Vol 12 (3), 2023, 14-27 DOI: 10.23960/jppk.v12.i3.2023.02
Jurnal Pendidikan dan Pembelajaran Kimia
e-ISSN: 2714-9595| p-ISSN 2302-1772
http://jurnal.fkip.unila.ac.id/index.php/JPK/index

Supporting the Digital Era Through the Application of Discovery Learning with the TPACK Framework Assisted to Improve Student Learning Outcomes and Interests

Varradiah Choirun Nisa[1], Dian Novita Sari [2*], Arni Wiyati[3], and Yuti Rahinawati[4]

1 Teacher Professional Education Program, State University of Surabaya, Surabaya, Indonesia
2 Department of Chemistry Education, Faculty of Mathematics and Natural Sciences, State University of Surabaya, Surabaya, Indonesia
3,4 SMAN 6 Surabaya, Jl. Gubernur Suryo No. 11, Surabaya, Indonesia
.
*Correspondinge-mail: diannovita@unesa.ac.id

Received: August 14th, 2023 Accepted: September 5th, 2023 Online Published: December 26th, 2023

Abstract: Supporting Digital Era Through Implementation of Discovery Learning and TPACK Framework Assisted to Increase Student's Learning Outcomes and Interest. This study aims to increase student's interest and learning outcome by implementing discovery learning and the TPACK framework in chemical bonding material. This study is a collaborative class action research with quantitative and qualitative methods. The subjects of this study were 33 students of XI-3 from Senior High School 6 Surabaya. The research was conducted in three cycles. Data were analyzed descriptively with the data source being improved learning outcomes using Discovery Learning with TPACK between cycles 1, 2 and 3 which were supported by students' interest in learning. The average of learning outcomes in cycle 1 was 77 and went up to 90 and 97 in cycles 2 and 3 while the classical mastery from all cycles went up from 67% to 91% and 100%. Student's interest in learning chemistry also went up through each cycle seeing through the percentage of the number of students in the high interest category from 21% in cycle 1 to 58% in cycle 2 and 87% in cycle 3. From these data on student's learning outcomes and interest, it can be concluded that the implementation of discovery learning and the TPACK framework was effective to increase the student's learning outcomes and interest in chemistry class.

Keywords: Class Action Research, Discovery Learning, Technological Pedagogical and Content Knowledge, learning outcome, interest.

Abstrak: Mendukung Era Digital melalui Penerapan Discovery Learning berbantuan Kerangka TPACK untuk Meningkatkan Hasil Belajar dan Minat Peserta Didik. *Penelitian ini bertujuan untuk meningkatkan minat dan hasil belajar peserta didik dengan menerapkan model pembelajaran Discovery Learning dan kerangka TPACK pada materi ikatan kimia. Penelitian ini merupakan penelitian tindakan kelas kolaboratif dengan metode kuantitatif dan kualitatif. Subjek penelitian ini adalah peserta didik kelas XI-3 SMA Negeri 6 Surabaya yang berjumlah 33 orang. Penelitian ini dilakukan dalam tiga siklus. Data dianalisis secara deskriptif dengan sumber data peningkatan hasil belajar menggunakan Discovery Learning dengan TPACK antara siklus 1, 2 dan 3 yang didukung oleh minat belajar peserta didik. Rata-rata hasil belajar pada siklus 1 adalah 77 dan meningkat menjadi 90 dan 97 pada siklus 2 dan 3 sedangkan ketuntasan klasikal dari seluruh siklus meningkat dari 67% menjadi 91% dan 100%. Minat peserta didik terhadap pembelajaran kimia juga mengalami peningkatan pada setiap siklusnya dilihat dari persentase jumlah peserta didik yang berada pada kategori minat tinggi dari 21% pada siklus 1 menjadi 58% pada siklus 2 dan 87% pada siklus 3. Dari data tersebut hasil belajar peserta didik hasil* *dan minat, maka dapat disimpulkan bahwa penerapan pembelajaran penemuan dan kerangka TPACK efektif untuk meningkatkan hasil belajar dan minat peserta didik pada kelas kimia.*

Kata kunci: *Penelitian Tindakan Kelas, Discovery Learning,* Technological Pedagogical and Content Knowledge, *hasil belajar, minat.*

▪ INTRODUCTION

Education is a deliberate and intentional endeavor to guide children in developing their physical and spiritual potential so they can live independently (Hidayat & Abdillah, 2019). According to Constitution no. 20 of 2023, The goals of education are to help students reach their full potential in terms of their spiritual development, self-control, personality, intelligence, and moral character as well as the abilities required by themselves, society, the nation, and the state. The educational process involves collaboration between various parties and the development of potential requires multidisciplinary understanding from various fields of knowledge.

