

Analysis of Level of Student Learning Independence Through Phet Simulation Assisted Padlet Media Implementation

(Received 30 December 2021; Revised 31 May 2022; Accepted 31 May 2022)

**Siti Fatimah Az Zahro^{1*}, Supahar Supahar², Insih Wilujeng¹, Mega Indah Puspitasari¹,
Novia Amarta Handayani¹**

¹Department of Science Education, Faculty of Mathematics and Natural Sciences,
Yogyakarta State University, Yogyakarta, Indonesia

²Department of Physic Education, Faculty of Mathematics and Natural Sciences,
Yogyakarta State University, Yogyakarta, Indonesia

Corresponding Author: *siti0005pasca.2020@student.uny.ac.id

DOI: 10.30870/jppi.v8i1.13646

Abstract

Curriculum 2013 emphasizes education that can build an independent attitude of students. This study aimed to measure the level of student learning independence by implementing e-learning padlets assisted by PhET Simulation. The method used is descriptive quantitative where the sample involved is 35 people who are determined by cluster random sampling technique. The data collection technique used a learning independence questionnaire. Based on descriptive quantitative data analysis techniques, the results of research on the learning independence profile of students are based on five indicators, namely the responsible indicator of 76% in the high category, 63% initiative in the medium category, 65% confidence in the medium category, motivation 79% in the middle category. high category, and discipline of 86% in the very high category. The results of this study can be used as a basis for developing science learning media that is integrated with ICT to facilitate student learning independence.

Keywords: Padlet, PhET Simulation, Learning Independence

INTRODUCTION

Education will always be held in accordance with the applicable curriculum, including education in Indonesia. The curriculum currently being implemented is the curriculum 2013. Through the curriculum 2013 which is designed with the characteristics of developing a balance between spiritual and social attitudes.

Independence is the ability that a person has to do something and be responsible for it (Fadhillah & Faradina, 2016). Independence can be applied in many ways, one of which is independence in learning. A conducive learning environment will support the formation of independent learning as expected by the curriculum 2013.

Yuen et al., (2018), defined independent learning as “learning in which the learner, in conjunction with relevant others, can make the decisions necessary to meet the learners own learning needs... within the bounds of social acceptability and by self-directed, self-motivated, willing learners”. In line with this independence according to Lee et al., (2017), is an active and constructive process.

So, independent learning is the ability of students to make informed choices and take responsibility for their own learning activities. Learning

independence is based on efforts to carry out learning activities independently on the basis of their own motivation to master a certain material so that it can be used to solve the problems at hand, thus independent students must be proactive and not dependent on teachers (Amalia et al., 2018). By educating students to become information literate, teachers will respond to their role as advocates of informed and rational citizens, and they will respond to changes in their role as educators, as teaching shifts from teacher-centered to more learner-centered (Alabdulkareem, 2015; El Islami, Nuangchalerm, & Sjaifuddin 2018; Nuangchalerm & El Islami 2018; Parmin, Nuangchalerm, & El Islami, 2019; Parmin et al 2020; El Islami & Nuangchalerm, 2020; Mnguni et al 2020).

Learning independence is one of the important attitudes that must be possessed by students. Learning independence has benefits for students not only to support their activities at school but also to develop skills when entering the world of work (Endedijk et al., 2015). An independent attitude needs to be instilled in the individual from an early age as a form of developing self-potential.

In fact, most students tend to be reluctant to do independent learning

activities. One of the causes of low learning independence is the learning system that does not require students to play an active role in finding the information needed in the learning process (Ott et al., 2018). The low level of student activity according to Thoken et al (2017), is caused by the use of the information-discussion learning method applied to learning activities because in this method the material has been delivered by the teacher so that students only act as recipients of information.

As Logan & Skamp (2013), says that this problem with science education is associated with a decrease in students' attitudes towards interest in science especially in the high school years. Whereas a positive attitude towards science makes students more interested in focusing on the science process. In other words, when students understand science process skills, science becomes more attractive to them thereby increasing positive attitudes towards science (Zeidan & Jayosi, 2014). This low positive attitude causes students not to have independence in conducting scientific investigations (Tan, 2013).

Student learning independence can be measured using a questionnaire. To make it easier to measure the level of student independence, (Hidayati & Listiyani, 2010) divides the attitude of

student learning independence into six indicators, namely (1) independence from others, (2) having self-confidence, (3) disciplined behavior, (4) having a sense of belonging. responsibility, (5) behave on their own initiative, and (6) exercise self-control. Meanwhile, according to Rijal & Bachtiar (2015), indicators of learning independence include: (1) setting learning goals, (2) analyzing learning needs, (3) planning and organizing learning, (4) viewing difficulties as challenges, and (5) self-control. efficacy / self-ability.

