). Evaluating the Impact of an Educational Intervention Using Project-Based Learning on Postpandemic Recovery in Rural Colombia. *Education Sciences*, 14(12), 1–27. <https://doi.org/10.3390/educsci14121341>
- Asogwa, O. A., Koekkoek, J. A. F., Peeters, M. C. M., Zwinkels, H., Vos, M. J., Dirven, L., & Taphoorn, M. J. B. (2025). Challenges in Interpreting Individual-Level Changes in Health-Related Quality of life in Patients with Glioma Using Minimally Important Differences (MIDs) and a 4-Point Likert Scale. *Quality of Life Research*, 34(Agustus), 2809–2819. <https://doi.org/10.1007/s11136-025-04029-3>
- Branchini, E., Bianchi, I., & Burro, R. (2025). Thinking in Opposites Improves Hypothesis Testing Performance in Wason's Rule-Discovery Task. *Memory and Cognition*, 53(6), 1927–1943. <https://doi.org/10.3758/s13421-025-01691-3>
- Chen, F. Z., Chen, L. A., Tseng, C. C., Pai, C. H., Tsai, K. E., Liang, E. C., Chen, Y. F., Chen, T. L., Liu, S. Y., Lee, P. C., Lai, K. C., Liu, B. R., Fouad, K. E., & Chen, C. W. (2025). Enhancing Student Engagement and Learning Outcomes in Life Sciences: Implementing Interactive Learning Environments and Flipped Classroom Models. *Discover Education*, 4(102). <https://doi.org/10.1007/s44217-025-00501-x>
- Cheng, C., & Weatherly, K. I. C. H. (2025). Navigating the Double-Edged Aword: A Meta-Analysis of the Effects of Digital Games on 21st Century Skills. *Educational Research Review*, 48(April), 1–22. <https://doi.org/10.1016/j.edurev.2025.100710>
- Du, W., Tanu, T., Cao, Y., & Li, X. (2025). What Factors Influence Secondary Students' Active Participation in Mathematics Classrooms : A Theory of Planned Behavior Perspective. *Acta Psychologica*, 253(January).
- Eskiyurt, R., & Özkan, B. (2024). Exploring the Impact of Collaborative Learning on the Development of Critical Thinking and Clinical Decision-Making Skills in Nursing Students: A Quantitative Descriptive Design. *Heliyon*, 10(17). <https://doi.org/10.1016/j.heliyon.2024.e37198>
- Estigoy, E. B., Li, H., Wang, Z., Bai, J., Zhao, R., Zhang, Y., Wang, Y., & Clorion, F. D. D. (2025). Exploring Intentions in Leveraging Cloud Computing to Transform the Learning Experience of 21st Century Chinese Engineering Students. *Procedia Computer Science*, 272, 131–138.
- Eticha, M. D., Hunde, A. B., & Ketema, T. (2026). The Role of a Designed Problem-Solving Method with Metacognitive Scaffolding on Students' Conceptual Change Learning and Teachers' Instructional Practices in Biology. *Thinking Skills and Creativity*, 59(October 2025). <https://doi.org/10.1016/j.tsc.2025.102033>
- Fiharsono, A., Carey, M. D., Hyde, M., & Beazley, H. (2025). Enhancing School Belonging for Indigenous Students in Papua, Indonesia. *International Review of Education*, 0123456789. <https://doi.org/10.1007/s11159-025-10157-2>

- Ginting, A. P. (2023). *Pengaruh Model Pembelajaran Investigation Through Cooperative Problem Solving (ITCPS) Terhadap Keterampilan Berpikir Kritis, Kolaborasi, dan Hasil Belajar IPA* [Universitas Sebelas Maret Surakarta]. <https://digilib.uns.ac.id/dokumen/detail/108665/Pengaruh-Model-Pembelajaran-Investigation-Through-Cooperative-Problem-Solving-ITCPS-Terhadap-Keterampilan-Berpikir-Kritis-Kolaborasi-dan-Hasil-Belajar-IPA>
- Herlinawati, H., Marwa, M., Ismail, N., Junaidi, Liza, L. O., & Situmorang, D. D. B. (2024). The Integration of 21st Century Skills in the Curriculum of Education. *Heliyon*, 10(15), 1–11. <https://doi.org/10.1016/j.heliyon.2024.e35148>
- Ho, N. T. T., & Le, H. Van. (2026). Embedding 21st-Century Competencies into Higher Education: Insights from Vietnamese Lecturers' Perspectives and Pedagogical Strategies. *Thinking Skills and Creativity*, 59. <https://doi.org/10.1016/j.tsc.2025.101990>
- Huh, I., & Gim, J. (2025). Exploration of Likert scale in terms of continuous variable with parametric statistical methods. *BMC Medical Research Methodology*, 25(1), 1–10. <https://doi.org/10.1186/s12874-025-02668-1>
- Iyamuremye, A., Twagilimana, I., & Niyonzima, F. N. (2025). Investigating the Impact of Using Web-Based dDiscussion Tools on Students' Conceptual Understanding and 21st Century Skills Development in Organic Chemistry Education. *Discover Education*, 4(187). <https://doi.org/10.1007/s44217-025-00548-w>
- Jilcha, K. (2025). Identifying Existing Research Challenges and Enhancing Outcomes Through the Development of Standardized Methodologies. *Humanities and Social Sciences Communications*, 12(1), 1–12. <https://doi.org/10.1057/s41599-024-04269-7>
- Jitpaisarnwattana, N. (2025). The Effects of a Personalized Learning Plan in a Language MOOC on Learners' Oral Presentation Skills. *JALT CALL Journal*, 21(2), 1–23. <https://doi.org/10.29140/jaltcall.v21n2.102601>
- Johnson, D. D., & Johnson, R. T. (2019). Cooperative Learning: The Foundation for Active Learning. *Active Learning-Beyond the Future*.
