23 (2), 2022, 400-409

Jurnal Pendidikan MIPA

e-ISSN: 2550-1313 | p-ISSN: 2087-9849

http://jurnal.fkip.unila.ac.id/index.php/jpmipa/

Improving Problem Solving Skills of High School Students using Online Discovery Learning in Chemical Equilibrium

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Abstract: This research was aimed to describe the improvement of students problem solving skills through discovery learning and student readiness in online learning. This study is a quasi-experimental design using a nonequivalent pretest-posttest control group design. The population were all students of class XI MIPA SMAN 3 Bandar Lampung. The sampling technique used purposive sampling. Problem solving skills, student readiness in online learning were analyzed by independent t-test and correlation test. The results showed: (1) discovery learning is effective to improve problem solving skills on chemical equilibrium material; (2) there is a significant relationship between self-control and problem solving skills; (3) there is a significant relationship between the efficacy of using the internet in online learning with problem solving skills; (4) there is a significant relationship between self-control and the efficacy of using internet in online learning with problem solving skills.

Keywords: online learning, student readiness, problem solving skills, discovery learning.

Abstrak: *Tujuan penelitian adalah mendeskripsikan: peningkatan keterampilan pemecahan masalah siswa melalui pembelajaran discovery dan kesiapan siswa pada pembelajaran online. Penelitian ini merupakan kuasi eksperimen dengan menggunakan desain non-equivalent pretest-posttest control group. Populasi penelitian ini seluruh siswa kelas XI MIPA SMAN 3 Bandarlampung. Teknik pengambilan sampel menggunakan purposive sam¬pling. Data keterampilan pemecahan masalah, kesiapan siswa dalam pembelajran online dianalisis dengan uji t-independent dan uji korelasi. Hasil penelitian menunjukkan: (1) pembelajaran discovery efektif untuk meningkatkan keterampilan pemecahan masalah pada materi kesetimbangan kimia; (2) terdapat hubungan yang signifikan kontrol diri pada pembelajaran online dengan keterampilan pemecahan masalah; (3) terdapat hubungan yang signifikan efikasi menggunakan internet pada pembelajaran online dengan keterampilan pemecahan masalah; (4) terdapat hubungan yang signifikan antara kontrol diri dan efikasi mengguna¬kan internet pada pembelajaran online dengan keterampilan pemecahan masalah.*

Kata kunci: *pembelajaran online, kesiapan siswa, keterampilan pemecahan masalah, pembelajaran discovery.*

▪ INTRODUCTION

Twenty-first century is closely related to the rapid and disruptive development of science and technology. One of the effects is that there are more and more complex problems faced by humans. In this era who is successful and able to survive is someone who is able to think critically, think creatively, communicate, and collaborate to solve a problem at hand (Triling & Fadel, 2009). To solve a problem, a *problem solver* is not enough to rely on knowledge alone, but must be able to comprehensively understand the elements involved and their relationship to one another. Then plan a solution, implement, and evaluate related actions in solving the problem (Polya, 1973). This relates to problem solving skills.

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DOI: http://dx.doi.org/10.23960/jpmipa/v23i2.pp400-409

Received: 14 May 2022

Accepted: 11 June 2022

Published: 13 June 2022

Problem solving skills have become the focus of attention of a number of researchers (Schwab, 2016; Fadiawati, Diawati, Meidayanti, & Syamsuri, 2019; Alias, Ikhsan, Nawawi, & Nawawi, 2020) and make a person able to adapt and survive (Norman, 1988) . A problem solver who has problem solving skills is able to think critically and analytically as well as form mental abilities and beliefs to arrive at conclusions that successfully overcome all kinds of problems (Schwab, 2016; Alias, Ikhsan, Nawawi, & Nawawi, 2020). Problem solving skills are closely related to thinking skills where these skills are one of the main goals of education (Permendikbud, 2016). Herron (1996) mentions that teaching problem solving and problem solving skills is at the heart of chemistry learning and research in the field of chemistry education. Problem solving skills in learning are needed by students to solve various kinds of problems given by the teacher in their daily lives (Ismawati, 2014; Fadiawati et al., 2019).