In independent learning, initiative is a very basic indicator (Knowles). In a broader sense, learning independence describes a process in which individuals take the initiative themselves, with or without the help of others, to diagnose learning needs, formulate learning goals, identify learning resources, select and determine learning strategy approaches, and evaluate learning outcomes (Saefullah, Siahaan, & Sari, 2013). Independent learning demands a great responsibility on students so that students try to carry out various activities to achieve learning goals.

Vassallo (2011), states about independent learning as a form of learning that has the main responsibility for planning, implementing, and evaluating its business. Learning independence needs to be given to

teaching participants so that they have the responsibility to regulate and discipline themselves in developing learning abilities of their own accord (Dalgarno et al., 2014). In addition to responsibility, high motivation from teaching participants is very much needed in independent learning.

According to research conducted by Sobri & Moerdiyanto (2014), student learning independence has a positive effect on learning outcomes with a tcount value of 2.361 and a significance level of 0.019. Individuals who have high learning independence tend to be more active in learning, monitor their learning activities and can find out which learning strategies are suitable to be applied.

Individual learning independence is understood as the adjustment of the environment to meet their needs, such as learning strategies, goal structures, and self-confidence to meet task demands (Yuen et al., 2018). However, according to Hodson (2014), changes in the environment can be made to support students' efforts to adapt to the learning context. For example, in the classroom, environmental adaptation might include strategically asking a teacher, selecting peers with whom to collaborate, selecting models to emulate, and undertaking challenging activities. There are many ways that can be done

to create an environment that allows students to support their learning activities. Learning models and learning media are several aspects that can support student learning activities. Learning models that require students to actively look for their own learning materials make students accustomed to doing independent learning activities (Sugianto et al., 2020).

In science education, modifying the learning environment is becoming increasingly important. All of these approaches are designed, in one way or another, to transform the experience of learning science (Micari & Light, 2009). The science learning environment can be updated by conducting finding-based learning, or by using the discovery learning method. According to Honomichl & Chen (2012), discovery learning is a learning technique to help students create and organize knowledge that involves full participation, attention and active inquiry. This learning produces scientific reasoning which includes the skills involved in investigation, experimentation, evaluation of evidence, and inferences made in conceptual change or scientific understanding (Zimmerman, 2008). By focusing on discoveries that confirm their ideas, so students can be more confident in the predictions they make

and in relation to the theory they are learning (Harlen, 2013).

In addition to the application of learning models, the use of learning media can also support increasing learning independence. The evolution of E-learning, as a new form of distance learning whose terminology is close to traditional learning, has prompted a variety of learning applications that use terms such as multimedia, interactive, hyperlinked, and media-rich environments (Elfeky & Yakoub Masadeh, 2016).

According to research conducted by Aurora & Effendi (2019), there is a positive influence between student learning independence and the use of learning media with the result $t_{count} = 33.18$ where the value is greater than the table value. Learning media helps students increase learning independence as a means of supporting independent learning activities so that the teacher's role can change only as a facilitator (Oktavera, 2015). In addition, according to research conducted by Amalia et al (2018), the use of learning media is able to present authentic problems in the form of objects that are not directly observed or abstract material.

Technology-based media can be used to assist the teaching and learning process by teachers. One of the media

that can be used is a laptop / computer. Computer facilities that have been provided by the school accompanied by the availability of internet signals make it easier for someone to access learning sites so that the development of internet-based learning is needed as stated by Sahin et al (2016), the use of mobile technology is very closely related to the lives of children, children and parents, so its use for educational purposes is a must. The integration of technology in science teaching can be very effective if used properly (Ekmekci & Gulacar, 2015).

Utilization of information technology-based learning media has many benefits. The use of mobile e-learning helps students in conducting discussions, exchanging information, and reflecting on their learning (Rogers, 2008). In addition, Elfeky & Yakoub Masadeh (2016), revealed that the use of e-learning for students can improve student learning outcomes and abilities.

A variety of learning sites or commonly referred to as e-learning have begun to be developed and can be accessed easily through current technology such as gadgets, laptops, and computers, one of which is padlets. Padlet is an online whiteboard that facilitates students and teachers to enter notes in public places (DeWitt et al., 2015).

It allows students and teachers to share notes with others in the form of links, images, videos, and different documents. Padlet has advantages, one of which is that there is no software or application that needs to be downloaded or installed, so it can be used directly by anyone who has internet access, either through mobile phones, laptops or computers (Kamaruddin & Ibrahim, 2021). Another advantage is that by using Padlet teachers can distribute teaching materials in the form of e-modules, e-student worksheets, as well as virtual laboratories and practice questions that can support students' independent learning (DeWitt et al., 2015).

In order to support independent learning, padlets can be equipped with e-modules, e-student worksheets, and virtual laboratories such as PhET Simulation. PhET Simulation is a physics learning media in the form of a virtual laboratory that provides opportunities for students to build their own knowledge (Sinulingga et al., 2016).