- Karagöl, E., Bilgen, D. Y., & Korkmaz, C. B. (2025). The Impact of AI Applications on Pre-Service Teachers' Public Speaking Anxiety and Academic Speaking Skill in the Context of Oral Presentations: A Mixed-Methods Study. *Teaching and Teacher Education*, 166(August).
- Kaya, E., Karatana, Ö., & Yıldırım, T. Ö. (2023). The Relationship Between the Online Learning Process, 21st Century Skills and Work Readiness in Senior Nursing Students. *Nurse Education in Practice*, 73(3). <https://doi.org/10.1016/j.nepr.2023.103801>
- Koçoğlu, A., & Kanadlı, S. (2025). The Effect of Problem-Based Learning Approach on Learning Outcomes: A Second-Order Meta-Analysis Study. *Educational Research Review*, 48(100690). <https://doi.org/10.1016/j.edurev.2025.100690>
- Ma, Y. (2026). The Effect of Risk-Taking Tendency on Student Creative Problem-Solving Skills: The Moderating Role of Perceived Teacher Support for Creativity. *Thinking Skills and Creativity*, 59(102036). <https://doi.org/10.1016/j.tsc.2025.102036>
- Milenković, A., Stevanić, J., & Zdravković, N. (2025). The Impact of Discovery-Based Learning with Physical Manipulatives in Teaching the Area of Triangles and Quadrilaterals on Students' Achievement. *JPR: Journal of Pedagogical Research*, 9(3), 102–115.
- Msuya, D., & Abdala, J. (2025). Exploring teaching practices for developing paragraph writing skills in English as a foreign language through a competence-based approach in Tanzania's secondary schools. *Discover Education*, 4(1). <https://doi.org/10.1007/s44217-025-00478-7>
- Nahar, L., & Machado, C. (2025). Inquiry-Based Learning in Bangladesh: Insights Into Middle and High School Students' Experiences and 21st Century Skill Development. *Disciplinary and Interdisciplinary Science Education Research*, 7(1), 1–17. <https://doi.org/10.1186/s43031-025-00122-2>
- Naseer, F., Tariq, R., Alshahrani, H. M., Alruwais, N., & Al-Wesabi, F. N. (2025). Project Based Learning Framework Integrating Industry Collaboration to Enhance Student Future Readiness in Higher Education. *Scientific Reports*, 15(1), 1–25. <https://doi.org/10.1038/s41598-025-10385-4>
- Ningsih, T. Z., Aman, A., Nasrulloh, A., Ofianto, O., Erniwati, E., Asri, Z., Judijanto, L., & Firza, F. (2025). Enhancing Communication and Collaboration Skills Through Discovery, Cooperative and Problem-Based Learning Models in Social Studies Education. *Cogent Education*, 12(1), 1–17. <https://doi.org/10.1080/2331186X.2025.2500110>
- Prasadityo, B. R., Masykuri, M., & Utami, B. (2023). Empowerment of Problem-Solving Skills Through the Investigation Through Cooperative Problem Solving (Itcps) Model in Living of Classification Materials. *Jurnal Penelitian Pendidikan IPA*, 8(2), 52–58. <https://doi.org/10.26740/jppipa.v8n2.p52-58>
- Pretorius, E., & de Beer, J. (2025). Engagement of Pre-Service Teachers with the RIPU Heuristic in a Cooperative- and Problem-Based Learning Context: Affordances for Self-Directed Learning. *Research in Science Education*, ONLINEFIRST(November). <https://doi.org/10.1007/s11165-025-10298-2>
- Radharani, N. K. S., Parno, Suwasono, P., & Nawati, N. D. (2025). The Effect of STEAM-Integrated PBL-C Model with Formative Assessment on Increasing N-Gain of Students' Scientific Literacy Skills on Statics Fluid Topic. *Journal of Physics: Conference Series*, 3139(1), 012099. <https://doi.org/10.1088/1742-6596/3139/1/012099>
- Radović, S., & Seidel, N. (2025). Uncovering Variations in Learning Behaviors and Cognitive Engagement Among Students with Diverse Learning Goals and Outcomes. *Educational Technology Research and Development*, 13, 2877–2895. <https://doi.org/10.1007/s11423-025-10528-4>

- Rapti, S., & Sapounidis, T. (2024). "Critical thinking, Communication, Collaboration, Creativity in kindergarten with Educational Robotics": A scoping review (2012–2023). *Computers and Education*, 210(April). <https://doi.org/10.1016/j.compedu.2023.104968>
