PAKAR Pendidikan
p-ISSN: 1693-2226 ; e-ISSN: 2303-2219
Vol. 22, No. 2, July 2024
Page. 36-46
http://pakar.pkm.unp.ac.id/

Jigsaw Infused Tic-tac-toe Learning Model: A Chance to Gain Student's Concentration and Conceptual Understanding of Chemistry

Model Pembelajaran Jigsaw Berbasis Game Tic-tac-toe: Kesempatan untuk Meningkatkan Konsentrasi dan Pemahaman Konseptual Siswa Materi Kimia

https://doi.org/10.24036/pakar.v22i2.538

Stevani Nurjanah[1], Jamil Suprihatiningrum[1*]
[1]Universitas Islam Negeri Sunan Kalijaga, Yogyakarta, Indonesia
[*]E-mail: jamil.suprihatiningrum@uin-suka.ac.id

Abstract

This study aims to determine the effect of concentration and student learning outcomes on colloidal material using a Jigsaw model infused with a tic-tac-toe game. The quasi-experimental study used a pretest and posttest nonequivalent control group design. Students in grade XI of three science classrooms in Prambanan High School were identified as the population in this study, and two of them were selected to be samples (one as a control group and another as an experimental group) using a cluster random sampling technique. While applying the Jigsaw-infused Tic-tac-toe Game, learning concentration was measured with a questionnaire. On the other hand, conceptual understanding of colloidal material was analyzed using multiple-choice tests. All data collected used statistical analysis (Mann-Whitney test for data from the questionnaire and data from the tests). The research result shows the value of sig. Questionnaire 0,002 < 0,05 and sig. Test questions 0,003 < 0,05. Based on the research results, the finding shows that applying a Jigsaw-infused Tic-tac-toe game positively affects students' concentration and conceptual understanding of chemistry.

Keywords: *Jigsaw learning model, Tic-tac-toe game, concentration learning, conceptual understanding*

Abstrak

Penelitian ini bertujuan untuk mengetahui pengaruh konsentrasi dan hasil belajar siswa pada materi koloid dengan menggunakan model Jigsaw yang disisipi permainan Tic-tac-toe. Penelitian ini merupakan penelitian kuasi eksperimen dengan menggunakan desain pretest dan posttest nonequivalent control group design. Siswa kelas XI dari tiga kelas IPA di SMA Negeri X Prambanan diidentifikasi sebagai populasi dalam penelitian ini, dan dua di antaranya dipilih menjadi sampel (satu sebagai kelompok kontrol dan satu lagi sebagai kelompok eksperimen) dengan menggunakan teknik cluster random sampling. Selama menerapkan Permainan Tictac-toe yang diintegrasikan dengan Jigsaw, konsentrasi belajar diukur dengan kuesioner. Di sisi lain, pemahaman konseptual materi koloid dianalisis dengan menggunakan tes pilihan ganda. Seluruh data yang terkumpul dianalisis menggunakan analisis statistik (uji Mann-Whitney untuk data dari kuesioner dan data dari tes). Hasil penelitian menunjukkan nilai sig. angket 0,002 < 0,05 dan nilai sig. soal tes 0,003 < 0,05. Berdasarkan hasil penelitian, diperoleh temuan bahwa penerapan model pembelajaran Jigsaw berbantuan permainan Tic-tac-toe berpengaruh positif terhadap konsentrasi dan pemahaman konsep kimia siswa.

Kata Kunci: model pembelajaran Jigsaw, game Tic-tac-toe, konsentrasi belajar, pemahaman konsep

1. Introduction

Learning is the process by which students acquire information and knowledge, master skills and habits, and build their perspectives and beliefs (Fitrah et al., 2022). Learning in the modern era is centred on projects, problems, questions, design, and discovery (Fahrozy et al., 2022). Instruction should be conducted by a student-centred approach as one of the main principles of 21st-century learning (Rahayu et al., 2022). Through this approach, students can participate actively in gathering information and solving problems (Harmon SW in Wahyuni, 2022). To maximize the approach, students and teachers must have a positive relationship in learning interactions (Faizin et al., 2022), where educators are facilitators of learning activities, and students use their cognitive to build understanding. Therefore, learning competencies can be achieved (Izmi, 2022).

Learning success is dependent on some variables, including students, educators, learning tools, media, techniques, materials, and the learning atmosphere (Tae et al., 2019). Learning through discussion affects student interest, motivation, and learning outcomes (Baroroh et al., 2022). However, in practice, learning tends to be ineffective during discussions. Creating effective learning requires teachers' pedagogical knowledge and ability, though it remains a challenge for teachers (Elitasari, 2022). Therefore, teachers must choose learning models or combine them with learning media and activities such as games. This is done so that learning progresses well, students remain focused and concentrated on the material, and students gain optimal conceptual understanding.