Problem solving skills are skills that can be trained and developed. Therefore, the learning carried out by the teacher must make students actively seek, process, construct, explore to gain new understanding which will be used comprehensively to solve a problem at hand. However, the reality on the ground shows that current chemistry learning is generally only emphasized on mastery of concepts (Sudarmin, 2009; Syamsuri, Fadiawati, & Kadaritna, 2013). The Trends in International Mathematics and Science Study (TIMSS) and Program for International Student Assessment (PISA) in 2015 is one indication. Indonesia is ranked 44th out of 47 countries in the 2015 TIMSS results (IEA, 2019; NCES, 2019). The 2015 PISA results also inform that Indonesia is ranked 69th out of 76 countries (OECD, 2018). Indonesia's low score on TIMSS and PISA is because the questions tested are contextual questions related to problems in everyday life that require reason, argumentation, and creativity in solving them (IEA, 2019; NCES, 2019; OECD, 2018). The questions in PISA are highly dependent on problem solving skills (Puspendik, 2016).

Instilling thinking and problem-solving skills in chemistry learning requires changes in learning methods and environments (Diawati, Fadiawati, & Herlina, 2019). Discovery learning is an example of a strong learning environment in the contemporary educational paradigm and is recommended to be applied as a consequence of the issuance of Permendikbud No. 20 of 2016 (Permendikbud, 2016). With discovery students are given stimulation or stimulation by being faced with problems or phenomena encountered in students' daily lives. Furthermore, students are asked to identify the problem, collect data to prove through an experiment and then process it so that conclusions can be drawn.

learning Online was first recognized because of the influence of the development of electronic-based learning (e-learning) which was introduced by the University of Illinois through a computer-based learning system (Riyana, 2019). E-learning refers to the use of information and communication technologies to assist in the development and acquisition of knowledge from various locations. E-learning uses the internet and communication through video, audio and text through software to create a learning environment (Basilaila & David, 2020). Discovery Learning is learning that is developed based on the constructivism view. Meanwhile, online learning contributes to the constructivist and observational aspects of learning, which allows students to expand their knowledge outside the classroom by conducting experiments and investigations independently (Siemens and Tittenberger, 2009). This means, discovery can be carried out with online learning.

The success of the learning process is influenced by internal factors and external factors. If these factors can be overcome, then the learning process takes place well, so that the resulting learning outcomes are also good. One of the internal factors is the readiness of students to learn. Students are said to be ready if they are willing to respond or act in learning that arises from within (Slameto, 2015). Readiness of students in online learning, means that students are ready in terms of knowledge of technology use, self-management and social. Indicators of student readiness in online, namely self-efficacy in using the internet/computer, independent learning, student control (self-control), learning motivation, and self-efficacy in online (Hung, Chien, Chen, & Own, 2010; Chung, Norlina, & Vloreen, 2020). Based on the aforementioned background, the improving of problem solving skills of high school students through online discovery learning need to be analyzed.

▪ METHOD

The population in this study were all students of class XI MIPA SMAN 3 Bandarlampung in the 2020/2021 academic year. The sampling technique used was purposive sampling. This study is a quasi-experimental design using a nonequivalent pretest-posttest control group design (Fraenkel, Wallen, & Hyun, 2012) and correlation analysis. Research instruments include: 1) test instruments (pretest and posttest) problem solving skills;learning online learning online; 3) student worksheets on discovery learning. Students in both the experimental and control classes were given a pretest of problem-solving skills. Furthermore, the students were given chemistry learning treatment through online. The experimental class uses discovery and the control class uses conventional learning. During online, activities are accessed using observation sheets.learning online via google form link. Data on problem solving skills, data on student readiness (self-efficacy in using the internet/computers, student self-control) in online obtained were then processed and analyzed descriptively and statistically. The improvement of problem solving skills was carried out by the t-independent n-gain test of problem solving skills which was carried out at a significance level of = 0.05.learning online and improving problem solving skills through discovery tested product moment correlation and multiple correlation tests using SPSS version 16.0 for windows.

▪ RESULT AND DISSCUSSION

The research data obtained are: (1) pretest and posttest scores of problem solving (2) students' self-control during online learning; (3) self-efficacy of using computer/internet in online learning. The data that has been obtained is then processed with the help of SPSS software version 25.0 for Windows and Microsoft Office Excel.

