The Influence of Web-Based Learning on Students' Self-Regulated Learning in High School Chemistry Learning

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The rapid development of technology has impacted various areas, including education. Web-based learning is an integration of technology and education. Students are the main agents of learning; hence, increasing students' self-regulated learning certainly influences the success of learning. Chemistry is a main course studied by senior high schoolers majoring in natural science. This research was an experimental study using a one-group pre-test and post-test design. The subjects of this research were eleventh graders while the object was students' self-regulated learning and the intervention was web-based learning. This research aims to see the influence of web-based learning in increasing students' self-regulated learning in Chemistry. The results showed that implementing web-based learning as a learning method in Chemistry learning was provably able to increase students' self-regulated learning. It was seen from the result of hypothetical testing where showed the tcount is higher than ttable. However, the effect size (ES) showed that the influence of web-based learning was considered moderate (proved by the ES value of 0.58 or in the range of 0.2 and 0.8). Therefore, the results indicated that implementing web-based learning in Chemistry learning moderately influenced students' self-regulated learning.

INTRODUCTION

Since the emergence of the Covid-19 pandemic in early 2020, various changes have occurred in every area of life, including Education (Assidiqi & Sumarni, 2020). The pandemic opened up new innovations in the world of education, through the integration of technology and education. In the past, technology had often only served as an aiding tool for education, not because of its importance but due to the irreplaceable of technology in human life (Abidah et al., 2020). This situation was clearly seen especially in developing countries, including Indonesia. However, the condition of the Covid-19 pandemic triggered educational practitioners in various parts of the world (especially developing countries) to begin thinking about how to integrate technology into education (Abidah et al., 2020; Assidiqi & Sumarni, 2020). Many studies have previously been conducted on the use of technology as an educational support facility, for example as a learning aid (helping students to search for information and knowledge independently (Lin & Wu, 2016; Rathore & Sonawat, 2015), as learning media in classroom activity (Hartman et al., 2019; Hikmah et al., 2018; Kusumaningrum et al., 2022; Rathore & Sonawat, 2015), as a learning device to assist in doing assignments (Ayon & Dillon, 2021; Roy, 2019), etc. In Indonesia, the emergence of the Covid-19 pandemic became the driving factor and stepping stone for educational practitioners to use technology in education, not as an aiding media but as part of the education system itself (Dinc, 2017; Rathore & Sonawat, 2015). Many education practitioners began to carry out various research and studies to see the potential for technology integration in education, both as the main medium of learning (for conducting online or hybrid classes), as a method of learning (using internet-based applications as learning media), or as a learning approach (learning based on a seamless learning approach), and many others (Abidah et al., 2020; Assidiqi & Sumarni, 2020). Various forms technology integration of technology products have been used as learning media, such as Smart Classes, Quipper, Google Classroom, Schoology, and others (Davies & West, 2014; Rathore & Sonawat, 2015). These web-based media act as learning platforms that allow both teachers and students to carry out learning activities without being limited by space and time (Dinc, 2017; Soussi, 2018). This form of learning that uses web-based media has become a popular option for education practitioners when there is a ban from the government on conducting face-to-face learning activities (Abuhassna, 2020; Dinc, 2017; Hamzah et al., 2017). Web-based learning, then, becomes a form of development in the education system which makes policyholders in educational institutions begin to look at and develop web-based systems as one of the main media in the learning process (Lin & Wu, 2016).