The concentration of student learning in learning, according to Husna et al. (2021), can be seen from the level of attention, desire, enthusiasm, enthusiasm, needs, curiosity, and ideas shown by students during the learning process. The level of concentration plays an important role in achieving optimal learning outcomes (Fatchuroji et al., 2023). If students concentrate on the learning process, they will find it easy to work on problems that affect their understanding of concepts (Ismah in Sativa, 2022). The problem that often occurs is that learning only goes one way; students find it difficult to concentrate on the learning process and only depend on the educator's knowledge.

A preliminary study conducted on August 6, 2023, in High School Permata at Prambanan showed that the learning model commonly used in colloidal material is discovery learning. Through this learning model, students are asked to discuss making a paper on colloidal material, and then students are asked to present it. Interviews with teachers indicate that the learning model implemented is considered less effective in enhancing concentration and learning outcomes because few students reach the Minimum Completion Criteria (KKM). Data on student grades recorded by teachers at High School Permata Prambanan in the 2022/2023 school year has an average cognitive learning outcome of 65.7 from the applied KKM, especially colloidal material. In addition, according to the interview with students of High School Permata, they stated that the discovery learning model was very uninteresting because only students with above-average academic achievement were active and often dominated. Students considered this learning model uninteresting and monotonous, so they were not involved in the learning process. They believed that with a more interactive learning model, students would be more engaged in the class. Less engagement also leads to poor learning outcomes.

Colloidal material is an applied chemistry since this topic has many connections to everyday life (Nurmilawati et al., 2021). Colloidal material, however, is difficult for students to learn because many concepts must be remembered (Rumape et al., 2023). According to Ati et al. (2021), colloidal material requires a lot of memorization, so the presentation of the material must

P-ISSN: 1693 - 2226
E-ISSN: 2303 - 2219

actively involve students. Thus, a learning strategy that is fun and involves students a lot is needed so that it is easier for students to remember the concepts of colloidal material, which results in meaningful education.

In order to achieve the expected learning objectives, the use of learning models and media must be selected carefully to create a learning environment that allows students to stay concentrated, active, student-centred, and fun. Tic-tac-toe is a game that can be used as a fun cooperative learning media, and the application of the Jigsaw model is a cooperative model that can possibly solve this problem.

The Jigsaw learning model, according to Slavin (in Harefa et al., 2022), is a learning group with the characteristics of each member contributing their knowledge, experience, thoughts, opinions, abilities, and skills to help and improve each other's interpretation so that it has an impact on learning outcomes. This cooperative model makes learning more interactive, interesting, and productive (Zamhari et al., 2022). Tic-Tac-Toe is a game played by two people on a three-by-three board. To win, players must alternately fill in empty spaces on the board to form diagonal, horizontal, or vertical straight lines. Through the game, it trains social skills, playing skills, concentration, accuracy, and active involvement in student learning (Faqih & Fitrani, 2023). In addition to increasing student knowledge, learning media can help improve student memory related to learning materials (Ali et al., 2023).

The combination of the Jigsaw model and Tic-tac-toe game produces a learning activity that students might like. The Jigsaw model helps students become better prepared to learn, interact with others better, and participate more actively in discussions. Meanwhile, the tic-tac-toe game requires high concentration, so it is very fun. Therefore, combining Jigsaw and Tic-tac-toe will make students more engaged in learning. Several similar studies have shown that combining Jigsaw with games helps students learn.

Melivicasari et al. (2020) concluded that student activity and learning outcomes increased through Jigsaw learning with the help of paired card game media on science material. In addition, Aura and Azra's (2021) studies show that chemistry learning media based on Tic-tac-toe chem is said to be valid and practical for learning the basic laws of chemistry. The combination of the jigsaw model with the Tic-tac-toe game on human digestion material can improve student activity and learning outcomes Chrisdaniar et al. (2020). To fill the gap in previous research, the purpose of this study is to examine how the jigsaw model combined with the tic-tac-toe game affects students' concentration and concept understanding. It is hoped that this research will become a reference for teachers to increase student concentration while learning to increase student understanding of the material and develop various ways to use learning models so that they are not monotonous.

2. Literature Review

2.1 Jigsaw Learning Model

A learning method in which students are asked to take responsibility for their tasks and teach members between groups is the definition of the Jigsaw model. The goal is for students to understand each other (Kahar et al., 2020). This model focuses on understanding theories rather than formulas. Therefore, to increase student concentration, this model is suitable for use, especially in colloidal chemistry material, which contains concepts.