PhET Simulation is obtained for free by downloading on the official website. The use of PhET Simulation as a learning medium that is able to accommodate the increase in students' conceptual mastery of science material

is very much needed in the current era of technological development.

Correia et al (2019) states that through PhET Simulation the explanation of a material is more visible so that mastery of the material is easier to understand. However, the drawback here is that PhET Simulation is not equipped with Worksheets that are able to direct students to be more active and independent in carrying out experiments. So we need worksheets that can help students in honing their scientific abilities and learning independence.

Interviews conducted with teachers obtained information that teachers have never used other media other than science textbooks when learning, so students tend to be passive, their learning is teacher-centered and makes the teacher the only source of information. In line with the information obtained from interviews with students who stated that they were more interested and easier to understand when learning was carried out using visual media such as pictures, videos, or animations.

Thus, this study will analyze students' learning independence in science learning, especially looking at the independence indicators that appear when students use e-learning padlets equipped with PhET Simulation. The

indicators used in this study are (1) self-confidence, (2) initiative, (3) responsibility, (4) motivation, and (5) discipline.

METHOD

The method used in this study is a quantitative descriptive method to analyze student learning independence through the use of PhET Simulation-assisted padlet media. This research is located in MTs. Al-Mumtaz Gunung Kidul with research subjects are grade VII students with a total sample of 35 people taken with cluster random sampling technique.

The data collection technique used is a questionnaire. In this study, the data were analyzed with quantitative percentages to determine the category of student learning independence. Indicators of learning independence analyzed in this study are: 1) Self-confidence, 2) Initiative, 3) Responsibility, 4) Motivation, and 5) Discipline.

The data collection instrument used a questionnaire consisting of 25 statement items with 5 measuring scales. Each statement consists of 10 negative statements and 15 positive statements. The results of the learning independence questionnaire that have been obtained are then analyzed with the following steps: 1) changing the letter scoring into a numerical score

with the provisions as in Table 1, 2) tabulating all the data obtained for each assessment indicator, 3) calculating the average score for each indicators, 4) changing the average score into a category value as shown in Table 2 (Widoyoko, 2009).

Table 1. Convert Scoring to Number Score

Answer Choice	Score	
	Positive	Negative
Strongly Agree	5	
Agree	4	
Indecisive	3	
Disagree	2	
Strongly Disagree	1	

Table 2. Conditions for Converting Scores to Categories

Interval (%)	Categories
$80 \leq X$	Very High
$66 \leq X < 80$	Tall
$51 \leq X < 66$	Currently
$36 \leq X < 51$	Low
$X < 36$	Very Low

In this study, the authors use learning media in the form of e-learning padlets equipped with e-modules, PhET Simulation, and interactive quizzes. Figure 1. shows Padlet as an online learning media that can be used in science learning activities, especially learning involving virtual laboratories to increase student learning independence. The virtual laboratory will contribute to the teaching and learning process.

RESULTS AND DISCUSSION

Results from the Word Association Test

in the following ways: (1) Providing opportunities for students to learn by doing, (2) Offering interesting and motivating activities, (3) lively classroom interactions through discussion and debate, (4) Develop students' thinking skills and problem solving skills, (5) Open up various possibilities to use this kind of resource for independent learning in both formal and non-formal education (Oidov et al., 2012).

In addition, the Padlet media used can be accessed easily using a smartphone, computer/laptop. In line with several research results which explain that by using padlets, teachers and students have a connection and can access anything (Aulia et al., 2019). In addition to the ease of interaction, according to research Andrizar & Arif (2017), padlets have good accessibility as learning media that makes it easier for students to access material in the form of videos, links, and animations.

Ease of access which is the advantage of padlets makes padlets

accessible to students independently, so students can study independently. In this study, a padlet equipped with PhET Simulation was used as a medium to analyze the level of student independence, with an instrument in the form of a questionnaire, the results of student learning independence were obtained as shown in Figure 2. Based on Figure 2. It can be seen that each indicator of learning independence has varying results. There is one indicator in the very high category, two indicators in the high category and two other indicators in the medium category.

The results obtained indicate that the level of student learning independence is quite good when compared to the statements conveyed by the teacher during the interview. This is because the use of ICT-based learning media is not optimal in the previous science learning. So in line with the results of research conducted by Brinson (2015), the findings show that 89% showed higher learning outcomes in non-traditional laboratories than in traditional laboratories in all categories of learning outcomes.