Chemistry is a branch of natural science that has a role parallel to other branches of natural science, such as physics, biology, geology, and astronomy (García-Martínez, 2015; Touli et al., 2012). In Indonesia, chemistry lessons are starting to be accepted by high school students, especially those majoring in natural sciences. The curriculum in high school chemistry learning is provided based on the need for a basic understanding of general chemical knowledge such as the basic sequence of atoms including the periodic system, chemical bonds, chemical reactions of organic compounds and macromolecules, ions, electrolyte properties, elemental characteristics, and elemental composition (Hikmah et al., 2018; Sastrawijaya, 1988; Touli et al., 2012). From preliminary observations, the researchers found phenomena which generally show the low interest of students

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in learning Chemistry. This lack of interest is caused by many factors, such as how Chemistry learning was presented in textbooks, the way how it was taught (learning strategies, approach, or method), general information obtained by students, as well as the goals or objectives of students in learning Chemistry (Ahmad, 2017; García-Martínez, 2015; Marchak et al., 2021). Various existing educational curricula demand a change in the orientation of learning Chemistry. However, in reality, the way of learning Chemistry had not significantly changed. In general, Chemistry learning in high school has been dominated by teachers who deliver information as well as give examples and practice questions (Redhana, 2013). As a result, students did not get adequate insight into Chemistry learning. Mostly, the learning was often dominated by materials from textbooks but rarely corresponded learning to reality (Ahmad, 2017; García-Martínez, 2015) . On the other hand, students who study Chemistry view Chemistry as a subject that was needed to continue their studies at the tertiary level, such as education in medicine, agriculture, as well as Mathematics and Natural Sciences (Hikmah et al., 2018; Mani, 2016; Sastrawijaya, 1988).

SRL or Self-Regulated Learning is a process in which students carry out strategies by regulating cognition, metacognition, and motivation Puustinen & Pulkkinen, 2001; Schunk, 2005; Panadero, 2017;). Self-regulation is a process in which a person activates and maintains cognition, behavior, and goal systematically (Schunk, 2005; Schunk et al., 2008). According to Al-Hasani and Elgazzar (2015), SRL is a process and spirit that can be changed through training which includes making the achievement of goals, planning according to predetermined goals, using strategies, monitoring strategy implementation, and self-evaluating the entire process undertaken. In SRL, students monitor their own learning goals and motivation, manage existing resources, and become decision-makers in the entire learning process. SRL places great emphasis on learner autonomy and responsibility for their own learning activities (Abuhassna et al., 2021; Dinsmore et al., 2008; Panadero, 2017; You & Kang, 2014). In SRL, students are responsible for their own education and learning process, which includes awareness and evaluation of thought processes, the use of selective and appropriate strategies, and continuous self-motivation (Karlen, 2016; Mustofa et al., 2019).

Based on this background, this research is a case study conducted at one of the Islamic high schools in Surabaya with the aim of seeing the effect of Web-Based Learning using web-based media created by the school as a learning platform on the formation of SRL in students for chemistry learning. The choice of SRL as a variable in this study is because SRL is one of the determining factors for the effectiveness and success of distance learning-based learning (Dinata et al., 2016; Ejubović & Puška, 2019; Hidayat & Handayani, 2018; Kassim, 2013; Koivuniemi et al., 2021; Mustofa et al., 2019; Schunk & Greene, 2018; Wigfield et al., 2011; Winne & Perry, 2000; You & Kang, 2014; Zimmerman & Kitsantas, 2007). This is in line with the concept put forward by (Zimmerman & Kitsantas, 2007; Zimmerman & Moylan, 2009;) which states that SRL is a process that is directed independently and consists of a series of activities that students apply to transform their mental abilities into useful skills and habits (Karlen, 2016; Koivuniemi et al., 2021; Liang & Yang, 2017; Puustinen & Pulkkinen, 2001; Sutarni et al., 2021; Winnie, 2011;).

