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The Effectiveness of Online Learning in Solubility and Solubility Product Constant Materials on Students' Analytical Thinking Skills

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Abstract. Analytical thinking skill is a part of higher order thinking skills. The ability to think analytically is very important for students who want to help solve problems and make decisions that can be applied in learning and life. This study aims to determine the improvement of students' analytical thinking skills on the material solubility and solubility product which is carried out in online learning during the Covid-19 pandemic. This study uses a pre-experimental design, with the model The One Group Pretest – Posttest. The population of this study was students of class XI IPA SMAIT Insantama Bogor in the even semester of the 2019/2020 school year. The data were collected by using the thinking instrument skill test which was used in the form of an analytical thinking ability essay covering 3 indicators: distinguishing, organizing, and attributing. The results showed the dominance of students' analytical thinking skills at the beginning of the period with the average majority (44%), and after treatment, increased in the very good category (74%). The N-gain score for the results of increasing students' thinking skills is 0.70, which is in the high category. This study concludes that online learning in the material of solubility and solubility results proved to be effective in improving students' analytical thinking skills during the pandemic.
Keywords: online learning, solubility and solubility products constant, analytical thinking skills

Introduction

Learning is an attempt to influence someone, both in terms of emotional, intellectual, and spiritual. In a learning process, an educator must be able to build and develop various abilities of students (Syahputra, 2018). The learning process must be able to prepare students with a variety of skills, especially in dealing with life in the 21st-century. The skills that must be mastered by students amid the development of digital information and technology-based society today include critical thinking and problem-solving skills, creativity and innovation, collaboration skills, and communication skills (Zubaidah, 2018; Sugiyarti, et al., 2018; Redhana, 2019). The mastery of technology, information, and communication literacy is also important to successfully face increasingly complex life challenges.

The preparation of students who can master a variety of skills, especially thinking skills, has been accommodated in the 2013 curriculum. One of them is through a standardized process, educators are required to apply a scientific and contextual approach to learning. Each learning process is oriented towards students, equipped with activities to

observe, ask, process, present, conclude, and create (Dawati, et al., 2015). Unfortunately, its implementation on the ground still faces many challenges. Much learning in schools is centered on teachers who apply conventional methods in their learning (Annisa, et al., 2016; Qomariya, et al., 2018; Widiastuti, 2019). This has become one of the reasons why students are not active in learning in class. The lack of active students in learning in the classroom resulting in low thinking skills of students in the learning process (Naswir, et al., 2016).

One of the thinking skills needed by students in this modern era is analytical thinking (Mirzaei, et al., 2014). Someone who has analytical thinking skills will easily solve the problems faced with optimal results (Assegaff & Sontani, 2016). Analytical thinking skills include higher-order thinking skills (Anderson & Krathwohl, 2001; Sartika & Nuroh, 2017). Montaku, et al. (2012) suggested that analytical thinking is thinking about grouping into several parts. Analytical thinking skills are the skills of dividing and breaking down a problem into its parts and connecting its components (Yaumi, 2013). The process of analyzing includes the ability to distinguish, organize, and attribute (Astriani, et al., 2017). These skills play a role in helping students solve problems while making decisions that can be applied in learning and life. Unfortunately, only 5% of Indonesian students have analytical thinking skills. Most Indonesian students still think at a low level, namely memorization (Sartika & Nuroh, 2017).

Analytical thinking skill that is not well-trained is thought to be due to the lack of providing questions in the form of analysis. The analytical questions require informative descriptions, finding assumptions that distinguish facts and opinions, as well as cause and effect findings (Assegaff & Sontani, 2016). Analytical questions can make it easier for students to solve problems. During this time, learning has been carried out to improve analytical thinking skills, including through the application of problem-based learning models (Ware & Rohaeti, 2018), guided inquiry learning models (Annisa, et al., 2016), integrated science learning based on science process skills (Sartika & Nuroh, 2017), pictorial riddle method in guided inquiry learning (Qomariya, et al., 2018), cooperative problem solving and group investigation (Widiastuti, 2019). All learning approaches to improve analytical thinking skills are carried out in a face-to-face period.

