**The profile of students’ self-regulated learning in online mathematics learning**

L. P. Fahmad1 and K. Hidayati2

1Graduate School, Universitas Negeri Yogyakarta, Indonesia

2Department of Mathematics Education, Universitas Negeri Yogyakarta, Indonesia

E-mail: lathifahpermatasari.2019@student.uny.ac.id, kana@uny.ac.id

**Abstract.** Online learning has carried out in almost all schools in Indonesia. The executed implementation of online learning seems to have been sudden, and perhaps with minimal preparation needs attention. This is because the COVID-19 pandemic required teaching and learning activities to be carried out online to prevent the broader spread of COVID-19. Self-Regulated Learning (SRL) is an essential ability in implementing online learning, one of which is online mathematics learning. This study aimed to describe how the SRL profile of senior high school students in online mathematics learning. The study subjects were 138 high school students aged 16-18 in 4 high schools in Rejang Lebong who have received online mathematics learning. Data were collected through 5-point Likert-type scale instruments and interviews. The result showed that (1) the level of students' SRL in online mathematics learning was mostly moderate and low, (2) the percentages of students who have a very low, low, moderate, high, and very high mathematical SRL level are 1%, 27.5%, 61.5%, 10%, and 0%, and (3) the percentage of some SRL indicators such as self-motivation, time-management, and the determination of learning strategies and completion of student assignments was still at 60% each.

1. **Introduction**

Technological advances during the industrial revolution 4.0 have brought together various dimensions, including physical, digital, and biological. The complexity of industrial revolution 4.0 and society 5.0 has necessitated synergy between science and technology in human life. The present changes in the order of human life and human behavior have resulted from the growth of information technology [1]. Implementation of education that already existed before also requires adjustments according to the development of the times. This aims to develop students' skills so that they can contend with new environments according to the times. One way that can be an option is to use an appropriate combination of technology in learning to improve student skills.

Students have widely used the internet as supporting information in learning has undoubtedly become commonplace [2]. The internet can be used by students as a tool to provide much information and reached by students quickly. Several websites that can be accessed freely, for free and have been recommended by many experts such as GeoGebra resources, youtube, wolfram-alpha, and IXL, can be used to aid students in understanding mathematics. However, not all students know that not all information obtained on the internet has been verified by experts and has valuable quality information. It takes more effort for students to evaluate the quality and exactitude of the sources of information they get from several websites [2].

Currently, most schools in Indonesia have implemented online learning due to the impact of the COVID-19 pandemic. In online mathematics learning, students are expected to be able to find additional relevant learning resources and set their own time to be capable of understanding maths lessons better and solving problems in learning itself. Students are also expected to be capable of controlling the stimulus for action, feelings, and thoughts as well as exercise self-control and self-reflection. In other words, students must be capable of regulating their learning activities and be actively involved in the online learning process [3]. Therefore, students need to develop SRL so that online mathematics learning can be carried out successfully and achieve maximum learning goals.

Several researchers stated that Self-Regulated Learning (SRL) is a crucial ability to be managed and developed by students in an online learning environment [4][5][6][7]. Zimmerman and Schunk defined SRL as an individual's ability to direct thoughts, feelings, and behaviors to accomplish goals [8]. Students who have high SRL can control the factors that affect learning so that they can remove obstacles and create optimal conditions for learning [9] and have better academic performance than students who do not have self-regulated learning [10]. Several indicators in SRL such as planning learning objectives, intrinsic motivation, selecting relevant learning resources, choosing appropriate learning strategies, and self-reflection in learning are essential to support the successful implementation of online mathematics learning, which requires self-directed students. Several studies concluded that SRL is an essential aspect of online learning [11][12].

This study was conducted to answer two issues. The questions were as follows 1) what was the student's SRL in online mathematics learning that has been implemented in high school, and 2) what was the students' difficulties in implementing online mathematics learning related to the SRL indicators.

This study was expected to be essential to aid educators in obtaining data on descriptions of students' SRL mathematics abilities and the adversity experienced by students in online mathematics learning related to indicators on SRL. Besides, this study was expected to be the cornerstone for considering the factors influencing students' SRL in online mathematics learning.

1. *Online Mathematics Learning*

Online learning has become the most rational alternative method of learning for the pandemic situation caused by COVID-19. In education, online learning requires students self-regulate [5][13] so that learning becomes meaningful. Online learning was an adaptation of higher education in learning that fitted solve time and space constraints by exposure to virtual cyberspace [14][15]. In virtual cyberspace, online learning was carried out by students, and teachers with the assist of online learning platforms to students do not need to attend classes [16].

Wong defined online learning as a teaching and learning process that makes the internet a tool that helps to teach and to learn activities to take place [17]. The learning process in online learning takes place entirely online. The use of the internet is essential in online learning, such as accessing learning materials, interacting with teachers and other students, gaining knowledge and learning experiences.