METHOD

This research was pre-experimental design research using one group pre-test and post-test (Sugiyono, 2017, 2018). The object of this research was the self-regulated learning in Chemistry learning. The data were collected from 100 participants consisting of 34 male students and 66 female students who were eleventh graders at Al-Hikmah Islamic Senior High School located in Surabaya, Indonesia. The intervention used as the experimental method was the web-based program developed by the school. Instrument used in this research was closed-questioned questionnaires adapted from (Koivuniemi et al., 2021). The data were calculated using five-scale Linkert Scale consisting of strongly agree, agree, doubt, disagree, and strongly disagree. Self-Regulated Learning (SRL) served as dependent variable observed in this study while Web-Based learning (WBL) served as independent variable. In order to obtain the feasibility of the result of this research, the instruments were tested for their validity and reliability and the participants were analyzed for their homogeneity to ensure that the results of this study were valid, feasible, and reliable. From the homogeneity test, the data analysis indicated that all the participants in this research considered as homogeny considering their individual backgrounds, such as: education level, knowledge absorption, age, technology mastery, and social background. These backgrounds presumably had significant influence in causing the participant inhomogeneity. Another, for the instruments used in the questionnaires, the validity and reliability tests were

conducted and the results showed that the instruments were valid and reliable so they could be used in this research to obtain the data.

Table 1. Respondents Characteristics

Characteristics	Total	
	N	Percent
Gender		
- Female	34	34%
- Male	66	66%
Ethnicity		
- Javanese	68	68%
- Arabic	15	15%
- Madurese	10	10%
- Others	7	7%
Age		
- < 16 years old	25	25%
- 16 – 17 years old	67	67%
- > 17 years old	8	8%
Academic Achievement (using 4-grade standard) *		
- Excellent (85 – 100)	35	35%
- Good (70 – 84)	50	50%
- Satisfactory (60 – 69)	15	15%
- Poor (40 – 59)	0	0%
Family background: **		
- Professionals	28	28%
- Teachers/lecturers	15	15%
- Entrepreneurs	30	30%
- Civil Servant	27	27%

*4-grade standard was categorized using 4 standards from the previous final exam (grade 10th)
** parents' occupation

FINDING and DISCUSSION

The rapid development of technology today also has a big influence in the world of education. The rapid development of technology makes it easier for educational actors (teachers and students) to utilize technology to gain knowledge (Songkram, 2015). According to (Fuad et al., 2017), education in the modern era requires students to be more competitive and have strong competitiveness. Therefore, we need an appropriate approach in the world of education that can help students to have the ability to explore the knowledge gained in the learning process (Hikmah et al., 2018; Kassim, 2013; Uno, 2007). Responding to these needs, teachers and educational institutions are expected to be able to give students the ability to think creatively and critically (Prasistayanti et al., 2019). Bialik and Fadel (2015) identified a need for 4 C competencies, namely competencies in creative thinking, critical thinking, communicative and collaborative. Previous research (Aizikovitsh-Udi & Amit, 2011; Kassim, 2013; Lin & Wu, 2016; Songkram, 2015) proved that cultivating students' creative thinking significantly affects the level of creativity and learning achievement of students. Lin and Wu (2016) also said that in implementing strategies for creative thinking, innovative learning methods are needed that are able to foster student creativity by utilizing existing technology.

Learning is a process carried out by humans to develop their own potential as a result of obtaining knowledge and experience in interacting with the environment in order to fulfill their life needs (Mazid et al., 2021; Slameto, 2003; Yamin & Maisah, 2009). According to Hamalik (2008), the learning process combines various elements such as humans, procedures, environment, materials, regulations, and institutions in carrying out learning objectives. Drawing from these definitions, Chemistry learning can be understood as a process of learning in order to obtain knowledge related to Chemistry. Hence, to achieve the goals in Chemistry learning, it was required to select and design the appropriate strategies, methods, techniques, and learning models (Uno, 2007). Learning Chemistry in senior high school has a goal to introduce more basic