Average n-gain

Based on the research conducted, the average *n-gain* of students' problem solving skills in the experimental class and control class is presented in Figure 1.

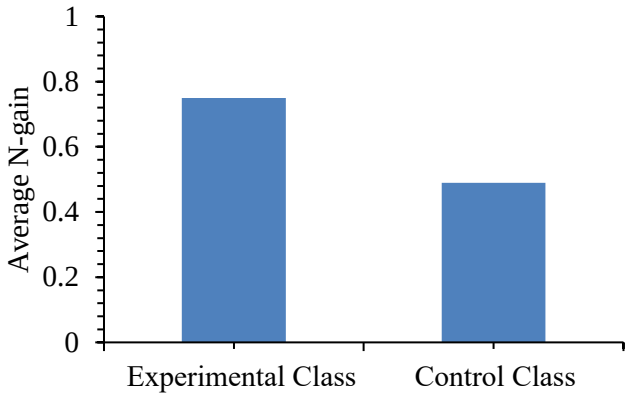

Figure 1. The average *n-gain* of students' problem solving skills

In Figure 1 obtained information that the average value of *n-gain* of students' problem solving skills in the experimental class is in the high category and the control class is in the medium category. This shows that the problem solving skills of students obtained by the experimental class are higher than the control class. To find out the significant difference *in n-gain* , a difference test of the two mean *n-gains*.

Test of the difference between the two averages n-gain

Before testing the difference between the two averages of n-gain, normality and homogeneity tests were carried out first. The normality test was tested using the Kolmogrov-Smirnov test with a significance level > 0.05. Sig. Kolmogrov-Smirnov test of normality for the experimental class 0,200 and the control class 0,063; sig value. > 0.05 so that the decision to accept H0 and H1 is rejected, which means that the research data obtained came from a population with a normal distribution. The homogeneity test was tested using the Levene Statstic with a significance level > 0.05. results SPSS 25.0 outputhomogeneity test of variances experimental and control classes was 0.949, so the decision was taken to accept H0 and reject H1 which means that the research data obtained has a homogeneous variance. Averages n-gain examined using parametric statistical tests, namely by using the Independent Samples T-test. Results sig. (2-tailed) t-test for equality of means 0.000 experimental class and 0.000 control class; sig. < 0.05, so the decision to reject H_0 and accept H_1. The average n-gain in the experimental class using the guided discovery is higher than the average n-gain in the control class with conventional learning. That is, there is a significant difference in the mean n-gain between the control class and the experimental class.

Correlation test

Three data were tested for normality, namely student self-control data (X1), internet efficacy data (X2), and problem solving skills data (Y). Normality test using SPSS version 16.0 for windows. Normality test results, sig. Kolmogorov-Smirnov , the three data are greater than 0.05, namely 1.203, so it can be stated that the student self-control data, internet-using efficacy data, and problem-solving skills data are normally distributed. The linearity test was conducted to determine whether the data formed a linear regression or not. If the data is linearly regressed, then the correlation and multiple correlation tests can be performed. Linearity test results, X_1* Y sig value 0.444; X_2*Y sig value 0.080. sig

value. of the two variables (X_1 to Y and X_2 to Y) is greater than 0.05 which means accept H_0, namely the regression data model in the form of regression. Because it meets the assumption of linearity, the correlation test can be performed. The multicollinearity test was conducted to determine whether or not there was a disturbing correlation between the independent variables. Multicollinearity test as a prerequisite to perform multiple correlation test. The results of the multicollinearity test are the variables X_1= 1.832 and X_2= 1.832, the VIF value of the X_1 and X_2 is less than 10, so there is no collinearity between the independent variables. This indicates that multiple correlation tests can be performed on research data.

The results of the calculation on the self-control variable, namely the value of Sig. smaller than 0.05, i.e. 0.000, then the decision is to accept $H1_{which}$ means that there is a significant relationship between students' self-control on students' problem-solving skills. The correlation coefficient value is 0.869, the correlation between the two is very strong with a positive correlation direction. In the efficacy variable using a computer/internet, the value of Sig. smaller than 0.05, which is 0.000, then the decision is to accept $H1_{which}$ means that there is a significant relationship between the efficacy of using the internet on students' problem-solving skills. The correlation coefficient value is 0.657, the correlation between the two is in the strong category with a positive correlation direction.