P-ISSN : 1693-2226
E-ISSN : 2303-2219

2.2 Tic-tac-toe Game

Budiartini (2016) defines the zero-cross game as a game where players use pencil and paper to draw a box of nine squares as a Tic-tac-toe game. In this study, the game was modified where group members from cards O and X did not have the opportunity to arrange the cards in the box if they could not answer the question correctly. The insertion of this game into the Jigsaw model is expected to increase students' interest in learning.

2.3 Learning Concentration

Cecep et al. (2022) state that learning concentration is focusing on a particular topic by ignoring all things that are not related to the learning process. In reality, students' focus is easily distracted if learning runs monotonously. Thus, to improve student concentration, an active learning model is needed which is not unidirectional, fun, and involves students directly.

2.4 Student Concept Understanding

Nabillah et al. (2020) stated that the ability that students have after the learning experience or treatment is referred to as learning outcomes. Students' concept understanding can be seen based on their learning outcomes. Concentration affects students' concept understanding. If students concentrate on learning, they will easily answer all the questions given by the teacher, but if students are less concentrated, they are unable to answer all the teacher's questions, which affects learning outcomes.

3. Research Methods

This study was conducted through a quasi-experimental with pretest and posttest nonequivalent control group design. The pretest and posttest were administered as seen in Table 1.

Table 1. Research Design

O_1	X	O_2
O_3		O_4

The pretest for the experimental and control groups are O_1 and O_3, while O_2 and O_4 are posttest for the experimental and control groups and X is the treatment (Jigsaw model assisted by Tic-tac-toe game).

This study was conducted at High School Permata Prambanan during the 2nd semester of the 2022/2023 academic year. This study aims to examine whether the Jigsaw learning model assisted by the Tic-tac-toe game can improve students' concentration and understanding of concepts. In addition, this study aims to examine whether there is a difference between the Jigsaw learning method assisted by the tic-tac-toe game and discovery learning. In this research, the application of the Jigsaw cooperative model assisted by the Tic-tac-toe game is the independent variable, and the dependent variable is the conceptual understanding and learning concentration of Grade XI Science and Mathematics (MIPA) program students.

All XI MIPA students of High School Permata Prambanan were the population and the samples were selected using cluster random sampling. MIPA 2 and MIPA 3 classes, each with 34 students, were randomized as experimental and control groups respectively. The experiment was conducted during 2nd semester, with two meetings lasting one week.

A questionnaire was used to collect data on learning concentration, while the test questions showed concept understanding. The learning concentration questionnaire consists of

twenty questions containing positive and negative statement items, and the answers are given on a Likert scale. By using the Jigsaw Tic-tac-toe model, the effect of chemistry learning on students' learning concentration was assessed through a questionnaire. Pretest and posttest used 18 multiple-choice questions as test instruments to determine how much students understood the colloidal system material that was taught. The questions were given in the same format for both tests. Before being used for data collection, the questionnaire and questions were tested for validity and credibility. In addition, the differentiating power and difficulty level of each question were also tested.

Prerequisite tests of normality and homogeneity are carried out before the data is analyzed, with the aim of ensuring that the samples taken come from the same population (Usmadi, 2020). The normality of both the questionnaire and test instruments was tested using Shapiro-Wilk with the help of the statistical program SPSS version 21. A homogeneity test was also carried out using SPSS 21. After the data has a normal distribution and homogeneous variants, hypothesis testing for interval data is carried out by t-test. If the data distribution was neither normal nor homogeneous, a nonparametric test such as Mann-Whitney was used. The ordinal data hypothesis test on the learning concentration questionnaire was used to answer the research hypothesis (Sugiyono, 2013, p. 160). The following are the hypothesis criteria used:

If the t value < t table, then H_0 is accepted, and H_a is rejected.

If the value of t> t table, then H_0 is rejected, and H_a is accepted.

A Jigsaw model with a Tic-tac-toe game can improve students' concentration and understanding of colloidal material is a hypothesis that must be proven. In addition, the effectiveness of this model and game used is tested through N-Gain.

4. Result and Discussion

4.1. Research Result

The results of filling out the questionnaire before and after treatment are presented in the learning concentration data in Table 2. The treatment has a significant effect on learning concentration if the hypothesis test <0.05. In this study, data on learning concentration and students' concept understanding on the use of the jigsaw learning model assisted by the Tic-tac-toe game proved significant to students' concept understanding. The pretest assesses students' initial abilities, while the posttest assesses the mastery of the Jigsaw model combined with the game. The following table shows the hypothesis test results for this model, which reached 0.05.