Chemistry is very essential because it has various applications in daily life (Anggraini et al., 2022). Moreover, chemistry material also helps students develop their communication skills at higher levels of education. Chemistry is one of the courses that is regarded as challenging for students since it is abstract and ambiguous, in addition to the many functions that chemistry roles in life (Utami & Muhtadi, 2019). Due to the abstract nature of chemical material, learning chemistry tends to be taught through lecture methods and working on problems. One of the factors contributing to the lack of interest in learning chemistry is the difficulty of the subject. Research carried out by Hemayanti et al., (2020) said that students' interest in chemistry is low because of the characteristics of the material which is abstract and difficult to understand.

(Djamarah (2008) states that Without any support from others, interest is a preference and a sense of connection for a thing or activity. Interest is someone's encouragement to do a job or activity ((Slameto, 2003). According to the above viewpoint, it may be inferred that interest is a sensation that motivates someone to engage in an activity. Interest in learning is encouraging someone to carry out learning activities. Feelings of enjoyment, student interest, student attention, and student involvement/participation are four signs of interest (Safari, 2003). Learning outcomes may be influenced by a person's interest in learning (Hemayanti et al., 2020).

It's important to comprehend the properties of chemical substances in the form of facts, concepts, principles, and computations for both discovery and application (Sari & Muchlis, 2019). Chemical material has interrelated and tiered properties between one concept and another so chemistry learning activities can stop if there are chemical terms or concepts that students do not understand (Sriwahyuni, 2021). Therefore, learning chemistry requires high intellectual abilities to build and apply understanding (Sari & Muchlis, 2019).

The intellectual abilities of students can be trained using the discovery learning model or better known as Discovery Learning. Discovery Learning is a learning design in which students actively build their understanding (Khasinah, 2021). According to the constructivist viewpoint, student participation in the learning process and their capacity to connect prior knowledge to new information will help them retain and comprehend what they are learning (SEAQIL’s Team, 2019). Discovery learning consists of several stages, namely stimulation, problem statements, data collection, data processing, verification, and generalization (Nugrahaeni et al., 2017). The problem-based activities in discovery learning increase student's curiosity and interest and train them to actively engage in the whole learning process (SEAQIL’s Team, 2019). Students that participate in the discovery learning approach can develop higher-order thinking abilities that will prepare them to compete and overcome globalization's challenges.

Globalization cannot be separated from the fact that the world continues to develop significantly toward digitalization. Everything in the digital world is access that is used to learn and collaborate wherever and whenever both locally and globally. The world of education is also developing according to the latest technological developments. The rapid development of technology and its applications turns the teaching and learning process into playful and enjoyable education (Hashim, 2018). Existing technology is widely carried out in teaching assistance from being used for the learning materials or activities (Solikhin & Rohiat, 2023). To create an environment that is conducive to learning and helps students achieve their goals, teachers must be knowledgeable about how to use technology in the classroom. The ability to integrate technology should be in line with their abilities in the fields of education and content.

Playing the role of an educator who directly deals with students, teachers must have competencies in pedagogy, content, and technology. These three skills are together referred to as Technological Pedagogical Content Knowledge (TPACK), which is an extension of Shulman's description of a teacher who expressly takes into account the role that technology knowledge might play in successful teaching (Utami & Muhtadi, 2019).

Mishra & Koehler (2006) explain three main knowledge pillars from the TPACK framework's founding principles as follows: 1) Content knowledge (CK) refers to any knowledge of a subject matter for teaching; 2) Pedagogical knowledge (PK) refers to the different instructional practices, strategies, and methods in learning; and 3) Technology knowledge refers to technologies that can be integrated into curricula and learning processes. The essential element of the TPACK framework is that teachers need to have in-depth knowledge of each component of knowledge to orchestrate and integrate technology, pedagogy, and content in instruction (Kohler et al., 2014).

This is in line with previous research by Yolanda et al., (2021) which stated that TPACK could improve student learning outcomes by 26% from 64% in cycle I to 90% in cycle II. Irawan, (2022) stated that there was an effect of the TPACK approach on learning outcomes with a significance value of 0.003. Anwar & Oktanovian, (2021) states that the Discovery Learning model generates student interest in learning with a percentage of 2.8% with very good criteria, as many as 30 students have a percentage of 83.3% with good criteria and 5 students have a percentage of 13.9% with fairly good criteria and 86% of students experienced learning completeness. So therefore with the implementation of the TPACK framework and Discovery learning, it is hoped that it can increase students' interest in studying abstract chemical bonds and facilitate the discovery of the concept of chemical bonds through visualization so that they can provide maximum learning outcomes in achieving completeness for class XI-3 students of SMAN 6 Surabaya.