- Rehman, N., Huang, X., Mahmood, A., AlGerafi, M. A. M., & Javed, S. (2024). Project-Based Learning as a Catalyst for 21st-Century Skills and Student Engagement in the Math Classroom. *Heliyon*, 10(23). <https://doi.org/10.1016/j.heliyon.2024.e39988>
- Ritoša, A., Åström, F., Björck, E., Borglund, L., Karlsson, E., McHugh, E., & Nylander, E. (2023). Measuring Children's Engagement in Early Childhood Education and Care Settings: A Scoping Literature Review. In *Educational Psychology Review* (Vol. 35, Issue 4). Springer US. <https://doi.org/10.1007/s10648-023-09815-4>
- Rumiantsev, T., van der Rijst, R., & Admiraal, W. (2023). A Systematic Literature Review of Collaborative Learning in Conservatoire Education. *Social Sciences and Humanities Open*, 8(1). <https://doi.org/10.1016/j.ssaho.2023.100683>
- Selimi, N., Berisha, F., & Vula, E. (2025). Enhancing High School Students' Mathematics Achievement and Skills Development Through Integrated STEM-PBL: A Collaborative Action Research Study. *European Journal of Science and Mathematics Education*, 13(4), 321–335. <https://doi.org/10.30935/scimath/17311>
- Shen, Y., Wang, X., Schwieter, J. W., & Liu, H. (2025). Imitation Learning and Co-presence Learning Influence the Acquisition of Word Formation Rules: A fNIRS Hyperscanning Study. *NeuroImage*, 323(October). <https://doi.org/10.1016/j.neuroimage.2025.121564>
- Sum, P. E., & Bădescu, G. (2023). Collaboration and Socio-Economic Inequality: Estimating the Effects of Intra-School and Inter-School Inequality on Collaborative Problem-Solving Skills. *International Journal of Educational Development*, 102(June). <https://doi.org/10.1016/j.ijedudev.2023.102843>
- Utami, B. (2021). *Pengembangan Model Pembelajaran Investigation Through Cooperative Problem Solving (ITCPS) untuk Meningkatkan Keterampilan Berpikir Kritis Siswa pada Pembelajaran Kesetimbangan Kimia*. Universitas Sebelas Maret.
- Utami, B., Probosari, R. M., Saputro, S., Ashadi, A., & Masykuri, M. (2023). The Effect of Problem-Solving and Cooperative Learning Models on Students' Affective Aspects and Social Interactions in Learning Chemical Equilibrium. *AIP Conference Proceedings*, 2751(1).
- Utami, B., Probosari, R. M., Saputro, S., Ashadi, & Masykuri, M. (2019). Empowering Critical Thinking Skills with Problem Solving in Higher Education. *Journal of Physics: Conference Series*, 1280(3). <https://doi.org/10.1088/1742-6596/1280/3/032047>
- Utami, B., Saputro, S., Ashadi, & Masykuri, M. (2021). *Investigation Through Cooperative Problem Solving Memberdayakan Keterampilan Berpikir Kritis Siswa*. Sebelas Maret University.
- Vaszkun, B., & Szakács, K. M. (2025). Looking for Student Success Factors Outside of the Educators' Scope : The Effect of Digital Literacy, Personal Skills, and Learning Habits and Conditions on Self-Evaluated Online Learning Effectiveness in Management Education. *The International Journal of Management Education*, 23(September).
- Weston, T. J., Laursen, S. L., & Hayward, C. N. (2023). Measures of Success: Characterizing Teaching and Teaching Change with Segmented and Holistic Observation Data. *International Journal of STEM Education*, 10(24), 1–21. <https://doi.org/10.1186/s40594-023-00413-y>
- Zhang, Q. (2025). Active Language Learning Strategies in Chinese University English Education: Effects on Proficiency, Motivation, and Teacher Engagement. *Acta Psychologica*, 261(October). <https://doi.org/10.1016/j.actpsy.2025.105914>
- Zoraida, L. F., Utami, B., & Khasanah, A. N. (2024). Application of Investigation Through Cooperative Problem Solving (ITCPS) Learning Model to Improve Science Process Skills. *Innovations in Science Education and Practice*, 1(1), 1–17.