Table 2. Comparison of Pretest, Posttest, and N-Gain Values of Student Learning Concentration Questionnaire

Group	Average pretest	Average posttest	N-Gain	Interpretation N-Gain
Experiment	66,86	74,91	0,254	Low
Control	67,57	69,85	0,013	Low

The average score of the experimental class rose from 66.86 to 74.91. The mean score of the control class also increased from 67.57 to 69.85. The N-gain was 0.254 for the experimental class and 0.013 for the control class, indicating that it was in the low category to increase student learning concentration using the Jigsaw learning model assisted by Tic-tac-toe and Discovery games.

P-ISSN : 1693-2226
E-ISSN : 2303-2219

Table 3. Comparison of Pretest, Posttest, and N-Gain Test Values Student Concept Understanding

Group	Average pretest	Average posttest	N-Gain	Interpretation N-Gain
Experiment	52,21	75,15	0,482	Medium
Control	47,79	57.06	0,126	Low

Table 3 shows that the understanding of the experimental class concept is better than that of the control class in terms of pretest, posttest, and N-gain scores. The average experimental class pretest score was 52.21, the average posttest score was 75.15, and the average N-gain of 0.482 was in the medium category. The control class pretest value averaged 47.79, and the average posttest value of 57.06 was in the low category.

Since the data sample was less than 50, the Shapiro-Wilk test was used to check the normality of students' learning concentration, namely pretest, posttest, and N-gain. Levene's test was also used to test the homogeneity of the data. Furthermore, the prerequisite test of normality and homogeneity used the nonparametric Mann-Whitney test to determine the hypothesis on the N-gain data. The significance of the difference between the average control class and the experimental class is known through hypothesis testing. The results of the statistical test of student learning concentration are shown in Table 4.

Table 2. Statistical Test Results of Normality and N-gain Hypothesis of Student Learning Concentration Questionnaire

Data	Group	Average (X) ± Sd	Normality Test	Homogeneity Test	Mann Whitney Test
Pretest	Experiment	66,86 ± 12,07	Sig. 0,104 > 0,05 (Normal)	Sig. 0,067 > 0,05 (Homogen)	
	Control	67,57 ± 19,66	Sig. 0,003 < 0,05 (Abnormal)		
Posttest	Experiment	74,91 ± 14,79	Sig. 0,020 < 0,05 (Abnormal)	Sig. 0,926 > 0,05 (Homogen)	Sig. (2-tailed) 0,043 < 0,05 (H_a accept)
	Control	69,85 ± 23,71	Sig. 0,001 < 0,05 (Abnormal)		
N-gain	Experiment	0,254 ± 0,261	Sig. 0,008 < 0,05 (Abnormal)	Sig. 0,655 > 0,05 (Homogen)	
	Control	0,013 ± 0,394	Sig. 0,000 < 0,05 (Abnormal)		

As shown in Table 4, the prerequisite test results showed both classes were not normal. The samples on the posttest had non-normal distributions for both experimental and control classes with sig values. < 0.05, but the samples remained homogeneous because of the sig value. 0,926 > 0,05. The learning concentration questionnaire is ordinal data, and the hypothesis test uses nonparametric analysis. The samples were homogeneous and abnormal based on the prerequisite analysis, so the hypothesis was tested with the Mann-Whitney test. The sig value. (2-tailed) 0.002 <0.05 means H_0 is rejected, and H_a is accepted as the result of the questionnaire hypothesis test. This means that the jigsaw learning model assisted by the tic-tac-toe game is effective in enhancing student learning concentration.

Normality, homogeneity, and Mann-Whitney tests are statistical analyses of multiple-choice test data used to analyze significant improvements in students' concept understanding.

Table 5. Statistical Test Results of Student Concept Understanding Data Statistical Test Results of Student Concept Understanding Data

Data	Group	Average (X) ± Sd	Normality Test	Homogeneity Test	Mann Whitney Test
Pretest	Experiment	52,21 ± 12,07	Sig. 0,345 > 0,05 (Normal)	Sig. 0,000 < 0,05 (Not Homogen)	
	Control	47,79 ± 19,66	Sig. 0,005 < 0,05 (Abnormal)		
Posttest	Experiment	75,15 ± 14,79	Sig. 0,000 < 0,05 (Abnormal)	Sig. 0,000 < 0,05 (Not Homogen)	Sig. (2-tailed) 0,003 < 0,05 (H_a accept)
	Control	57,06 ± 23,71	Sig. 0,027 < 0,05 (Abnormal)		
N-gain	Experiment	0,480 ± 0,252	Sig. 0,000 < 0,05 (Abnormal)	Sig. 0,052 > 0,05 (Homogen)	
	Control	0,126 ± 0,110	Sig. 0,000 < 0,05 (Abnormal)		