▪ METHOD

This study used quantitative and qualitative research with Classroom Action Research (CAR). CAR was created to watch student interaction and influence behavior via the use of various teaching styles and strategies (Muh Ali et al., 2023). Students from professional teaching programs, seminars, and chemistry professors from Senior High School 6 in Surabaya collaborated on this study. The research subjects were 33 students of XI-3. Figure 1 depicted the research process for the Kemmis and Taggart design, which has four components planning, implementation, observation, and reflection. Cycle one aimed to determine students' prompt skills and interest in learning using the Discovery Learning approach, and cycles two and three aimed to improve cycle one (Masruri, 2023). The number of cycles carried out depends on the increase in learning outcomes.

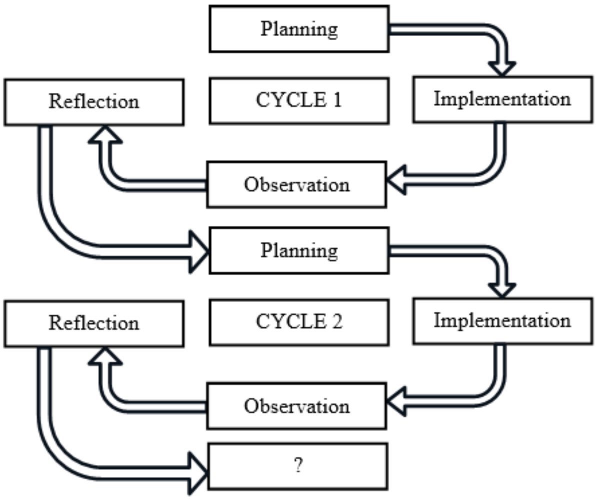

Figure 1. Kemmis and Taggart CAR Design (2014)

Planning

Planning is an important process to introduce the research action and reflection (Kemmis et al., 2014). The researchers determined the learning objectives where the main learning objectives were students were able to build the concept of chemical bonding. In the planning stage, students collaborate with tutors and chemistry teachers to formulate and compile the instruments needed for research. Planning was also carried out to plan three aspects of TPACK in each meeting. Implementing discovery learning through group conversations with a scientific approach demonstrated pedagogical knowledge. Applying discovery learning required teachers to understand the abilities of each student (SEAQIL's Team, 2019). Learning was organized to cover the subject in a logical order starting with utilizing tools to construct objects, observing visual objects, and learning to describe anything using words or symbols. The choice of discovery learning was following the cognitive development of students who were entering a formal operational period where students were able to think abstractly and formulate conclusions about the concept of chemical bonds. Content knowledge was demonstrated by the use of chemical bonding materials which are divided into three sub-materials namely atomic stability, ionic bonds vs covalent bonds, and types of covalent bonds along with octet deviation. In terms of technological knowledge, technology integration was carried out through videos, e-books, online games, and Augmented Reality (AR). The use of TPACK was intended to give teachers the flexibility to modify their lesson plans for straightforward student comprehension (SEAQIL's Team, 2019).

The instruments needed in this study were pre-research questionnaire sheets, teaching modules using the discovery learning model and TPACK framework, interest questionnaires, student activity observation sheets, and posttest sheets per cycle. After each cycle, students' learning outcomes were evaluated, and they also completed a self-reported questionnaire on their interests. The result of the student's interest was supported by the student's learning activity observation. Before beginning a class, teachers needed to be aware of the characteristics of their students, as these characteristics were utilized to choose methods and strategies for carrying out the learning process (Anom W et al., 2022). The pre-research questionnaire was utilized to ascertain the needs and characteristics of students, which served as the foundation for the research. The interest questionnaire was adapted from research conducted by Putra (2021), which consists of 20 negative and positive statements covering four indicators of interest in learning. The four indicators of interest in learning are feelings of pleasure, student interest, attention, and involvement/participation (Safari, 2003). The measurement of this interest research used a Likert scale of 1-5 which is used to measure responses from respondents, such as; scale 1 (strongly disagree); 2 (disagree); 3 (neutral); 4 (agreed); 5 (strongly agree) (Sugiyono, 2015). From the results of the interest questionnaire, a total score will be obtained which is then categorized with the following calculation:

Table 1. Formula Needed to Interest's Categorization

Coefficient	Formula
n	The number of instruments/questions
Xmin	N x smallest score
Xmax	N x biggest score
Means	$\frac{Xmax + Xmin}{2}$
Standard Deviation	$\frac{Xmax - Xmin}{6}$

The next descriptions were to categorize the total score obtained. The score was divided into 3 categories of tendencies which are determined based on:

Table 2. Categorization of Student's Interest

Category	Formula Determination range
High group	Mean score + 1 SD ke on
Low group	From the mean score of – 1 SD to a mean score of + 1 SD
Low group	Mean score – 1 SD to lower

(Azwar, 2011)

The posttest questions were adapted to the learning objectives owned by the school and have been formulated following the Class XI Phase F Chemistry Learning Outcomes stated in the Merdeka Curriculum. Meanwhile, student activity sheets were adapted to learning steps using discovery learning syntax coupled with irrelevant activity indicators.