Figure 1. Padlet Learning Media

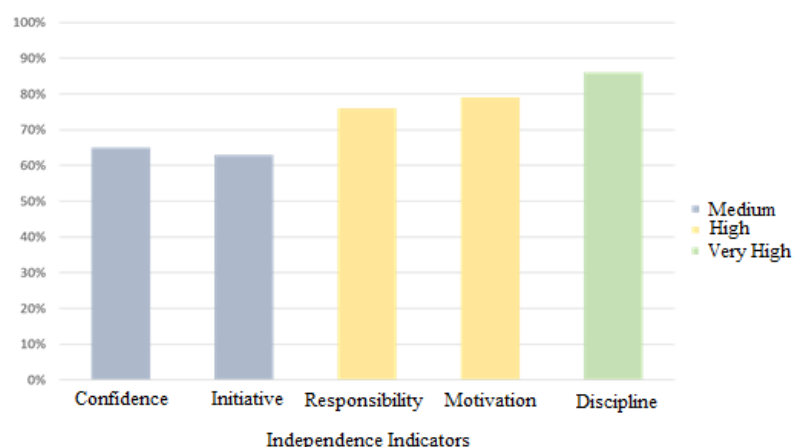


Figure 2. Level of Student Learning Independence per-Indicator

The results of this study are also in accordance with research conducted by Lee et al (2017), in a study that examined the use of computer technology in independent learning for students majoring in language. The results showed that the desire to learn had the strongest relationship with the use of computer technology compared to self-management and self-control. Sarabando et al (2016), in his research shows that students get a total score of 58% higher when using computer simulations. However, the total gain depends on the teacher's pedagogy when using computer simulations to teach concepts.

The majority of students feel that Virtual Laboratories help them identify and locate equipment items within the laboratory, and can increase their confidence and reduce anxiety. Student comments in interviews indicated that some students who had used the Virtual

Jurnal Penelitian dan Pembelajaran IPA
Vol. 8, No. 1, 2022, p. 74-90

Laboratory actually felt as if they were going to be in a real laboratory (Dalgarno et al., 2009).

Discipline

If it is seen from the results of the percentage of the questionnaire that the highest learning independence indicator is the discipline indicator (86%) with a very high category. The high indicators of discipline are also shown in the results of observations and interviews with students. Where based on the results of observations as many as 98% of students always show a disciplined attitude when the science learning process takes place. Likewise with the results of interviews with students who stated that they were always disciplined in doing and submitting assignments, and were always on time for science learning.

Independence is very closely related to the value of discipline, where if a student has a disciplined attitude, of

Az Zahro, et al

course he will know what his obligations as a student are, namely learning, so he will have high self-awareness to study diligently and persistently to achieve his learning goals trying to get good learning outcomes. good (Oktavera, 2015). Independent learning as an ability that exists in every student who develops because of a disciplined attitude.

Discipline carried out by students in learning activities will be able to create order and order so that learning activities become more conducive and run smoothly. If the activities run smoothly, then learning success will be easy to achieve, student learning achievement will also be easier to achieve (Sobri & Moerdiyanto, 2014). Students need discipline in their studies, but often students ignore things about learning discipline, as a result students fail to achieve optimal learning outcomes.

If students can discipline themselves, then these students have an efficient time in learning. As stated by Sugianto et al (2020), efficient learning requires high learning discipline, especially self-discipline, namely the ability to position oneself, self-control and self-consistency to act.

Confidence

The results showed that by using a PhET Simulation-assisted padlet,

students' independent learning attitudes on the self-confidence indicator (65%) were in the moderate category. The lack of the percentage of students on this indicator is also shown from the results of observations and interviews with students. Where from the observations on the confidence indicator only 65% of students always show a confident attitude. Likewise with the results of interviews which stated that students were quite embarrassed if appointed by the teacher to come to the front of the class, were reluctant to present their learning outcomes in front of the class, and were reluctant to answer questions or practice questions given by the teacher in front of the class.

Independent learning can be implemented by students if the student has self-confidence (Pratiwi & Laksmiwati, 2016) and able to provide satisfactory results later (Komara, 2016).

Initiative

The initiative indicator is also in the medium category with a percentage of 63%. The lack of the percentage of students on this indicator is also shown from the results of observations and interviews with students. Where from the results of observations on the indicators of initiative, only 78% of students always show an attitude of initiative. Likewise with the results of interviews which stated that the majority

of students did not dare to ask the teacher, did not look for other learning references other than what the teacher gave. And the results of interviews with teachers also stated that teachers did not provide students with references to other learning resources, either in the form of modules or student worksheets.

The use of learning resources is an important factor in increasing student initiative, according to Astuti et al (2019), the lack of variety of learning resources owned by students makes students depend on teachers so that their learning independence is in the low category.

E-Learning with e-portfolio modification is a means for formative development through a student-oriented and performance-based process of "planning, synthesizing, sharing, discussing, reflecting, giving, receiving and responding to feedback" which characterizes the realization of initiatives to learn to be independent (Chau & Cheng, 2010).

Students' learning independence will make them try to find other learning resources, such as books that will help them understand a lesson that has not been understood before asking the teacher during the learning process (Aulia et al., 2019).