The results of the normality test of homogeneity of pretest, posttest, and N-gain data of experimental and control classes are seen in Table 5. The normality test results show that the sig. Shapiro Wilk value below 0.05 indicates abnormal data distribution, but the sig. A value above 0.05 on the experimental class pretest data indicates normal data distribution. The pretest, posttest, and gain N data were tested with the Leven test. The sig value. A levene value below 0.05 indicates that the pretest and posttest data are not homogeneous, and the sig value. Levene's sig value above 0.05 indicates that the gain N data is homogeneous.

Following Table 4, the results showed that the Jigsaw learning model assisted by the tic-tac-toe game can improve students' concept understanding. The prerequisite test of the analysis showed that the samples came from non-normal and non-homogeneous populations. Consequently, the Mann-Whitney hypothesis was used. The results showed that the sig. (2-tailed) of 0.003 is smaller than 0.05, indicating that the Jigsaw learning model with the Tic-tac-toe game affects students' concept understanding. In addition, evidence that the Jigsaw learning model assisted by the Tic-tac-toe game has an impact on students' understanding of colloidal material is the N-gain value in the experimental class of 0.480 with moderate criteria and the N-gain value in the control class of 0.126 with low criteria.

4.2. Discussion

Students' scores before applying the Jigsaw learning model with the Tic-tac-toe game were considered low, and a large number of students did not meet the KKM (Minimum Completion Criteria) of 75. The scores of most students improved after the posttest treatment. Therefore, it can be concluded that, as indicated by the previous Mann-Whitney test, students' learning concentration and concept understanding have changed. This finding is also in line with previous research findings.

Overall, Jigsaw-type cooperative learning interspersed with games has an impact on students' concentration and their understanding of colloid material in senior high school.

P-ISSN : 1693-2226
E-ISSN : 2303-2219

Compared to Widarta's (2020) opinion, not only can students' learning outcomes be improved through the Jigsaw learning model, but it can also increase their motivation to learn. Game-based learning, according to Luarn et al. (2023), can help overcome the decline in student engagement and motivation that the current school system faces. Students' engagement in the learning process affects their concentration in the lesson; a high level of engagement in the learning process indicates that students are concentrating on the lesson (Matic et al., 2023). How well students understand concepts is influenced by this learning focus. When students concentrate during learning, they usually have better cognitive outcomes. Aviana and Hidayah (2015) also argue that low concentration is caused by learning activities that lack quality, which can cause seriousness in learning and have an impact on the lack of understanding of concepts about the material.

According to this research, the Jigsaw model can make students more active when learning. This learning model requires students to assume individual and group responsibilities because there are initial and expert groups. Since students from the expert group will explain the topic they discussed to the initial group, the discussion will be serious and fun. According to Fadila et al. (2020), Jigsaw Learning is a cooperative approach where students are given a lot of responsibility during the learning process. The use of this learning model aims to improve group work skills, learn cooperatively, and gain a deep understanding of the material, which is a challenge to learn independently.

It is possible that game-based learning models, such as Jigsaw and Tic-tac-toe games, can focus students on learning colloidal materials. This is because, initially, teacher-centred learning can change to student-centred learning (Deghedi, 2023). According to constructivism theory, meaningful learning is achieved by students having to be more involved in constructing their knowledge (Winatha & Setiawan, 2020). Students are given individual and group responsibilities in the Jigsaw learning model. This research, Tic-tac-toe game requires everyone to participate in the game with a share (Weingärtner & Weingärtner, 2023). This can encourage students to keep accumulating points while playing. Therefore, combining the Jigsaw model and the Tic-tac-toe game can result in a student-centred learning process (Lim & Park, 2023). As stated by Putri et al. (2019), understanding colloidal material will become easier because the presentation of the material requires the use of an active and fun learning model so that students are encouraged to participate actively.