Implementation

The implementation of this CAR was carried out by a professional pre-service teacher program which consisted of 3 cycles. Researchers used the discovery learning model and the TPACK framework to synthesize learning that has been put into implementation. Here is a description of how each cycle's implementation flowed:

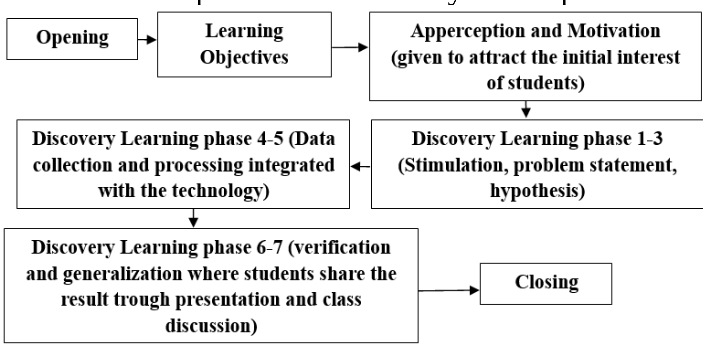

Figure 2. Implementation of CAR for Each Cycle

Observation

The researcher was assisted by two observers to observe the implementation of activities and students' interests during the learning process taking place in each meeting from the beginning to the posttest of learning outcomes. The Minimum Completeness Criteria (MCC) value in chemistry was 75 and classical completeness was achieved if 85% of students are said to have passed

Reflection

Reflection was done with students after the conclusion of conventional classes to determine how the learning was implemented generally and following each meeting to assess interests, learning activities, and learning results. Reflection activities were carried out to conclude in determining steps in the next cycle. The success of the research was when students' interest and learning outcomes were classical completeness achieved by 85%.

▪ RESULT AND DISCUSSION

The research was conducted using the CAR model wherein one cycle consisted of planning, implementation, observation, and reflection (Arikunto, 2010). The research was conducted based on the outcomes of observations and interviews wherein the learning process was still in the nature of lectures and working on questions without technology integration. It would help students understand the abstract description of chemical material. The interest questionnaire's results showed that this problem caused student's less interest in learning and also affected their learning outcomes. This research was the result of a collaboration between PPG Pre-service students, lecturers, and chemistry teachers at SMAN 6 Surabaya.

Cycle 1

Cycle 1 activities aimed to see the initial learning outcomes of students using the Discovery Learning model and limited technology integration to videos and e-books. The discovery learning worksheets were given to the students in six groups. Researchers also provided the e-worksheet for students. Three main aspects of TPACK in cycle 1 were shown below:

Table 3. TPACK Aspects in Cycle 1

TPACK aspect	Cycle 1
Pedagogical Knowledge	Discovery learning model through presentation, class, and group discussion
Content Knowledge	Atomic stability
Technological Knowledge	Video, e-book, and e-worksheet

During the implementation of cycle 1, two observers assisted in supervising learning activities. The results of cycle 1 observations showed some students could not focus during learning, were less active during discussion activities until the researcher appointed students to express opinions, lack of enthusiasm, and had less than optimal group discussion activities. Researchers try to help liven up the classroom atmosphere by going around helping each group and providing additional points for students who actively participate in class discussions.

The results of cycle 1 showed that 66% of students were declared complete while 33% of students were declared incomplete because they had learning outcomes below the MCC where the classical average value was 77 with a range of 48-91. The post-test results show that there are students who still have difficulty determining the number of valence electrons so that atoms can achieve stability. The learning interest of students from cycle 1 was 12% had low interest, 67% had moderate interest, and 21% had high interest. The observation results also showed that students carried out irrelevant activities by 13%.

Cycle 1 showed that the learning outcomes and interest of students had not been maximized so a follow-up plan was prepared for improvement in cycle 2. The first change was that the class would be divided into 8 groups so that each group had fewer members than the previous group. Small group discussions could improve the quality of individuals to be more active and build positive interactions between members to improve thinking processes and learning outcomes (Fauzan et al., 2022). Increasing interest in learning was done by providing a variety of learning media according to the topic of ionic bonds and covalent bonds. The usage of suitable learning media would attract the attention of students so that students would be more focused on receiving information (Gama et al., 2020).

Cycle 2

Cycle 2 activities were carried out to see an increase in learning results and students' interest in the application of discovery learning and the TPACK framework with broader technological integration. Three main aspects of TPACK in cycle 2 were shown below:

Table 4. TPACK Aspects in Cycle 2

TPACK aspect	Cycle 2
Pedagogical Knowledge	Discovery learning model through class and group discussion, presentation, and online games
Content Knowledge	Ionic Bonding vs Covalent Bonding
Technological Knowledge	Video, e-book, e-worksheet, and games

Cycle 2 activities were opened with a joint discussion of the difficulties of several students in cycle 1 in determining the number of atomic valence electrons to achieve stability. Students were asked to try to determine atomic stability. Repetition could help students to increase understanding and show positive learning outcomes.