As the public knows, mathematics is one of the compulsory subjects taught in almost every degree of education in Indonesia. Mathematics online learning can be described as online learning that is carried out to discuss several sub-subjects in mathematics according to the curriculum for each degree of education with the help of online learning platforms. There are no specific specifications for the online learning platform used by schools. Various online learning platforms was used as a liaison between students and teachers so that they can interact in teaching and learning activities.

1. *Self-Regulated Learning*

Self-regulated learning (SRL) could be described as a student's ability to regulate the learning process in the form of a cycle of behavior and thoughts to plan, monitor, and evaluate themselves according to their own will in learning [8][18]. The goal is to contribute to achieving the learning goals desired by these students. Highly SRL learners could plan goals, decide learning strategies, decide strategies for solving complex tasks [19][20], have more great academic performance [10], and can even improve performance by controlling their cognition [21].

 SRL defined as the individual ability to become masters of their learning activities to control metacognitive aspects, motivation, and learning behavior [18]. One of the SRL indicators that play an essential role in the sustainability of learners' SRL is motivation [22][23]. The motivation that students have is a trigger that guides students to initiate an initiative such as managing learning strategies, time management, and others. Students with high SRL abilities tend to have high motivation to complete tasks and solve problems in learning [24].

 In the SRL cycle, there are three phases, namely forethought, performance, and reflection [8][25][26][27]. The forethought phase includes task analysis (determining goals and plans in learning), self-motivation, and self-efficacy. The performance control phase includes self-observation (using learning strategies) and self-control (controlling the effectiveness of strategy, emotions, tasks, and efforts that have been made). The reflection phase includes self-reaction (adjusting emotional responses, reviewing learning objectives) and self-consideration of the efforts that have been made, such as the effectiveness of learning strategies or performance in the learning that has been done.

 SRL learners depend on individual interplays with the environment, both internal and external environment [28][29]. It should be noted that the traditional learning environment will be different from the online learning environment, which means that SRL students' behavior in online mathematics learning has its characteristics. Not all learners have SRL, but independent learning can still be taught and obtained by learners. It needs to be a concern for educators to manage and improve student SRL in the learning process [30].

1. **Method**
	1. *Types and subject of the research*

The type of this research was descriptive research [31]. This study aimed to describe how the SRL profile of high school students in online mathematics learning. The study was conducted in 2020, and subjects were 138 high school students aged 16-18 in 4 different high schools in Rejang Lebong who have received online mathematics learning. A total of 138 students participated in an online questionnaire. Then 20 students from 138 students were selected to participate in the individual online interview.

* 1. *Instruments for Data Collection*

Data were collected through a 5-point Likert-type scale questionnaire, ranging from *always* to *never*. The questionnaire was used to measure SRL students in online mathematics learning and consisted of 28 items. The questionnaire was adapted from Zimmerman [26] and [5] questionnaire to measure student's SRL in online learning environments. The questionnaire was validated by expert and reliable, with a Cronbach's alpha value of 0.863.

* 1. *Data Analysis*

The classification for students' SRL level in online mathematics learning can be seen in table 1.

**Table 1.** Category of student's SRL in online mathematics learning

|  |  |
| --- | --- |
| Total Score (X) | Category |
| X > 117.6 | Very High |
| 95.2 < X ≤ 117.6 | High |
| 72.8 < X ≤ 95.2 | Moderate |
| 50.4 < X ≤ 72.8 | Low |
| X ≤ 50.4 | Very Low |

1. **Result and Discussion**
2. *Description of student SRL in online mathematics learning*

A total of 138 high school students who were respondents in this study, the results of data processing in this study are presented in table 2.

**Table 2.** Frequency distribution and percentage of high school students by level of SRL

|  |  |  |
| --- | --- | --- |
| Grade | Level Category of SRL Students  | Total Students |
| **Very High** | **High** | **Moderate** | **Low** | **Very Low** |
| XI | 0 | 4 | 41 | 20 | 1 | 66 |
| XII | 0 | 10 | 44 | 18 | 0 | 72 |
| Total | 0 | 14 | 85 | 38 | 1 | 138 |
| Percentage | 0% | 10% | 61,5% | 27,5% | 1% | 100% |

Based on table 2, it can be seen that most of the students' SRL was in the moderate and low of the SRL level categories. More than 50% of students are in the moderate-level SRL category in online mathematics learning. Then, there are still 38 students who are in the low-level SRL category, while there are only 14 students who are at the high-level SRL category in online mathematics learning. This finding is in line with previous research, which shows that more students had a moderate-level of SRL [32] and low-level category of SRL [33] in mathematics learning.

**Table 3.** Percentage of student's SRL level based on each grade at high school

|  |  |
| --- | --- |
| Grade | Level Category of SRL Students  |
| **Very High** | **High** | **Moderate** | **Low** | **Very Low** |
| XI | 0% | 6% | 62% | 30% | 2% |
| XII | 0% | 13% | 61% | 25% | 0% |

According to table 3, The comparison of the percentage level category SRL in online mathematics learning for each grade in high school students saw almost the same. There was only a difference of about 1-7 percent for each student's SRL level in online mathematics learning.