The COVID-19 pandemic period is a challenge for the ongoing learning process. This is because during the pandemic, following circular number 4/2020 by the Ministry of Education and Culture regarding the Implementation of Education Policy in the Emergency Spread of COVID-19, establishing the educational process from pre-school to university level was carried out from home. This requires adjustments in the learning process so that it can still achieve the learning objectives, including forming analytical thinking skills, even if done from home, which is mostly done through the online process. Beyond the various challenges faced in online learning during the pandemic, especially related to the readiness of online learning facilities that are still minimal (Arifa, 2020; Allo, 2020; Zhang, et al., 2020), if utilized properly shifts the learning process towards the use of this technology will be beneficial for the integration of educational technology in the future, especially related to the needs of digital literacy in the 21st century (Sandars, et al., 2020; Zhou, et al., 2020).

The development of 21st-century skills can be carried out in all disciplines, including chemistry. Chemistry studies natural phenomena that arrange concepts, theories, and laws that can be reused to explain various phenomena that occur in nature. In explaining this natural phenomenon, chemistry links three levels, namely macroscopic, microscopic, and symbolic (Gabel, 1998). With these characteristics, chemistry is best used as a tool for developing 21st-century skills. One of the characteristics of chemistry is abstract concepts, and analytical skills are needed to support the learning process of abstract and concrete material. Chemistry allows students to understand the phenomena that occur around them.

Materials of solubility and solubility product constants are two of the chemistry materials that still considered difficult. This is because this material requires an understanding of concepts, mastery of related prerequisite material, abstract formulas, and applications into mathematical calculations to solve problems (Nomilasari, 2019; Hesti, et al., 2019; Fitriani, et al., 2019). Viyandari, et al. (2012), Ulfah, et al. (2016), and Sudiana, et al. (2019) state that the factors that cause students difficulty in learning the solubility material and the solubility product constant can be derived from internal and external factors. Internal factors, such as interest and motivation to learn chemistry are low, the meaning of students' concepts of material and prerequisite material is low, students' ability in mathematical operations is weak, students' inability to associate their knowledge and experience with actual concepts or scientific concepts. While external factors include the teacher and the environment, the negative influence of peers, and the way the teacher teaches.

Solubility material and solubility product have been taught in various models and methods, such as the Think Pair Share (TPS) model (Surianti et al., 2016), use of simulation virtual lab media PhET (Physics Education Technology) with experiment method (Marlinda, et al., 2016), Problem Based Learning models (Nelli, et al., 2016, Nomilasari et al., 2019) and team assisted individualization cooperative learning models equipped with worksheets (Sari et al., 2018). The learning model used must be appropriate so that it can be developed to train students' thinking skills (Kurniastuti, et al., 2018). Improving students' thinking skills, including analytical thinking skills, must be pursued even through online learning. This research is expected to be able to find an effective learning approach during the learning process from home during the pandemic by still paying attention to the achievement of the formation of students' thought processes so that educational goals can be achieved.

Methods

This study uses a modification of the pre-experimental design, with the model of The One Group Pretest - Posttest (Desyanti et al., 2018). The sample consisted of 50 students enrolled in class XI at SMA Insantama Bogor in the 2019/2020 school year. This model was chosen by considering the adjustment of learning time during the pandemic period which was reduced to reduce the learning burden of students from home. Besides, research was also conducted following the theme of ongoing lessons, so that the selection of this method will not interfere with the learning process but is considered to be able to support learning objectives following the intended research objectives.