Cycle 2 was carried out using small groups where one class was divided into 8 groups of 4-5 students. Small group discussions encourage students to actively build discussions to develop students knowledge, skills, and professionals (Grijpma et al., 2021). Research by Fauzan et al. (2022) showed that higher-order thinking skills and character learning can be done effectively with small group discussions.

Technology integration was varied with the use of games. The first games were online matchmakers between positive and negative ions in forming ionic compounds. Games based on matching effectively increase the attractiveness of students to take part in learning and train accuracy to improve learning outcomes (Lestari et al., 2021). The second game was an online game to collect points. The interest of students was shown by the competition between groups to get the highest points. Game-based learning had been proven through many studies to be more effective in increasing the effectiveness of the learning process (Liu & Chen, 2013). Game-based learning was able to improve learning outcomes, interests, and attitudes of students during the learning process, including science learning.

Cycle 2 observations showed the increasing learning atmosphere with the active participation of students. Students independently volunteered to answer questions and provide opinions in discussion activities. Each group accessed the learning resources and games provided. Students' interest increased to complete the series of games provided.

The results of cycle 2 showed that 91% of students were declared complete while 9% of students were declared incomplete because they had learning outcomes below the MCC where the classical average value was 90 with a range of 89-97. The results of the posttest showed that there were students who still had difficulty describing the Lewis bond structure. The learning interest of students from cycle 2 was 42% moderately interested, and 58% highly interested. The observation results also showed that students carry out irrelevant activities by 8%.

The results of cycle 2 showed an increase in learning outcomes and students' interest in learning by using the Discovery Learning and TPACK framework. Media games were able to create an atmosphere of "playing while learning". Games could motivate students to learn (Hidayah et al., 2017). Learning media was also able to increase student motivation, reasoning ability, thoroughness, and collaboration. Chemistry learning presented by playing is a constructivist learning from their initial knowledge to gain new knowledge (Marlon & St. Mulyana, 2009). Students' reflections revealed that game media reduced boredom and provided a new learning atmosphere from the learning process which had so far been carried out by sitting, listening, and taking notes.

Cycle 3

Cycle 3 activities were carried out to see an increase in learning outcomes and students' interests with the application of discovery learning and the TPACK framework with broader technological integration. Three main aspects of TPACK in cycle 3 were shown below:

Table 5. TPACK Aspects in Cycle 3

TPACK aspect	Cycle 3
Pedagogical Knowledge	Discovery learning model through class and group discussion, and presentation
Content Knowledge	Type of Covalent Bonding and Deviation of Octet Rule
Technological Knowledge	Video, e-book, e-worksheet, and augmented reality (AR)

Learning activities in cycle 3 used technological integration in the form of Augmented Reality (AR). The use of AR technology was based on the results of the post-test cycle 2, there were still students who had difficulty in describing the Lewis structure of a compound. Chemical bond material was abstract material. Thus, it described the process by which atoms form bonds, making it difficult to study contextually (Rizqullah & Lutfi, 2021). Augmented reality in this chemical bond material was able to project the structure of atoms and electrons in forming a compound in two or three dimensions into the real world. The consideration of using AR was implementing the technology that gave visualization and stimulation of the concept structure of atoms, molecules, and chemical bonds.

Cycle 3 showed the achievement of learning outcomes for all students with scores above the MCC and an increase in learning interest as evidenced by learning activities.

The observation results showed an increase in student participation in group and class discussions. Students installed the application and explore the available AR.

The results of cycle 3 showed that 100% of students were declared complete because they had learning outcomes above the MCC where the classical average value was 97 with a range of 90-100. The outcomes of the posttest revealed that some students could describe the Lewis structure, determine the type of bond, and explain deviations from octet arrangements. The learning interest of students from cycle 3 was 13% moderately interested, and 87% highly interested. The observation results supported the results of student interest where during learning irrelevant activities that appear are only 3%. The results showed that the use of AR was appropriate to overcome the problems that arose in the previous cycle. To improve understanding when discussing an object model and address the lack of interest among high school students, augmented reality (AR) was used (Sumpeno, 2014).

The achievement value of student learning outcomes for each cycle was as follows:

Table 6. Student's Achievement for All Cycle

Cycle	Average of Learning Outcomes	Classical mastery (%)	Score Range
Cycle 1	77	67	48-91
Cycle 2	90	91	74-97
Cycle 3	97	100	90-100

The results of learning through the posttest from cycle 1 to cycle 3 in this study showed an increase in both classical completeness and the range of students' scores. The chemistry subject at SMAN 6 Surabaya had a MCC score of 75, so students were declared complete if they get a score of 75 and above. Classical completeness increased successively starting from 67% to 91% and ending with 100% in cycle 3. The range of student scores also increased where the lowest score in cycle 1 was 48, while in cycles 2 and 3 it increased to 74 and 90. This shows how applying discovery learning and the TPACK framework can help students who have achieved classical mastery above 85% to learn more effectively.