knowledge of Chemistry to senior high school students in which allows them to obtain an understanding of how to apply this knowledge in the real world. Along with the changing times, the objectives of Chemistry learning have also changed in an effort to adapt to the needs and goals of schools and communities (García-Martínez, 2015; Mani, 2016). In Indonesia, the Chemistry learning curriculum of senior high school was regulated in the Regulation of the Ministry of Education and Culture of the Republic of Indonesia No. 36 of 2018 concerning the changes of the contents in the Regulation of the Ministry of Education and Culture of the Republic of Indonesia No 59 of 2014 regarding the senior high school curriculum. From these regulations, it was known that in Indonesia, Chemistry learning in senior high school has the main goal to provide knowledge about basic chemistry to senior high school students so they are able to recognize and apply this knowledge through real activities as well as gather experiences for future needs. These regulations were in line with the opinion of Sastrawijaya (1988) who mentions that the purpose of learning chemistry is to make students gain an understanding of various facts, an ability to recognize and solve problems, skills in the laboratory, and a scientific attitude in everyday life. However, from previous research (Mani, 2016; Hikmah et al., 2018; Marchak et al., 2021) as well as initial observations, it was found the facts which showed the reluctance and lack of interest in learning Chemistry among senior high school students. These phenomena were mostly due to the difficulties in memorizing chemical formulas and terms, as well as the lack of understanding of the direct relation of Chemistry and its uses in the real world (Ahmad, 2017; Marchak et al., 2021; Touli et al., 2012). Moreover, these reasons were supported by the lack of an attractive learning approach and method in learning Chemistry, so they worsened the situation. Therefore, an interesting chemistry learning innovation was highly needed in order to trigger an increase in students' motivation to learn about this knowledge (García-Martínez, 2015; Hikmah et al., 2018; Mani, 2016;).

Table 2. Analysis of SRL on Chemistry Learning

Description	Result		
	TS 1	TS 2	N-Gain
Maximum score	139	140	1
Minimum score	62	68	-0.58
Mean Score	97	106	0.20
Deviation	15.39	13.89	0.25
Normality testing	3.76	2.96	
	t_{count}	t_{table}	
Hypothetical testing	12.11	1.69	
Effect size (ES)	0.58		

Note:

TS 1 = Pre-test score

TS 2 = Post-test score

Implementing web-based learning as an intervention in Chemistry learning in the experimental research had been carried out for 3 months (half a semester) for the eleventh graders of the academic year of 2021/2022 at Al-Hikmah Islamic Senior High School of Surabaya. The intervention was given starting from the first meeting at the beginning of the semester until the midterm exams. The intervention was in the form of using the school-developed web-based application as learning media and assistance. The application used as the intervention consisted of learning materials, referential links, exercises, and individual assessments which corresponded to both the national and school curricula. The objectives of the contents in the application were to allow students to have unlimited access to learning materials (were not constrained by times or sources), possibilities to train themselves in understanding the knowledge obtained (by doing self-exercises), as well as the ability in managing oneself (discipline in doing assessment). Moreover, this developed application which was originally designed from a web-based learning method could facilitate students to learn independently (by accessing material from modules and additional reference links; answering practice questions; submitting assignments; and checking the results of submitted assignments from the teacher). The ability in carrying out independent learning certainly influenced individual regulated learning because it could train their ability to think critically, evaluate individual problems cognitively, as well as solve problems that occurred in their learning activities. Furthermore, a web-based learning method provided opportunities for students who were

still lacking in understanding the teacher's explanation to carry out independent learning activities as well as avoiding the feeling of being dejected as public failures by other peers.

Schuck and Zimmerman (1994), Schunk and Greene (2018), and Miller and Byrnes (2001a, 2001b) stated that SRL in students could be seen from their activeness in teaching and learning activities metacognitively, motivationally, and behaviourally. According to (Dinsmore et al., 2008), SRL was defined as an attitude of self-regulation to improve academic achievement, providing feedback during the learning process and self-motivation in acquiring knowledge during learning activities. The SRL concept stems from Bandura (1986) and McLeod (2016) explained that self-efficacy was related to how a person emphasizes the regulation of behavior and emotions. SRL began to appear in the 1980s and became popular from the 1990s, with an emphasis on the interaction of cognitive, motivational, and contextual factors. The terms metacognition and self-regulation are used in all human activities in all contexts of all ages and refer to developmental stages, whereas SRL, in most definitions, is restricted to students in academic contexts (Wigfield et al., 2011). Based on research conducted by Schuck & Zimmerman (1994) and Puustinen and Pulkkinen (2001), SRL was defined into two, namely goal-oriented definitions where SRL is seen as a process of goal setting and emphasizes constructive character and self-generation. In this definition, monitoring, regulation, and control of learning a person is based on cognitive, motivational, and social factors (Schunk & Greene, 2018; Schuck & Zimmerman, 1994; Wigfield et al., 2011; Winne & Perry, 2000). While other definitions are oriented towards a metacognitive framework (Karlen, 2016; Panadero, 2017; Schunk, 2005; Winnie, 2011). According to (Karlen, 2016; Hofer & Yu, 2003; Winnie, 2011), metacognitive processes use cognitive functions and strategies in solving learning problems.