The pretest was done in this research. The treatment given was in the form of online learning and posttest. Chemistry learning of solubility and solubility product constant was done online through the WhatsApp group. The first period of online learning was done through material explanation and discussion in the form of text in the WhatsApp group. After the first period of online learning, students were given questions as a pretest. In the next period of online learning, in addition to discussion in the form of text, students were welcome to increase their understanding of learning material through online media independently. Posttest questions were given in the form of 5 problem descriptions with material like pretest questions about solubility and solubility product constant which were done and collected through Google Form.

The instrument used to measure students' analytical thinking skills was the test item. Test questions were in the form of a description of 5 questions, covering the three indicators of analytical thinking, namely differentiating, organizing, and attributing. The data obtained were analyzed and rated according to the skills assessment rubric (Aprilia & Ramlah, 2019) in Table 1.

Table 1. Assessment Rubric of Analytical Thinking Skills

Indicator	Descriptions	Score
Differentiating	Students can describe problems by writing down what they know and what they will solve	3
	Students are only able to write down what is known or what will be solved in describing the problem	2
	Students describe the problem incorrectly	1
	Students do not answer	0
Organizing	Students can identify problems that are known and link them to the theory being studied	3
	Students can identify problems that are known but do not link to the theory being studied	2
	Students identify problems incorrectly	1
	Students do not answer	0
Attributing	Students can solve problems and provide conclusions	3
	Students are only able to solve problems	2
	Students solve problems incorrectly	1
	Students do not answer	0

Scores are calculated from each student on the given pretest and posttest, with the following formula:

$$Score = \frac{Total\ of\ obtained\ score}{Maximum\ score} \times 100 \qquad (1)$$

The results of the analytical skills test are categorized using the analysis skills assessment criteria modified by Purbaningrum (2017), as in Table 2.

Table 2. Criteria for Assessing Students' Analytical Skills

Score	Analysis Skill Level
80 ≤ Score ≤ 100	Very good
60 ≤ Score < 80	Good
40 ≤ Score < 60	Average
20 ≤ Score <40	Poor
0 ≤ Score < 20	Very poor

The effectiveness of the learning treatment carried out is measured by calculating and comparing the average score of achievement (gain) after the pretest and posttest. Analysis of student learning outcomes is done by calculating the score of N-gain. Competency improvement that occurs before and after learning is calculated with the following formula:

$$N - gain = \frac{Spost - Spre}{Smax - Spre} \quad (2)$$

Spost is a score obtained by students at the posttest, while Spre is a score obtained by students at the time of a pretest. The difference between the posttest and pretest scores compared to the Smaks difference (maximum score set) with the pretest scores will result in an N-gain score. The N-Gain interpretation is presented in Table 3.

Table 3. Classification of N-Gain Interpretations

Percentage	Interpretation
g > 0,7	High
0,3 < g < 0,7	Medium
g < 0,3	Low

Results and Discussion

Chemistry learning activities for solubility material and solubility products are carried out from home during the online pandemic using the WhatsApp group. Data regarding students' analytical thinking skills in solving the question about solubility and solubility product constant, one of which is given are as follows:

A total of 100mL of MgF_2 saturated solution at 18°C was evaporated, so that the MgF_2 precipitate was obtained as much as 1.24 grams. If it is known that Ar Mg = 24 and Ar F = 19, calculate the product of MgF_2 solubility at that temperature!

Data on the results of student work are analyzed and the level of analytical thinking skills described following the indicators specified. Examples of assessments and descriptions of student work results are shown in Figure 1 and Figure 2.