The control group used the discovery learning model, where students formed groups of 4-5 people answering the students' worksheet, while the experimental group was given treatment through the Jigsaw cooperative learning model inserted with the Tic-tac-toe game. Students were divided into five small groups, with each a different character. Next, this group will be split again to form an expert group that will gather to discuss the specified sub-material. Afterwards, the expert groups will return to the original group to share what they learned. The lesson will finally end with a game of Tic-tac-toe, where participants must answer the questions on the question cards before running the pawns. The game aims to grab students' attention and ensure they are following the lesson well. This activity makes learning fun while still bearing responsibility. As a result, students are actively involved in the learning process and can improve their concentration, thus gaining a better understanding of the concepts of colloidal material. Combining the learning model with games is a beneficial mix. Students showed positive changes in their concentration as well as their understanding of the concept of colloidal material. During the game, students will learn to work together, take turns, share knowledge, and correct each other's mistakes. The teacher should play an important role as a facilitator and always guide at the right time.

Therefore, utilizing games as part of the learning process does not mean that students are allowed to play without supervision or instruction. Play is very important for education as it helps them learn a lot but with the guidance of the teacher. Hopefully, teachers, without hesitation, can incorporate play activities into the learning process, and some of the research findings can be used as a reference.

5. Conclusion

The conclusions from the research are: (1) the cooperative learning model with the Tic-tac-toe game increases students' learning concentration significantly; (2) an increase in student's conceptual understanding is shown statistically with an N-gain value of 0.480, which is classified as moderate. Hypothesis test questions are 0.002 less than 0.05, and the questionnaire hypothesis test of 0.003 is less than 0.05, or H_a is accepted, meaning that the Jigsaw model assisted by the Tic-tac-toe game influences students' concentration and conceptual understanding.

Based on the results of the research that has been carried out, researchers suggest several actions that teachers need to take to create effective and interactive learning. *Firstly*, chemistry teachers can use the Jigsaw learning model based on the Tic-tac-toe game so that students' concentration and understanding of the concept of colloidal matter increases. *The second* is that the teacher must ensure that the class remains conducive during the game.

6. References

Ali, S. B., Talib, C. A., & Jamal, A. M. (2023). Digital Technology Approach in Chemistry Education: A Systematic Literature Review. *Journal of Natural Science and Integration*, *6*(1), Article 1. https://doi.org/10.24014/jnsi.v6i1.21777

Ati, K. D., Sholeh, M. I., Hartatiana, H., & Ningrum, W. P. (2021). Pengaruh Model Pembelajaran Teams Games Tournament (TGT) terhadap Hasil Belajar Kognitif pada Materi Sistem Koloid. *Al 'Ilmi : Jurnal Pendidikan MIPA*, *10*(1), 29–35.

Aura, S., & Azra, F. (2021). Pengembangan Permainan Tic-Tac-Chem Sebagai Media Pembelajaran Kimia pada Materi Hukum-Hukum Dasar Kimia Kelas X SMA/MA. *Entalpi Pendidikan Kimia*, *2*, 97–107. https://doi.org/10.24036/epk.v2i1.134

Aviana, R., & Hidayah, F. F. (2015). Pengaruh Tingkat Konsentrasi Belajar Siswa terhadap Daya Pemahaman Materi pada Pembelajaran Kimia di SMA Negeri 2 Batang. *Jurnal Pendididikan Sains Universitas Muhammadiyah Semarang*, *3*(1), Article 1. https://doi.org/10.26714/jps.3.1.2015.30-33

Baroroh, E. K., & Ismatulloh, K. (2022). Pengaruh Metode Pembelajaran Diskusi Kelompok Terhadap Prestasi Belajar Kimia di Kelas XI IPA SMAN 1 Pringgasela. *LAMBDA : Jurnal Ilmiah Pendidikan MIPA Dan Aplikasinya*, *2*(1), Article 1. https://doi.org/10.58218/lambda.v2i1.183

Budiartini, M. (2016). Validitas Kartu Permainan Tic-tac-toe Berorientasi Active Learning Strategi Mengajukan Pertanyaan pada Sub Materi Transpor Membran. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, *5*(2). https://ejournal.unesa.ac.id

Cecep, C., Waskita, D. T., & Sabilah, N. (2022). Upaya Meningkatkan Konsentrasi Belajar Anak Usia Dini melalui Metode Demonstrasi. *Jurnal Tahsinia*, *3*(1), 63–70. https://doi.org/10.57171/jt.v3i1.313

Chrisdaniar, C. S., Sikumbang, D., & Marpaung, R. R. (2020). Pengaruh Model Jigsaw Berbantu Game Tic Tac Toe Terhadap Aktivitas Dan Hasil Belajar. *Jurnal Bioterdidik: Wahana Ekspresi Ilmiah*, *8*(1), Article 1. http://jurnal.fkip.unila.ac.id/index.php/JBT/

P-ISSN : 1693-2226
E-ISSN : 2303-2219

Deghedi, G. A. (2023). Game-Based Learning for Supply Chain Management: Assessing the Complexity of Games. *International Journal of Game-Based Learning (IJGBL)*, *13*(1), 1–20. https://doi.org/10.4018/ijgbl.319715