Although there were differences in the two SRL models (in terms of constructs and mechanisms), it could be assumed that SRL can be seen from 1) activeness in constructing its own meaning, goals and strategies from the external context (environment); 2) the potential of the learner to control, monitor, and regulate the characteristics of cognition, motivation, and action; 3) determination of problems in the learning process; 4) self-regulatory behavior as a mediator between personal and contextual characteristics and academic achievement; and different stages in various regulatory areas (Ejubović & Puška, 2019; Sutarni et al., 2021; Wigfield et al., 2011; You & Kang, 2014). Of the five assumptions, it can be interpreted that SRL was a proactive involvement in one's learning behavior, especially in directing thoughts, feelings, and actions in a systematic manner oriented towards achieving one's own goals. This definition supported the opinion of (Schuck & Zimmerman, 1994; Zimmerman & Kitsantas, 2007; Zimmerman & Moylan, 2009) which states that SRL was a student's ability to monitor academic goals and self-motivation, manage human and material resources, and become the subject of decisions and performance in the entire learning process. In general, self-regulation was defined as the ability to develop knowledge, skills, and attitudes that could be transferred from one learning context to another, and from learning situations where information was obtained to work contexts and other times (Boekaerts, 2007). In general, students did more learning activities because of their status as students in a school. Each school generally had a predetermined curriculum and learning plan. That was, the process of setting learning goals and directing learning activities was often not fully carried out by the students themselves. Dinsmore et al. (2008), Schunk and Greene (2018), and Sáiz-Manzanares et al. (2022) mention that there were three types of student regulation, namely internal, external, and shared regulation. This opinion was supported by Schunk (2005) and Schunk et al. (2008) which stated that students who had good SRL capacity did not need other people to direct their learning process because they had the independent ability to assess the conditions of academic assignments, set goals to master assignments and use strategies to complete tasks. This meant that self-regulation in learning made a student have the ability to actively accept the environment and the ability to actively control and change their environment, thinking, and behavior by making action plans to achieve task mastery.

From the analysis of the data obtained in this research, the result showed that there was an influence in implementing WBL in form of using a web-based developed application on improving students' self-regulated learning (SRL) in Senior High School Chemistry learning. This was proved by the N-gain results of 0.25 (on the standard deviation score) and 0.20 (on the standard mean value obtained from the pre-test and post-test (see Table 2). The result of N-gain was obtained by dividing the result of the total score from the post-test minus the total score from the pre-test and the result of the standard deviation minus the pre-test score (see formula 1). In addition, the hypothetical testing showed that the t_{count} was higher than the t_{table} (12.11 > 1.69)

meaning that the intervention (the method used) had an influence in improving students' SRL in Chemistry learning at senior high school (see Table 2).

Formula (1): N-gain

$$N gain (g) = \frac{TS\,2 - TS\,1}{Standard\,TS - TS\,1}$$

In addition, from calculating the Effect size of the intervention using the designed formula (see formula 2), the result showed a score of 0.58 or categorized as a moderate level. The category was set based on three classifications namely: low (ES < 0.2); moderate (0.2 < ES < 0.8); and high (ES > 0.8). This standard was obtained by looking at a sample size of 100 in calculating the effect size of experimental research [Sugiyono, 2013]. Accordingly, the calculation obtained from the data analysis (0.58) indicated that the intervention used in this research had a moderate influence on the variable concerned.