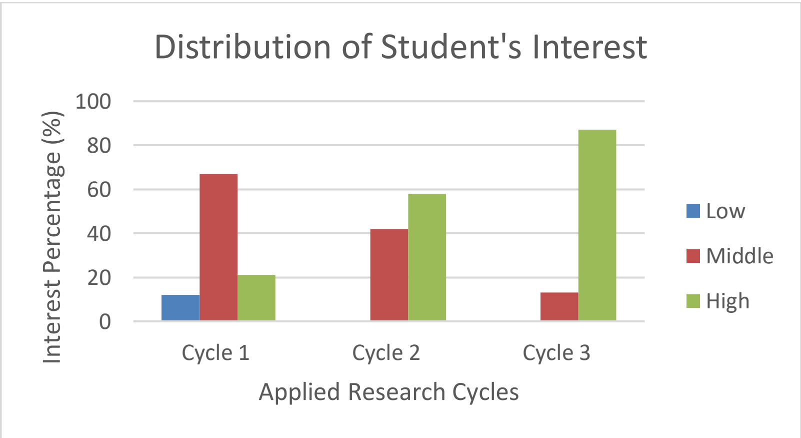

Figure 3. Diagram of Student's Interest in All Cycle

Improved learning outcomes can also be influenced by an increase in students' learning interests. Interest in learning was an important factor in maintaining consistency and enthusiasm for learning students to achieve learning goals. In this study, an increase in learning outcomes was also accompanied by an increase in students' learning interests.

In cycle 1, students were divided into low, medium, and high interest categories with successive percentages of 12%, 67%, and 21%. Furthermore, in the second cycle, there were no students with low-interest categories where students were only divided into medium and high-interest categories of 42% and 58% respectively. In cycle 3, there was an increase in students' interest in the high category to 87%.

This shows that the use of discovery learning and the TPACK framework was able to increase students' interest in learning because learning activities had adapted both content, pedagogy, and technology to the conditions of students.

Table 7. Activities Observation Result

Indicators	**Percentage (%)**		
	Cycle 1	**Cycle 2**	**Cycle 3**
Noticed teacher explanation	11	11	11
Observed stimulus	12	14	14
Involved in problem statements	11	14	14
Access materials and technology Study	11	14	14
Do data collection	17	11	11
Analyze and process data	15	16	17
Presenting the results	11	13	14
Do irrelevant activities	13	8	5

Enhancement data from observations of student's learning-related behaviors were used to support the student's interest. The student's engagement in learning activities to develop their understanding may enhance if they are organized using the syntax of discovery learning. This is in accordance with Ramadhani, (2021) because the discovery learning model can supports students' active participation in the learning process, fosters a sense of desire know, enabling the development of learning skills throughout life, and make the learning experience more personal. This is in line with previous research by Yolanda et al., (2021) which stated that TPACK could improve student learning outcomes by 26% from 64% in cycle I to 90% in cycle II and the increasing of student's activities from 66.67% in cycle I to 100% in cycle II because the learning process became more enjoyable for students. Observations showed that there was a decrease in the percentage of irrelevant activities by students. Student irrelevant activities fell from cycle 1 to cycle 3, namely by 13% to 8% and ended by 5%. Based on these results, it was known that could increase their participation during the teaching-learning process. The TPACK assisted in learning activities is proven to give positive impact for learning outcomes and interest because learning is more in line with the conditions of the learners and the characteristics of the material.

▪ CONCLUSION

According to the results of this study, it can be said that using Discovery Learning (DL) with the TPACK framework in chemical bonding materials can improve student's learning results and interest in class XI-3 because students were involved and used their ability in the learning process with fun learning experiences through the variety of technology and visualization used to enable them to easily understand what they were learning. When student learning outcomes met MCC with at least 85% of the class present, that served as the success indicator that served as the standard in this CAR for student learning results. The average of learning result in cycle 1 was 77 and went up to 90 and 97 in cycles 2 and 3 while the classical mastery from all cycles went up from 67% to 91% and 100%. Student's interest in learning chemistry also went up through each cycle seeing through the percentage of the number of students in the high-interest category from 21% in cycle 1 to 58% in cycle 2 and 87% in cycle 3. It can therefore say that the discovery learning with the TPACK framework that was applied in XI-3 gives a positive effect to increase student's learning outcomes and interest.