Responsibility

The results showed that by using a PhET Simulation-assisted padlet, students' independent learning attitudes on the responsible indicator (76%) were in the high category. These results are consistent with the results of observations and interviews with students and teachers. Based on the results of observations showed as many as 90% of students showed an attitude of responsibility in learning science. This can be seen from the fulfillment of 3 aspects of responsibility that must be owned by students. Likewise with the results of interviews which stated that students have good responsibilities in doing assignments and directions given by the teacher.

A finding from the various literatures on the effectiveness of instructional media is that even when one type of teaching consistently yields greater average gains in learning than another, there are always some children who do not learn from the more effective methods but learn from the more effective methods. less effective (Strand-Cary & Klahr, 2008). So that the use of interesting media and learning strategies allows students to arrange their own learning sequence, so that students have responsibility for themselves (Zeidan & Jayosi, 2014). According to Saefullah et al (2013),

high responsibility makes students able to identify themselves, organize and target their learning outcomes independently.

Motivation

Based on the results of the questionnaire, the motivation indicator is in the high category with a percentage of 79%. So that it can be said that students already have high learning motivation, are able to regulate themselves enough to find and study learning resources that suit their needs, and are able to determine suitable learning strategies to complete their tasks. This is because science learning is applied using ICT-based learning media so that it attracts students' interest in learning.

This is in line with the results of interviews with students which stated that students were more interested in learning using visual media. Such as in the form of images, videos, and animations. This interest then increases students' motivation in participating in learning. The observations made also support the results obtained, where as many as 94% of students have high motivation in participating in science learning with padlet media and virtual laboratories.

The reason why children are less independent in learning, one of which is the lack of motivation in learning

(Isnawati & Samian, 2010). The growth of strong motivation in learning will certainly foster independence in learning. Because the influence of learning independence is important to measure the maximum learning achievement results, because with students having good learning independence, they will have broad learning insights and initiatives to carry out a good learning process at school and at home by utilizing available learning facilities and resources (Sarabando et al., 2014).

In line with this, Guy & Lownes-Jackson (2015), in her research stated that computer simulations provide more motivation so that it can provide reinforcement of the concepts discussed in learning, so that students can repeat the simulation until they get better understanding results and thus improve their learning outcomes. .

The use of information technology integrated learning media results in a fairly high level of student learning independence. So that it is expected to be able to support science learning which can facilitate students' independent learning as part of the attitude that must be possessed based on the demands of the 2013 curriculum and the development of 21st century learning. However, it is necessary to apply learning with ICT integrated

media to increase confidence and initiative indicators. This research can be used as a reference for schools and teachers in planning science learning in schools.

CONCLUSION

Based on the five indicators of learning independence measured, the results of student learning independence are obtained in each indicator, namely the responsible indicator of 76% in the high category, 63% initiative in the medium category, 65% confidence in the medium category, motivation 79% in the medium category. high, and discipline of 86% in the very high category.

So that students' learning independence is high because the use of ICT-based learning media can increase students' motivation in learning and students can easily access the learning materials presented. This research is an initial study to develop teaching materials assisted by virtual laboratories to increase student learning independence.

REFERENCES

- Alabdulkareem, S. A 2015, 'Exploring the Use and the Impacts of Social Media on Teaching and Learning Science in Saudi', *Procedia - Social and Behavioral Sciences*, vol. 182, 213–24. <https://doi.org/10.1016/j.sbspro.2015.04.758>
- Amalia, A., Syafitri, L. F., Triyana, V., & Sari, A 2018, 'Masalah Jurnal Penelitian dan Pembelajaran IPA Vol. 8, No. 1, 2022, p. 74-90
- Matematik Dengan Self Efficacy Dan Kemandirian Belajar Siswa Smp, *Jurnal Pembelajaran Matematika Inovatif*, vol.1, no.5, pp. 887–94.
- Andrizal, A., & Arif, A 2017. 'Pengembangan Media Pembelajaran Interaktif Pada Sistem E-Learning Universitas Negeri Padang. *INVOTEK: Jurnal Inovasi Vokasional Dan Teknologi*' vol. 17, no. 2, pp. 1–10. <https://doi.org/10.24036/invotek.v17i2.75>
- Astuti, I. A. D., Putra, I. Y., & Bhakti, Y. B. 2019, 'Developing Practicum Module of Particle Dynamics Based on Scientific Methods to Improve Students' Science Process Skills. *Scientiae Educatia*, vol. 7, no. 2, pp. 183. <https://doi.org/10.24235/sc.educatia.v7i2.2513>
- Aulia, L. N., Susilo, S., & Subali, B 2019 'Upaya peningkatan kemandirian belajar siswa dengan model problem-based learning berbantuan media Edmodo', *Jurnal Inovasi Pendidikan IPA*, vol. 5, no.1, 69–78. <https://doi.org/10.21831/jipi.v5i1.18707>
- Aurora, A., & Effendi, H. 2019, 'JTEV (JURNAL TEKNIK ELEKTRO DAN VOKASIONAL) Pengaruh Penggunaan Media Pembelajaran E-learning terhadap Motivasi Belajar Mahasiswa di Universitas Negeri Padang. *Universitas Negeri Padang. JTEV*, vol. 5, no.2, pp. 11–16.
- Brinson, J. R 2015, 'Learning outcome achievement in non-traditional (virtual and remote) versus traditional (hands-on) laboratories: A review of the empirical research. *Computers and Education*, vol.87, 218–37.
- Az Zahro, et al