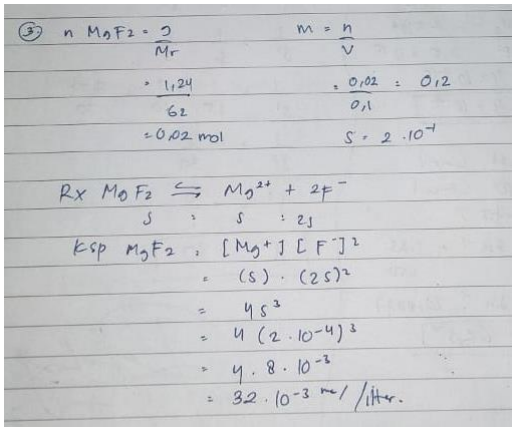

Figure 1. Assessment of students' analytical thinking skills subject 1 (S-1)

Based on the answers written above, it can be seen that subject 1 (S-1) has not been able to describe the problem correctly through the description of the problem by writing down what is known and what will be solved, which shows S-1 does not have the skills to differentiate. In this answer, it can also be seen that S-1 has not been able to identify all the problems, such as incorrectly writing equilibrium constant equations, but has been able to relate to the theory studied by calculating moles and solubility first. In attributing indicators, S-1 has been able to solve the problem but does not provide conclusions.

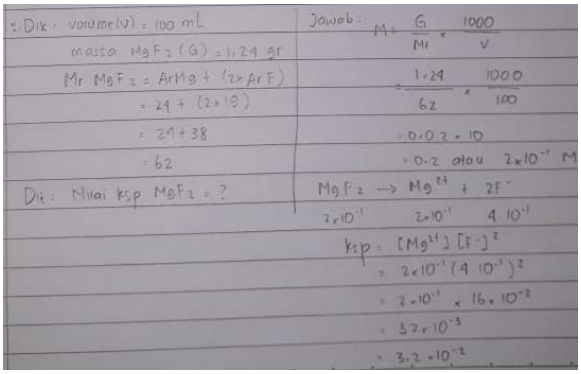

Figure 2. Assessment of students' analytical thinking skills subject 2 (S-2)

Based on the answers written above, it can be seen that subject 2 (S-2) can write down what is known in advance and what is asked in full. In this answer, S-2 fulfills the differentiating indicator, which can describe the problem of what is known and what will be resolved. S-2 is also able to identify known problems and relate them to the theory being studied. Connecting data that is known to find the desired answer, ranging from calculating the relative mass of the molecule, counting the mole, and the solubility of the compound. This shows that organizationing skills are also good. But for the fulfillment of attributing indicators, S-2 is only able to solve problems and not provide conclusions.

The results of students' analytical thinking skills are obtained from the pretest and posttest scores, which can be seen in Table 4.

Table 4. Pretest and Posttest Results of Students' Analytical Skills

Criteria	Pretest		Posttest	
	Frequency (N)	Percentage	Frequency (N)	Percentage
Very good	5	10	37	74
Good	9	18	13	26
Average	22	44	0	0
Poor	11	22	0	0
Very good	3	6	0	0
Total students	50		50	

Based on Table 4, it can be seen that the results of the pretest show that in the first period of learning, the majority of students have the analytical thinking skills on average criteria (44%), while the posttest results showed an increase in analytical thinking skills to be dominated by very good criteria (74%).

The improvement of analytical thinking skills that occurs in students shows the ability of students to understand and solve problems well. The achievement of differentiating indicators can be seen when students can sort out the relevant parts of the information provided. Through the questions given students can describe the problem by stating what is known and what will be solved, for example by distinguishing solutes from solutions as a basis for determining concentration. The achievement of organizing indicators is indicated by that most students are able to identify problems and relate them to the theory being studied. Connecting known data to find the desired answer, starting from calculating the relative molecular mass, calculating moles, and compound solubility. This shows that the organizational skills are good. Meanwhile, the achievement of attribution indicators is

shown by students being able to solve problems and provide conclusions. Solving the problem to the end means getting the results you are looking for, then concluding the results obtained.

In an effort to improve analytical thinking skills, students should be encouraged to find appropriate techniques in organizing knowledge to be learned. Any learning that encourages students to develop thinking skills can improve their learning achievement as well (Siribunnam & Tayraukham, 2009; Irwanto, et al., 2017). Training students' analytical thinking skills also means training students to think at higher levels. This is because problem solving ability is one of the best ways to train students to think, analysis, synthesis and evaluation, which are considered high-level cognitive skills (Zahriah, et al., 2016).