Formula (2): Effect Size

$$ES = \frac{TS\,2\,Ave - TS\,1\,Ave}{Deviation\,Standard}$$

The results of data processing showed that implementing web-based learning (WBL) in Chemistry learning at senior high school was provably able to improve students' self-regulated learning (SRL). It was proved by the result of hypothetical testing that indicated the higher value of tcount (12.11) on its ttable (1.69). This result meant that the intervention given (implementation of WBL in Chemistry learning) showed a positive influence on the improvement of students' SRL. In addition, from the Effect Size (ES), this research showed that the intervention moderately influenced the variable analyzed, meaning that WBL had a moderate effect on the improvement of SRL. This result was proved by the ES value of 0.58 meaning that it was in between the range of 0.20 and 0.80 of the standard set for a total of ≤ 100 participants in experimental research. Accordingly, these indicated that WBL implementation in Chemistry learning provably had a moderate effect on increasing students' SRL.

CONCLUSION

From the analysis and the discussion, this research found that by implementing web-based learning as a learning method in Senior High School Chemistry learning was proved to be able to increase students' self-regulated learning. It was seen from how tcount (12.11) was higher than ttable (1.69) in its hypothetical testing. In addition, from calculating its effect size (ES), the results found the moderate influence of web-based learning in teaching-learning Chemistry (proved by the ES value of 0.58 or 0.2<ES<0.8). Therefore, it indicated that implementing web-based learning in Chemistry learning moderately influenced students' self-regulated learning.

The result of this research had positive implications to develop the education system, especially in the integration of technology and education. It was because it can be served as a reference for educational practitioners who conduct research on media development and technology-based learning methods. In addition, it can be used as a reference for policymakers in education as well as power holders in educational institutions to provide support to the development of web-based learning systems as part of learning activities. However, although it provided positive implications, there were several limitations that existed in this research resulting in the possibility of different results obtained once they were addressed (used as variables in the research). There were two existing limitations in this research, including the limitations related to participants and population as well as limitations related to the application of activities (implementation of web-based learning) as interventions in research. In terms of participant and population limitations, the limitations included the limited population, the number of participants, and the exclusion of individual factors of the participants from the research variables. Meanwhile, the limitations on the implementation of activities included the limited duration of the intervention (half a semester), the exclusion of detailed content/features in the application, and the standards for assessing the results/review in the application. The existence of these limitations possibly allows different results in other studies once those were addressed. Therefore, it was recommended to conduct further studies that address aspects excluded in this research as variables to be observed. Therefore, the possibilities of similar and different results in the future research can support the results of this research either positively or negatively. Several suggestions for future studies within the scope of this research can be made. Individuals can be informed through counselors so that they can practice self-

disclosure behaviors in a healthier and safer way. Within the scope of self-disclosure problems which individuals might experience in the online environment, group counseling or individual counseling can be offered by counselors. Through the psycho-educational groups which counselors can prepare, awareness-themed studies can be conducted on the effects which users experience and might potentially experience because of psychological self-disclosure behavior.

Declarations

Conflict of Interest

No potential conflicts of interest were disclosed by the authors with respect to the research, authorship, or publication of this article.

Funding

No specific grant was given to this research by funding organizations in the public, commercial, or not-for-profit sectors.

Research and Publication Ethics Statement

Hereby, we as the authors consciously assure that for the manuscript "Influence of Web-Based Learnıng on Students' Self-Regulated Learnıng in Chemıstry Learning" the following is fulfilled:

- This material is the authors' own original work, which has not been previously published elsewhere.
- The paper reflects the authors' own research and analysis in a truthful and complete manner.
- The results are appropriately placed in the context of prior and existing research.
- All sources used are properly disclosed.

Contribution Rates of Authors to the Article

The authors provide equal contribution to this work.

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