Multiple correlation test

Multiple correlation test was conducted to see whether there is a significant relationship between self-control and efficacy using computers/internet on problem solving skills simultaneously (simultaneously). Multiple correlation test results show the value of Sig. < 0.05 i.e. 0.000; this means that H_1 accepted, namely self-control and efficacy of using the internet in *online* have a significant and significant effect on students' problem solving skills. The R value is 0.86, the criteria for the relationship between the two independent variables and the dependent variable are very strong. In addition, the R Square value obtained is 0.749, this means that 74.9% of students' problem solving skills are influenced by self-control and efficacy using the internet.

Improvements of problem solving skills through online discovery learning

In the learning process using students' worksheet with discovery on the material factors that influence the direction of the shift in chemical equilibrium in the experimental class includes 6 stages, namely: 1) Giving stimulation (stimulation), 2) Identification of problems (problem statement), 3)data collection, 4)data processing, 5)verification, 6)generalization. With this syntax, students' problem solving skills can be trained. Based on the results of the difference test of the two average n-gains of the experimental class and the control class, there is a significant difference, the average n-gain of problem solving skills of experimental class students is higher than the control class, because the experimental class applied discovery learning model. Why this can happen will be discussed in a step-by-step process.

a. Stimulation

At this stage students observe the discourse given by the teacher as contained in the students' worksheet and in its implementation students are guided to read and understand the discourse given and the teacher guides students in arousing curiosity and occasionally

the teacher associates current knowledge with previous knowledge. At this stage students are trained in problem solving skills, namely being able to understand problems and ask questions related to the given discourse. For example, in students' worksheet 1, students observed a discourse about solutions containing $Fe(SCN)_6^{3-}$ at first and after being given different solutions ($FeCl_3$, KSCN, and NaOH). When students read and observe the discourse, the teacher guides students to arouse students' curiosity by asking "Is there anything asked from the discourse?". There were several groups who asked the question "why the color can be different ma'am?", "what affects the color change of each solution ma'am?".

b. Problem statement

At this stage students are directed to be able to identify and find problems from the given discourse so that students can formulate problems and hypotheses. At this stage pro

blem solving skills that can be trained to students are able to write down information or problems contained in the discourse that has been given.

c. Data collection

At this stage students collect the information needed by making observations. Problemsolving skills that can be trained to students are having a strategy to be able to solve the given problem. For example in students' worksheet, at this stage, students observe the animation of the effect of temperature on the direction of the shift in chemical equilibrium. After that, students write down the information obtained from the animation in the table of observations.

d. Data processing

In the data processing stage, students answer the questions in the students' worksheet according to the data that has been previously collected, so that they can test the hypothesis they formulated is true or false. For example, in the students' worksheet, after observing the animation of the effect of temperature on the direction of the shift in equilibrium, students answered questions that led students to find concepts. At this stage students are trained to be able to solve problems with previously obtained data.

e. Verification,

Based on the results of data processing and interpretation, students check carefully whether the proposed hypothesis is acceptable. At this stage, students are also given the opportunity to find new knowledge based on problems solved using the knowledge they have.

f. Generalization

At this stage, students draw the conclusions they have obtained based on data processing and hypothesis testing. The stage of drawing conclusions can train evaluation skills by connecting all the information that has been obtained in order to get the right conclusions.

The relationship between students' self-control in online and problem solving skills

The results of the Spearman Rank correlation test show a significant relationship between students' self-control in carrying out online and problem solving skills, where the correlation coefficient value is 0.869. The relationship between self-control and problem-solving skills, when viewed from the interpretation of the value of the correlation coefficient with criteria is very strong. The results of this study are in accordance with another study conducted by Patty et al., (2016), entitled "The Relationship of Peer Social Support, Self-Control, and Gender with Student Achievement", which concluded that self-control has a significant relationship with achievement. study. The results of this study indicate the relationship between self-control and problem-solving skills is positive.learning online good, then students' problem solving skills are also good, resulting in satisfactory learning outcomes. This is in accordance with the research of Sari et al., (2017) namely, "Student Self-Control in Learning and Perception of Counseling Teacher's Efforts to Improve Self-Control", students who are able to control themselves in learning will display positive behavior and lead to consequences which is also positive.