Elitasari, H. T. (2022). Kontribusi Guru dalam Meningkatkan Kualitas Pendidikan Abad 21. *Jurnal Basicedu*, *6*(6), Article 6. https://doi.org/10.31004/basicedu.v6i6.4120

Fadila, I., Amir, H., & Elvia, R. (2020). Perbandingan Model Pembelajaran Kooperatif Tipe Number Head Togethet (NHT) dan Tipe Jigsaw terhadap Hasil Belajar Kimia Siswa di SMA Negeri 6 Kota Bengkulu. *ALOTROP*, *4*(2), Article 2. https://doi.org/10.33369/atp.v4i2.16694

Fahrozy, F. P. N., Iskandar, S., Abidin, Y., & Sari, M. Z. (2022). Upaya Pembelajaran Abad 19-20 dan Pembelajaran Abad 21 di Indonesia. *Jurnal Basicedu*, *6*(2), Article 2. https://doi.org/10.31004/basicedu.v6i2.2098

Faizin, M., Sholihah, A., Puspita, N., & Cantika, I. (2022). Pola interaksi pendidik dan peserta didik pada abad 21 dalam perspektif pemikiran pendidikan Islam Al-Ghazali. *At Turots: Jurnal Pendidikan Islam*, *4*(2 Desember), Article 2 Desember. https://doi.org/10.51468/jpi.v4i2.142

Faqih, A. A., & Fitrani, A. S. (2023). Penerapan Game Tic-Tac-Toe dengan Metode Artificial Neural Network dalam Pengambilan Keputusan untuk Meraih Kemenangan. *Jurasik (Jurnal Riset Sistem Informasi Dan Teknik Informatika)*, *8*(1), Article 1. https://doi.org/10.30645/jurasik.v8i1.559

Fatchuroji, A., Yunus, S., Jamal, M., Somelok, G., Yulianti, R., & Sihombing, M. (2023). Pengaruh Tingkat Konsentrasi Terhadap Hasil Belajar. *Journal on Education*, *5*(4), Article 4. https://doi.org/10.31004/joe.v5i4.2388

Fitrah, A., Yantoro, Y., & Hayati, S. (2022). Strategi Guru dalam Pembelajaran Aktif Melalui Pendekatan Saintifik dalam Mewujudkan Pembelajaran Abad 21. *Jurnal Basicedu*, *6*(2), Article 2. https://doi.org/10.31004/basicedu.v6i2.2511

Harefa, D., Sarumaha, M., Fau, A., Telaumbanua, T., Hulu, F., Telambanua, K., Lase, I. P. S., Ndruru, M., & Ndraha, L. D. M. (2022). Penggunaan Model Pembelajaran Kooperatif Tipe Jigsaw Terhadap Kemampuan Pemahaman Konsep Belajar Siswa. *Aksara: Jurnal Ilmu Pendidikan Nonformal*, *8*(1), Article 1. https://doi.org/10.37905/aksara.8.1.325-332.2022

Husna, S. M., Maison, Kurniawan, D. A., & Resnawati. (2021). Analisis Konsentrasi Belajar Siswa pada Mata Pelajaran Fisika di Kelas X IPA MAN 1 Merangin. *SENRIABDI*, 62–74.

Izmi, R. (2022). Penerapan Strategi Cara Belajar Siswa Yang Aktif (CBSA) Untuk Meningkatkan Hasil Belajar Siswa. *Jurnal Pendidikan Teknologi Informasi Dan Komputer*, *1*(1), Article 1.

Kahar, M. S., Anwar, Z., & Murpri, D. K. (2020). Pengaruh Model Pembelajaran Kooperatif Tipe Jigsaw terhadap Peningkatan Hasil Belajar. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *9*(2). https://doi.org/10.24127/ajpm.v9i2.2704

Lim, J., & Park, J. (2023). Self-study enhances the learning effect of discussions. *Journal of the Learning Sciences*, *0*(0), 1–22. https://doi.org/10.1080/10508406.2023.2185148

Luarn, P., Chen, C.-C., & Chiu, Y.-P. (2023). The Influence of Gamification Elements in Educational Environments. *International Journal of Game-Based Learning (IJGBL)*, *13*(1), 1–12. https://doi.org/10.4018/IJGBL.323446

Matic, L. J., Karavakou, M., & Grizioti, M. (2023). Is Digital Game-Based Learning Possible in Mathematics Classrooms?: A Study of Teachers' Beliefs. *International Journal of Game-Based Learning (IJGBL)*, *13*(1), 1–18. https://doi.org/10.4018/IJGBL.323445

Melivicasari, D., Sikumbang, D., & Marpaung, R. R. T. (2020). Pengaruh Model Kooperatif Jigsaw Berbantu Media Permainan Kartu Berpasangan Terhadap Aktivitas dan Hasil Belajar. *Jurnal Bioterdidik*, *8*(1).