▪ REFERENCES

Anggraini, T., Nurhamidah, & Rohiat, S. (2022). Analisis Hubungan Pelaksanaan Praktikum Terhadap Hasil Belajar Kimia Siswa SMA Negeri di Kota Bengkulu. *Jurnal Pendidikan Dan Ilmu Kimia Alotrop*, *6*(1), 28–34. https://ejournal.unib.ac.id/alotropjurnal/article/download/20320/9387

Anom W, K., Sukaryawan, M., Ibrahim, A., & Ad'hiya, E. (2022). Chemistry Learning Module Based on Student Characteristics in The New Normal Era. *Jurnal Pendidikan Kimia Indonesia*, *6*(2), 123–132. https://doi.org/10.23887/jpki.v6i2.49791

Anwar, Y., & Oktanovian. (2021). Pengaruh Minat Terhadap Hasil Belajar Geografi Menggunakan Model Discovery Learning. *Indonesian Journal of Social Science Education (IJSSE)*, *3*(2), 161–168.

Arikunto, S. (2010). *PROSEDUR PENELITIAN: Suatu Pendekatan Praktik* (4th ed.). PT Rineka Cipta.

Azwar, S. (2011). *Metode Penelitian* (12th ed.). Pustaka Pelajar.

Djamarah, S. B. (2008). *Psikologi Belajar*. Rineka Cipta.

Fauzan, M. F., Nadhir, L. A., Kustanti, S., & Suciani, S. (2022). Pembelajaran Diskusi Kelompok Kecil : Seberapa Efektif kah dalam Meningkatkan Keterampilan Berfikir Kritis Pada Siswa ? *Aksara: Jurnal Ilmu Pendidikan Nonformal*, *8*(3), 1805. https://doi.org/10.37905/aksara.8.3.1805-1814.2022

Gama, D., Dan, I., & Dwiningsih, K. (2020). MODEL MULTIMEDIA INTERAKTIF BERBASIS UNITY UNTUK MENINGKATKAN HASIL BELAJAR IKATAN ION. In *Jurnal Inovasi Pendidikan Kimia* (Vol. 14, Issue 2).

Grijpma, J. W., de la Croix, A., Kleinveld, J. H., Meeter, M., & Kusurkar, R. A. (2021). Appreciating small-group active learning: What do medical students want, and why? A Q-methodology study. *Medical Teacher*, *43*(4), 411–420. https://doi.org/10.1080/0142159X.2020.1854705

Hashim, H. (2018). Application of Technology in the Digital Era Education. *International Journal of Research in Counselling and Education*, *02*(01), 1–5. https://doi.org/http://dx.doi.org/10.24036/002za0002

Hemayanti, K. L., Muderawan, I. W., & Selamat, I. N. (2020). ANALISIS MINAT BELAJAR SISWA KELAS XI MIA PADA MATA PELAJARAN KIMIA. *Jurnal Pendidikan Kimia Indonesia*, *4*, 20–25. https://ejournal.undiksha.ac.id/index.php/JPK/index

Hidayah, R., Suprianto, S., & Rahmawati, A. (2017). Permainan "Kimia Kotak Katik" Sebagai Media Pembelajaran Pada Materi Sistem Periodik Unsur. *JTK (Jurnal Tadris Kimiya)*, *2*(1), 91–96.

Hidayat, R., & Abdillah. (2019). *Ilmu Pendidikan: Konsep, Teori, dan Aplikasinya*. LPPPI.

Irawan, A. F. (2022). EFEKTIVITAS PENDEKATAN TPACK TERHADAP HASIL BELAJAR IPA SEKOLAH DASAR. *SEMINAR NASIONAL HASIL RISET DAN PENGABDIAN*, 985–990.

Kemmis, S., McTaggart, R., & Nixon, R. (2014). *The Action Research Planner: Doing Critical Participatory Action Research* (2nd ed.). Springer.

Khasinah, S. (2021). Discovery Learning: Definisi, Sintaksis, Keunggulan dan Kelemahan. *Jurnal MUDARRISUNA: Media Kajian Pendidikan Agama Islam*, *11*(3), 402. https://doi.org/10.22373/jm.v11i3.5821

Kohler, M. J., Mishra, P., Kereluik, K., Shin, T. S., & Graham, C. R. (2014). The Technological Pedagogical Content Knowledge Framework. In *Handbook of Research on Educational Communication and Technology*. Springer Science+Bussiness Media. https://doi.org/10.1007/978-1-4614-3185-5_9

Lestari, G., Farida, I., Helsy, I., Kimia, P., Tarbiyah, F., & Keguruan, D. (2021). PEMBUATAN MEDIA CHEMINOSMART PADA MATERI TATA NAMA SENYAWA ANORGANIK MAKING CHEMINOSMART MEDIA ON INORGANIC COMPOUND NOMENCLATURE MATERIAL. *Gunung Djati Conference Series*, *2*.