Learning that is done online makes teacher supervision during learning less than optimal, even parents cannot always accompany and be patient when accompanying children in carrying out online. These are some of the obstacles to online, as in the research conducted by Anugraha (2020), entitled "Barriers, Solutions, and Hopes: Online Learning During the Covid-19 Pandemic". All parties must try to present conditions that are able to make online effective, one of which is the students' efforts to control themselves. Students who can control themselves will have discipline and motivation to achieve learning targets. The student will direct positive behaviors to achieve satisfactory learning achievement. The internet and computers/devices are the main tools needed for online. There are many things that students can do when they open the internet through their computers/devices, such as games, videos/films, youtube, social media (instagram, twitter, tiktok, etc.). Students will very easily open these applications during learning, because the level of online certainly not as strict as when learning at school and it is also not easy for teachers to find out whether the student is following the learning process well or not. These things can be a factor in reducing student achievement if students do not have good self-control.

The relationship of efficacy using the internet in online with students' problem solving skills

Self-efficacy is a student's belief in his ability to achieve goals (Yonnita et al., 2016). Efficacy using the internet means students' confidence or trust in their capabilities in using computers to perform assigned tasks (Wiratama & Rahmawati, 2013). Student efficacy questionnaire data were analyzed using the Spearman Rank, the result was the correlation coefficient value of 0.657. This shows that there is a significant relationship between the efficacy of using the internet on students' problem solving skills. If the value of the correlation coefficient is interpreted, it shows a strong criterion between the efficacy of using the internet and problem solving skills. Positive correlation coefficient value indicates a positive relationship. It means that if the student's efficacy is good, the students' problem solving skills are also good.

The efficacy of using the internet is one of the important factors for students when learning at school using the e-learning. This is concerned with how students take online

and do their assignments, which are mostly in the form of documents, power points, and even video assignments. Students must also use websites or applications that have never been used or at least rarely used in learning. The ability of students to use the internet is also very necessary to find sources other than those given by the teacher to increase learning outcomes. This is in accordance with the research conducted by Wiratama & Rahmawati (2013) entitled "The Influence of Information Quality, Perception of Usefulness, and Computer Self Efficacy on the Use of the Internet as a Library Source", where the results of the research are that there is a significant and positive influence between computer self-efficacy on the use of the internet as a source of literature with the power of influence of 63.4%.

The relationship between self-control and the efficacy of using the internet in online on problem solving skills Students'

Self-control and efficacy using the internet are included in aspects of student readiness in online (Hung et al., 2010; Chung et al., 2020). This is in accordance with the research results obtained. Using multiple correlation test, it can be seen that self-control and efficacy of using the internet have a significant effect on students' problem solving skills, even the criterion of 0.865 indicates a very strong relationship. Based on the results of the study, it can also be seen that self-control and efficacy using the internet have an effect of 74.9%, so it can be predicted that if students have self-control and efficacy using the internet when studying in class or independently, then these students can understand the concept of chemistry well. also. This is also in accordance with what was expressed by Slameto (2015) that learning readiness is one of the important factors in the success of student learning. If students prepare themselves to carry out learning, students will respond or react so that students achieve satisfactory learning outcomes. So that if students control themselves well and have high efficacy when using the internet, it is expected that students can master the concepts of chemistry and can improve problem solving skills

▪ CONCLUSION

Based on the results of the analysis and discussion in the study, it can be concluded that: (1) the gain in problem solving skills of students who applied discovery is higher than the average n-gain of the control class on chemical equilibrium material; (2) Learning by using discovery is effective to improve problem solving skills on chemical equilibrium material; (3) There is a significant relationship between self-control in online and problem solving skills; (4) There is a significant relationship between the efficacy of using the internet in online with problem solving skills; (5) There is a significant relationship between self-control and efficacy using computers/internet in online with problem solving skills.

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