**Figure 4.** Percentage of SRL indicator in online mathematics learning

Figure 4 reveals that several SRL indicators in online mathematics learning, such as self-motivation, time management, and task strategies, were still below 60%. Most students had scored low on indicators of self-motivation, which was included in the forethought aspect, indicators of time-management, and task-strategies, which ware included in the aspect of performance control. It needs to be taken into deliberation by educators to optimize online mathematics learning.

1. *Difficulties Experienced by Students in Online Mathematics Learning*

As previously known, SRL plays an essential role in online learning. Interviews were established with 20 students with various levels of student SRL to determine the factors of difficulties experienced by students in online mathematics learning related to the SRL indicator in online mathematics learning.

Data revealed that more than 35% of students answered "rarely" and sometimes" to each item on the time-management items. Based on further interviews regarding time-management, most students stated difficulties in managing learning time. Here are some representations of student answers:

S2:" I have difficulty managing my study time according to the weekly schedule that has been made. Mathematics assignment given by math teacher is quite a lot and takes more time than expected."

S15: "I don't know why, but I quite often procrastinate the work that I should be doing."

S18: "I can't predict how long the assignment will take. So, I can't always keep up with the weekly study schedule that has been made."

Most students were accustomed to procrastinating time in learning and doing assignments so that the learning plans that have been prepared by students previously not carried out properly. This finding is in line with the research results before, which found that one of the characteristics that emerged from students with low SRL was the habit of procrastinating academic activities [34]. The difficulty that many students encounter in time-management indicators was a lot of time that students spend doing large quantities of assignments. Teachers need to be more selective in presenting assignments to students and not prioritizing quantity in the assignments. Quality of assignments should be prioritized to evolve the abilities required by students in the future to meet the needs of the times. Following the findings of Pastoriko, Hidayati, and Rasmuin that although homework assignments were able to evolve SRL, it is necessary to consider the number of questions so that negative perceptions about homework was reduced [35].

More than 32% of students on self-motivation items answered "seldom" to all question items. These findings reveal that student motivation in online mathematics learning is quite low. Merely about 10% of students answered "always" and "often" on each item of self-motivation items. This is in line with the study by Wong, which found that online learning was not able to arouse student motivation. Further interviews regarding one of the SRL indicators, specifical motivation, was presented in the following presentation [17].

S4: "I have difficulty maintaining motivation in mathematics learning in an online environment. I am bored with the explanation of math material that only sees and hears the explanation of the PowerPoint slides that the teacher has presented."

S13: "I need a more detailed video about the mathematics material being taught to be more motivated in learning."

S19: "Sometimes, my learning motivation gets down when the teacher gives too many tasks, while I still need to understand the material that the teacher has just explained."

It emerges that an attractive learning media is needed to motivate students in online mathematics learning. Students only relied on YouTube and directed searches from Google to help with tasks and to understand mathematics subjects that students feel they don't understand. Based on several schools that were the subject of research, teachers had not provided many website recommendations as to additional student learning resources and do not use learning media that could be accessed through the website as material for student exploration in online mathematics learning. Even though there had been many studies on the effectiveness of using technology in mathematics learning, Edwards stated teachers in mathematics learning underutilized trustworthy and quality online learning resources for the exploration of mathematics lessons [36].

The utilize of multimedia proven develops students' SRL in mathematics learning [37]. Through multimedia, the delivery of material had been more enticing so that it can increase student motivation [37]. In an online learning environment, teachers can recommend websites that can help students explore mathematics learning, remembering that the internet is easy to reach and provides various learning resources that can help students explore mathematics material. Teachers had needed to help students choose learning resources because the trustworthiness of learning sources from the internet was needs to be considered [2]. The employ of technology that supports mathematics learning such as GeoGebra, IXL Math, Khan Academy, Wolfram-Alpha, and other reliable online learning resources could be taken into consideration for employ by students.

1. **Conclusion**

Based on the results of a questionnaire from 138 high school students who had responded to this study, the conclusions are as follows. First, the level of students' SRL in online mathematics learning was mostly moderate and low. The comparison of the percentage level category SRL in online mathematics learning for each grade for senior high school students looked almost the same. In general, the percentages of students who have a very low, low, moderate, high, and very high mathematical SRL level are 1%, 27.5%, 61.5%, 10%, and 0%.

Second, the percentage of some SRL indicators such as self-motivation, time-management, and the determination of learning strategies and completion of student assignments was still at 60% each. Based on student perspective, the difficulties faced by students related to the three SRL indicators that were still at 60% as follows, 1) less different learning media, 2) tasks that were considered sufficiently large so that students have difficulty managing study time, 3) the habit of delaying academic activities, and 4) lack of recommendations for reliable learning sources originating from the internet for mathematics learning.

The use of technology derived from the internet can be considered students to explore mathematics to be more motivated. However, it should be noted that students and teachers need to evaluate and recommend reliable learning sources as additional learning resources for students in mathematics learning to improve students' SRL. Additionally, teachers were advised to be more selective in assigning homework both in terms of quality and quantity.

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