The N-gain test is conducted to see the results of online learning while learning from home based on an increase in students' analytical thinking skills. The results are presented in Table 5.

Table 5. N-Gain Score

	Average score of pretest-posttest score	Average of max. score-pretest score	N-gain	Criteria
Test class	35,7	51,9	0,70	High

N-gain score that can be seen in the table above is equal to 0.70. This score is in the high criteria. The score of N-gain which is still between the medium and high limits shows that there are still challenges that must be solved in increasing the effectiveness of online learning in the learning process from home during the pandemic seen from the increase in students' analytical thinking skills.

Online learning during the pandemic is done through the use of a text-based discussion forum, WhatsApp Group. The online learning process is carried out through a scientific approach by following 5 steps, namely observing, asking questions, gathering information/trying, reasoning or associating, and communicating. Supporting video material is done in the step of observing and gathering information or trying. The learning facilities used are one of the factors that determine the success of online learning. While online, learning activities are relatively monotonous, just providing material and collecting assignments, affects the effectiveness of online learning (Handayani, 2021). In carrying out online learning, teachers are required to improve the ability to use software and learning applications in order to increase students' independence and creativity (Fajriana, 2021).

The results of the pretest show students' analytical thinking skills are still not good because students still do not understand the concept as a whole so they have not been able to detail the problem and get the answer to the problem correctly. This is in line with the results of research conducted by Qomariya, et al. (2018) which states that students can be said to have analytical thinking skills if the student can break down a problem into parts and understand the relationship of these parts. Analytical thinking skills relate to differentiating, by sorting out information through the activity of writing down what is known and asked, organizing by identifying the main ideas of the problem and connecting with known theories, and attributing namely solving problems correctly and including conclusions (Aprilia & Ramlah, 2019). Students' analytical thinking skills on solubility and solubility product constant materials are already in the very good category. This shows that students already have good analytical skills, namely sorting or deciphering information, identifying and connecting, and completing with the right steps. The use of a scientific approach can help direct students to think analytically. Moreover, online learning allows

students to access unlimited learning tools from the internet, to increase student understanding of concepts through digital literacy. This is evidenced by an increase in students' analytical thinking skills after the second period.

Even the N-gain of 0.70 is in the high category, but it still needs improvement in learning. Effectiveness during online learning is influenced by many factors. Not all educators and students are ready to face online learning. During the online learning process, students feel forced to learn distance learning. The culture of distance learning is not yet formed so it takes time to adapt to change. The long absence of school activities with all the interactions has the opportunity to increase the level of saturation (Purwanto, et al., 2020). Not all educators can take advantage of supporting devices for online learning activities. Teacher competence in using technology also affects the quality of online learning that is carried out during the study period from home. The absence of a culture of distance teaching causes educators to adapt, especially to the saturation of the situation due to limited communication and interaction with students. Various limitations that occur as an impact experienced by students has the potential to affect the absorption of learning. In general, the impact of a pandemic experienced by education practitioners can affect the quality of online learning that occurs.

Conclusion

Based on the research results, it is known that online learning during the pandemic period on the solubility and solubility product constant materials can be conducted effectively. The dominance of students' analytical thinking skills at the beginning of the period was average (44%) and after treatment increased in the very good category (74%). Effectiveness is seen based on an increase in student learning outcomes as indicated by the score of N-Gain from the sample class that is equal to 0.70 (high category). Even though it has been considered effective, the online learning process still needs to be improved to further enhance student involvement in a fun learning process amid the pressures of the learning process from home during the pandemic.