<https://doi.org/10.1016/j.compedu.2015.07.003>

- Chau, J., & Cheng, G 2010, 'Towards understanding the potential of e-portfolios for independent learning: A qualitative study', *Australasian Journal of Educational Technology*, vol. 26, no.7, pp. 932–50. <https://doi.org/10.14742/ajet.1026>
- Correia, A. P., Koehler, N., Thompson, A., & Phye, G 2019, 'The application of PhET simulation to teach gas behavior on the submicroscopic level: secondary school students' perceptions. *Research in Science and Technological Education*, vol. 37, no.2, pp. 193–217. <https://doi.org/10.1080/02635143.2018.1487834>
- Dalgarno, B., Bishop, A. G., Adlong, W., & Bedgood, D. R 2009, 'Effectiveness of a Virtual Laboratory as a preparatory resource for Distance Education chemistry students. *Computers and Education*, vol. 53, no.3, pp. 853–65. <https://doi.org/10.1016/j.compedu.2009.05.005>
- Dalgarno, B., Kennedy, G., & Bennett, S. 2014, 'The impact of students' exploration strategies on discovery learning using computer-based simulations. *Educational Media International* vol. 51, no.4, pp. 310–29. <https://doi.org/10.1080/09523987.2014.977009>
- DeWitt, D., Alias, N., Ibrahim, Z., Shing, N. K., & Rashid, S. M. M. 2015, 'Design of a Learning Module for the Deaf in a Higher Education Institution Using Padlet. *Procedia-Social and Behavioral Sciences*, vol. 176, pp. 220–6. <https://doi.org/10.1016/j.sbspro.2015.01.464>
- Ekmekci, A., & Gulacar, O. (2015). A case study for comparing the effectiveness of a computer simulation and a hands-on activity on learning electric circuits. *Eurasia Journal of Mathematics, Science and Technology Education*, vol. 11, no.4, pp. 765–75. <https://doi.org/10.12973/eurasia.2015.1438a>
- Elfeky, A. I. M., & Yakoub Masadeh, T. S 2016, 'The Effect of Mobile Learning on Students' Achievement and Conversational Skills. *International Journal of Higher Education*, vol. 5, no. 3, pp. 20–31. <https://doi.org/10.5430/ijhe.v5n3p20>
- El Islami, R. A. Z., Nuangchalerm, P., & Sjaifuddin, S, '2018, 'Science process of Environmental Conservation: Cross National Study of Thai and Indonesian Pre-service Science Teachers, *Journal for the Education of Gifted Young Scientists*, vol.6, no.4, pp. 72-80.
- El Islami, R. A. Z., & Nuangchalerm, P. 2020, 'Comparative study of scientific literacy: Indonesian and Thai pre-service science teachers report, *Int. J. Eval. & Res. Educ.* vol, 9, no. 2, pp. 261-68.
- Endedijk, M. D., Brekelmans, M., Sleegers, P., & Vermunt, J. D 2015, 'in professional education: bridging the gap between event and aptitude measurements', *Quality & Quantity*. <https://doi.org/10.1007/s11135-015-0255-4>
- Fadhillah, N., & Faradina, S, 2016 'Hubungan Kelekatan Orangtua Dengan Kemandirian Remaja SMA Di Banda Aceh', *Jurnal Ilmiah Mahasiswa Psikologi*, vol. Az Zahro, et al
- Jurnal Penelitian dan Pembelajaran IPA
Vol. 8, No. 1, 2022, p. 74-90