Liu, E. Z. F., & Chen, P.-K. (2013). The Effect of Game-Based Learning on Students' Learning Performance in Science Learning – A Case of "Conveyance Go" . *INTERNATIONAL EDUCATIONAL TECHNOLOGY CONFERENCE IETC2013* . https://doi.org/10.1016/j.sbspro.2013.10.430

Marlon, L., & St. Mulyana. (2009). *Tutorial Membangun Multimedia Interaktif Media Pembelajaran*. Universitas Atma Jaya.

Masruri, M. (2023). Meningkatkan Prestasi Belajar Informatika Menggunakan Model Blended Learning di Kelas X IPS 1 MAN 1 Cilacap. *PTK: Jurnal Tindakan Kelas*, *3*(2), 139–154. https://doi.org/10.53624/ptk.v3i2.148

Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record*, *108*(6), 1017–1054. https://doi.org/https://psycnet.apa.org/doi/10.1111/j.1467-9620.2006.00684.x

Muh Ali, A., Satriawati, S., & Nur, R. (2023). Meningkatkan Hasil Belajar IPA Menggunakan Metode Eksperimen Kelas VI Sekolah Dasar. *PTK: Jurnal Tindakan Kelas*, *3*(2), 114–121. https://doi.org/10.53624/ptk.v3i2.150

Nugrahaeni, A., Wayan Redhana, I., & Made Arya Kartawan, I. (2017). Penerapan Model Pembelajaran Discovery Learning Untuk Meningkatkan Kemampuan Berpikir Kritis dan Hasil Belajar Kimia. In *Jurnal Pendidikan Kimia Indonesia* (Vol. 1, Issue 1). https://doi.org/https://doi.org/10.23887/jpk.v1i1.12808

Putra, I. M. A. A. (2021). *Korelasi Antara Minat Belajar dan Kepribadian Dengan Prestasi Belajar Siswa Kelas X MIPA SMA Negeri di Kota Negara* [Undergraduated Thesis, Universitas Pendidikan Ganesha]. http://repo.undiksha.ac.id/

Ramadhani, A. H. (2021). Pengaruh Pendekatan Pembelajaran Discovery Learning pada Hasil Belajar Siswa. *Jurnal Pendidikan Guru Sekolah Dasar*, *2*(1), 96–102.

Rizqullah, A. F., & Lutfi, A. (2021). *Interactive Chemistry Teaching Material Based on Augmented Reality Technology In Covalent Bonding Submaterial*. *4*, 49–58. https://doi.org/10.29303/cep.v4i1.2441

Safari. (2003). *Kurikulum Berbasis Kompetensi*. Rineka Cipta.

Sari, D. S., & Muchlis. (2019). Penerapan Model Pembelajaran Learning Cycle 5-E untuk Meningkatkan Pemahaman Konsep Siswa pada Materi Redoks Kelas X SMA Negeri

1 Driyorejo Gresik. *UNESA Journal of Chemistry Education*, *8*(3), 305–312. https://doi.org/https://doi.org/10.26740/ujced.v8n3.p%25p

SEAQIL's Team. (2019). *HOTS-Oriented Module: Discovery Learning*. SEAMEO QITEP in Language.

Slameto. (2003). *Belajar dan Faktor-Faktor yang Mempengaruhinya*. Rineka Cipta.

Solikhin, F., & Rohiat, S. (2023). The TPACK Profile of Chemistry Prospective Teacher in Microteaching Class, University of Bengkulu. *Jurnal Pendidikan Kimia Indonesia*, *7*, 19–28. https://doi.org/https://doi.org/10.23887/jpki.v7i1.49009

Sriwahyuni, E. (2021). Studi Pendahuluan Pengembangan Flashcard Sistem Periodik Unsur pada Pembelajaran Kimia Kelas X SMA. *Jurnal Pendidikan Kimia Unkhair*, *1*, 42–48. https://ejournal.unkhair.ac.id/index.php/jpku/article/view/5656/3605

Sugiyono. (2015). *Metode Penelitian: Kuantitatif, Kualitatif dan R&D* (22nd ed.). Alfabeta.

Sumpeno, S. (2014). Chemical Bonds Visualization using Particle Effect and Augmented Reality. In *Journal of Proceeding Series* (Vol. 1). https://doi.org/http://dx.doi.org/10.12962/j23546026.y2014i1.285

Utami, R. A., & Muhtadi, A. (2019). TPACK-Based E-Book for Learning Chemistry in Senior High School. *International Conference on Online and Blended Learning 2019*, 166–168.

Yolanda, K. C., Oktaviany, V., & Dwiprabowo, R. (2021). Peningkatan Hasil Belajar Tematik Dengan Penerapan Model Pembelajaran Technological-Pedagogical-Content-Knowledge (TPACK). *Prosiding Seminar Nasional Pendidikan STKIP Kusuma Negara III*, 236–242.