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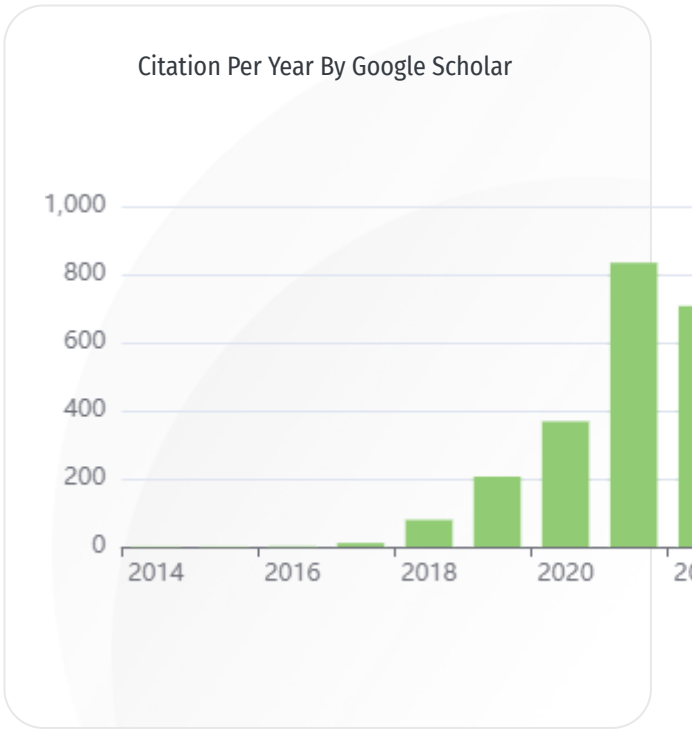

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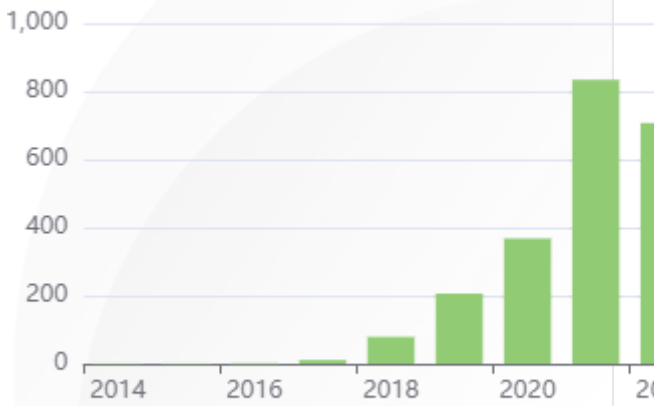

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CHARACTERISTICS OF CHEMISTRY TEACHING MATERIAL VOLTAIC CELLS ON STUDENTS' CREATIVITY AND CONCEPT MASTERY

Giyanto Giyanto, Bibin Rubini, Leny Heliawati

Abstract

This study aims to find the characteristics of chemistry teaching material used by 16 teachers on the concept of voltaic cells in vocational high schools. The characteristics of teaching material accommodate 21st-century learning which includes the accuracy of the contents, the accuracy of the scope, the updating of the material, the comprehensibility of the text, the use of the language, and the use of the illustrations. The research identifies student competency profiles that are indispensable in 21st-century learning, namely creativity and concept mastery. The subject of the research is teaching material used by 16 chemistry teachers in 16 vocational high schools with 95 students studied. Data were collected using observation sheets, product creativity questionnaires, and tests of students' concept mastery. The data obtained were analyzed using a quantitative descriptive method. The results show that the teaching materials used in learning had not used an approach that encouraged creativity and learning outcomes for students. This resulted in low creative-thinking ability at a rate of 27.03% and in low mastery concept showed from the mean of learning outcomes at a score of 22.4 from a maximum score of 100. The study concludes that the characteristics of chemistry teaching material voltaic cells are not under the demands of the characteristics of 21st-century learning in the aspect of the content.

Keywords

Teaching material, STEM, Creativity, Concept Mastery

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