- 1, no. 4, pp. 42–51.
- Guy, R., & Lownes-Jackson, M 2015, 'The Use of Computer Simulation to Compare Student performance in Traditional versus Distance Learning Environments. *Issues in Informing Science and Information Technology*', vol.12, pp. 95–109. <https://doi.org/10.28945/2254>
- Harlen, W 2013, 'Inquiry-based learning in science and mathematics. Review of science, mathematics and ICT education', *Review of Science, Mathematics and ICT Education*, vol. 7, pp. 9–33
- Hidayati, K., & Listiyani, E 2010 'Improving Instruments of Students Self-Regulated Learning', *J. Pendidik. Mat.*
- Hodson, D 2014, 'Learning Science, Learning about Science, Doing Science: Different goals demand different learning methods. *International Journal of Science Education*, vol. 36, no. 15, pp. 2534–53. <https://doi.org/10.1080/09500693.2014.899722>
- Honomichl, R. D., & Chen, Z 2012, 'The role of guidance in children's discovery learning, *Wiley Interdisciplinary Reviews: Cognitive Science*, vol.3, no.6, pp. 615–22. <https://doi.org/10.1002/wcs.1199>
- Isnawati, N., & Samian 2010, 'Kemampuan belajar ditinjau dari kreativitas belajar dan motivasi belajar mahasiswa'. *Journals.Ums.Ac.Id*, 1, pp. 128–144.
- Kamaruddin, M., & Ibrahim, S. I 2021. 'Diagnostik Item Kebolehgunaan Padlet dalam Mengaplikasi Model Trialogical Menggunakan Pengukuran Rasch', *Journal of ICT Jurnal Penelitian dan Pembelajaran IPA* Vol. 8, No. 1, 2022, p. 74-90
- in Education (*JICTIE*), vol. 8, no. 1, pp. 61–72.
- Komara, I. B. (2016). *Hubungan antara Kepercayaan Diri dengan Prestasi Belajar dan Perencanaan Karir Siswa*. pp. 5, no.1, pp. 33–42.
- Lee, C., Yeung, A. S., & Ip, T 2017, 'University english language learners' readiness to use computer technology for self-directed learning. *System*', vol. 67, pp. 99–110. <https://doi.org/10.1016/j.system.2017.05.001>
- Logan, M. R., & Skamp, K. R. 2013, 'The Impact of Teachers and Their Science Teaching on Students' "Science Interest": A four-year study', *International Journal of Science Education*, vol. 35, no. 17, pp. 2879–2904. <https://doi.org/10.1080/09500693.2012.667167>
- Micari, M., & Light, G 2009, 'Reliance to Independence: Approaches to learning in peer-led undergraduate science, technology, engineering, and mathematics workshops', *International Journal of Science Education*, vol. 31, no. 13, pp. 1713–41. <https://doi.org/10.1080/09500690802162911>
- Mnguni, L., El Islami, R. A. Z., Hebe, H., Sari, I. J., & Nestiadi, A 2020 'A comparison of the South African and Indonesian teachers preferred curriculum ideology for school science', *Curriculum Perspectives*, vol.40, no.1, pp. 3–13.
- Nuangchalerm, P., & El Islami, R. A. Z 2018, 'Comparative study between Indonesian and Thai novice science teacher students in content of science. *Journal for the Education of Gifted Young* Az Zahro, et al

- Scientists', vol.6, no.2, pp. 23-9.
- Oidov, L., Tortogtokh, U., & Purevdagva, E 2012, 'Virtual laboratory for physics teaching. *2012 International Conference on Management and Education Innovation*, vol. 37, pp. 319–23.
- Oktavera, S 2015, 'Pengaruh Media Pembelajaran Dan Kemandirian Belajar Terhadap Hasil Belajar Ipa Siswa Kelas Iv Sekolah Dasar. *Jurnal Pendidikan Dasar*, vol. 6, no. 2, pp. 312.
- Ott, L. E., Carpenter, T. S., Hamilton, D. S., & LaCourse, W. R. 2018. 'Discovery Learning: Development of a Unique Active Learning Environment for Introductory Chemistry. *Journal of the Scholarship of Teaching and Learning*, vol. 18, no.4, pp. 161–180.
<https://doi.org/10.14434/josotl.v18i4.23112>
- Parmin, P., Khusniati, M., El Islami, R. A. Z., Deta, U. A., & Saregar, A 2022, 'Online Scientific Argumentation Strategy on Improving Pre-Service Science Teachers' Scientific Reasoning through Experiment Activity: A Case Study in Indonesia, *Science and Education*, vol. 55, no.1, pp. 607-19.
- Parmin, P., Nuangchalerm, P., & El Islami, R. A. Z. 2019, 'Exploring the indigenous knowledge of Java North Coast Community (Pantura) using the science integrated learning (SIL) model for science content development. *Journal for the Education of Gifted Young Scientists*, vol.7, no.1, pp. 71-83.
- Pratiwi, I. D., & Laksmiwati, H 2016. Kepercayaan Diri dan Kemandirian Belajar Pada Siswa *Jurnal Penelitian dan Pembelajaran IPA* Vol. 8, No. 1, 2022, p. 74-90
- SMA Negeri “X.” *Jurnal Psikologi Teori Dan Terapan*, vol. 7, no.1,pp. 43.
<https://doi.org/10.26740/jppt.v7n1.p43-49>
- Rijal, S., & Bachtiar, S 2015, 'Hubungan antara Sikap, Kemandirian Belajar, dan Gaya Belajar dengan Hasil Belajar Kognitif Siswa. *Jurnal Bioedukatika*, vol. 3, no.2, pp. 15.
<https://doi.org/10.26555/bioedukatika.v3i2.4149>
- Rogers, Y 2008, 'The role of mobile devices in facilitating collaborative inquiry in situ. *Research and Practice in Technology Enhanced Learning*, vol. 3, no.3, pp. 209-29
- Saefullah, A., Siahaan, P., & Sari, I. M 2013, 'Hubungan Antara Sikap Kemandirian Belajar Dan Prestasi Belajar Siswa Kelas X Pada Pembelajaran Fisika Berbasis Portofolio, *WaPFI (Wahana Pendidikan Fisika)*, vol.1, no. 1, 26–36.
<https://doi.org/10.17509/wapfi.v1i1.4891>
- Sahin, A., Top, N., & Delen, E. (2016). Teachers' First-Year Experience with Chromebook Laptops and Their Attitudes Towards Technology Integration. *Technology, Knowledge and Learning*, vol. 21, no.3, 361–78.
<https://doi.org/10.1007/s10758-016-9277-9>
- Sarabando, C., Cravino, J. P., & Soares, A. A 2014, 'Contribution of a Computer Simulation to Students' Learning of the Physics Concepts of Weight and Mass', *Procedia Technology*, vol. 13, pp. 112–21.
<https://doi.org/10.1016/j.protcy.2014.02.015>
- Sarabando, C., Cravino, J. P., & Soares, A. A 2016, 'Improving student understanding of the concepts of
Az Zahro, et al