Nabillah, T., & Abadi, A. P. (2020). Faktor Penyebab Rendahnya Hasil Belajar Siswa. *Prosiding Sesiomadika*, *2*(1c), Article 1c. https://journal.unsika.ac.id/index.php/sesiomadika/article/view/2685

Nurmilawati, S., Agung, S., & Murniati, D. (2021). Identifikasi Pengetahuan dan Kompetensi Sains Siswa Berdasarkan Socio-Scientific Issues (SSI) pada Materi Sistem Koloid. *Jurnal Riset Pendidikan Kimia (JRPK)*, *11*(1), Article 1. https://doi.org/10.21009/JRPK.111.06

Putri, R. F., Suharto, B., & Rusmansyah, R. (2019). Penerapan Model Pembelajaran Inkuiri Terbimbing terhadap Hasil Belajar Peserta didik pada Materi Koloid. *JCAE (Journal of Chemistry And Education)*, *3*(2), Article 2. https://doi.org/10.20527/jcae.v3i2.339

Rahayu, R., Iskandar, S., & Abidin, Y. (2022). Inovasi Pembelajaran Abad 21 dan Penerapannya di Indonesia. *Jurnal Basicedu*, *6*(2), Article 2. https://doi.org/10.31004/basicedu.v6i2.2082

Rumape, O., Pomuato, S., Mohamad, E., Ischak, N. I., Salimi, Y. K., Munandar, H., & Najmah, N. (2023). Identifikasi Kemampuan Kognitif Siswa pada Materi Koloid. *Jambura Journal of Educational Chemistry*, *5*(1), Article 1. https://doi.org/10.34312/jjec.v5i1.13215

Sativa, Y. A., & Purwanto, J. (2022). Pengaruh Konsentrasi Belajar dan Kejenuhan Belajar terhadap Prestasi Belajar Matematika. *JURNAL MathEdu (Mathematic Education Journal)*, *5*(2), Article 2. https://doi.org/10.37081/mathedu.v5i2.4065

Sugiyono, Prof. D. (2013). *Metode Penelitian Kuantitatif, Kualitatif dan R&D*. Alfabeta.

Tae, L. F., Ramdani, Z., & Shidiq, G. A. (2019). Analisis Tematik Faktor-Faktor yang Mempengaruhi Keberhasilan Siswa dalam Pembelajaran Sains. *Indonesian Journal of Educational Assessment*, *2*(1), 79. https://doi.org/10.26499/ijea.v2i1.18

Usmadi, U. (2020). Pengujian Persyaratan Analisis (Uji Homogenitas dan Uji Normalitas). *Inovasi Pendidikan*, *7*(1). https://doi.org/10.31869/ip.v7i1.2281

Wahyuni, D. W., Sunismi, dan Sri. (2022). *Pembelajaran Aktif dengan Case Method*. CV Literasi Nusantara Abadi.

Weingärtner, M., & Weingärtner, T. (2023). Quantum Tic-Tac-Toe—Learning the concepts of quantum mechanics in a playful way. *Computers and Education Open*, *4*, 100125. https://doi.org/10.1016/j.caeo.2023.100125

Widarta, G. M. A. (2020). Penerapan model pembelajaran kooperatif tipe jigsaw untuk meningkatkan motivasi dan hasil belajar. *Indonesian Journal of Educational Development*, *1*(2), Article 2. https://doi.org/10.5281/zenodo.4003775

Winatha, K. R., & Setiawan, I. M. D. (2020). Pengaruh Game-Based Learning Terhadap Motivasi dan Prestasi Belajar. *Scholaria: Jurnal Pendidikan Dan Kebudayaan*, *10*(3), Article 3. https://doi.org/10.24246/j.js.2020.v10.i3.p198-206

Zamhari, M., Subekti, Z. A., Setiawati, E. M., & Kangkamano, T. (2022). Development of Puzzles for Chemical Laboratory Glassware Integrated with Islam as A Learning Medium. *Journal of Natural Science and Integration*, *5*(1), Article 1. https://doi.org/10.24014/jnsi.v5i1.16896

P-ISSN : 1693-2226
E-ISSN : 2303-2219