- weight and mass with a computer simulation, *Journal of Baltic Science Education*, vol. 15, no. 1, 109–126.
<https://doi.org/10.33225/jbse/16.15.109>
- Sinulingga, P., Hartanto, T. J., & Santoso, B 2016, 'Implementasi Pembelajaran Fisika Berbantuan Media Simulasi PhET untuk Meningkatkan Hasil Belajar Siswa Pada Materi Listrik Dinamis, *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, vol.2, no.1, pp. 57–64.
<https://doi.org/10.21009/1.02109>
- Sobri, M., & Moerdiyanto, M 2014, 'Pengaruh Kedisiplinan Dan Kemandirian Belajar Terhadap Hasil Belajar Ekonomi Madrasah Aliyah Di Kecamatan Praya. *Harmoni Sosial: Jurnal Pendidikan IPS*, vol. 1, no.1, pp. 43–56.
<https://doi.org/10.21831/hsjpi.v1i1.2427>
- Strand-Cary, M., & Klahr, D 2008, 'Developing elementary science skills: Instructional effectiveness and path independence. *Cognitive Development*, vol. 23, no.4, pp. 488–511.
<https://doi.org/10.1016/j.cogdev.2008.09.005>
- Sugianto, I., Suryandari, S., & Age, L. D 2020, 'Efektivitas Model Pembelajaran Inkuiri Terhadap Kemandirian Belajar Siswa Di Rumah', *Jurnal Inovasi Penelitian*, vol. 1, no.3, pp. 159–170.
<https://doi.org/10.47492/jip.v1i3.63>
- Tan, E 2013, 'Informal learning on YouTube: Exploring digital literacy in independent online learning', *Learning, Media and Technology*, vol. 38, no. 4, pp. 463–477.
- <https://doi.org/10.1080/17439884.2013.783594>
- Thoken, F., Asrori, & Purwanti, 2017, *Analisis Kemandirian Belajar Pada Siswa Kelas X*. 1–7.
- Vassallo, S 2011, 'Implications of Institutionalizing Self-Regulated Learning: An Analysis from Four Sociological Perspectives. *Educational Studies*' vol. 47, no.1, pp. 26–49.
<https://doi.org/10.1080/00131946.2011.540984>
- Widoyoko, E. P 2009, *Evaluasi Program Pembelajaran*, Pustaka Pelajar.
- Yuen, M. C., Koo, A. C., & Woods, P. C 2018, 'Independent learning of digital animation. *International Journal of Information and Communication Technology Education*, vol. 14, no. 4, pp. 107–120.
<https://doi.org/10.4018/IJICTE.2018100108>
- Zeidan, A. H., & Jayosi, M. R 2014, 'Science Process Skills and Attitudes toward Science among Palestinian Secondary School Students', *World Journal of Education*, vol. 5, no. 1, pp. 13–24.
<https://doi.org/10.5430/wje.v5n1p13>
- Zimmerman, B. J 2008, 'Investigating self-regulation and motivation: Historical background, methodological developments, and future prospects, *American Educational Research Journal*, vol. 45, no. 1, pp. 166–83.
<https://doi.org/10.3102/0002831207312909>