Exploring the Self-Regulated Learning Skills of Physics Students in an Online Learning Environment

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Abstract. This research investigates the factors of students' self-regulated learning (SRL) skills in online learning environments from the demographic perspectives of gender and major. The study employs a survey design and involves 103 students selected through simple random sampling. Data collection uses the SOL-Q questionnaire and observation. The collected data is analyzed using descriptive statistics, t-tests, and one-way ANOVA. The research results indicate that among the five components of SRL, the environmental structure obtained a high score, meaning that environmental structure contributes significantly to SRL in online learning for physics and non-physics majors. Meanwhile, time management received a low score, indicating that time management contributes less to SRL. There is no significant difference in each component of SRL based on gender and major. Furthermore, there is no significant effect of gender and major on the level of SRL.

Keywords: Self-regulated learning, Online learning, Physics

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INTRODUCTION

The online learning environment needs to be supported by the availability of hardware and software, more accessible and faster internet access, and instructional design. This is important for face-to-face and online learning that is more personal and self-directed (ÖzdemïR & Önal, 2021). Support for education features such as self-directed learning, motivation, and setting student goals is crucial in online learning (Mayda et al., 2020).This calls for self-regulated learning (SRL) to align the two concepts. Students are expected to be more responsible for their education and more active and self-directed during the process (ÖzdemïR & Önal, 2021).

The results of observations conducted by researchers on campus during online learning indicate that students must be responsible for their knowledge because they must attend classes from a distance of the face-to-face classroom environment. Students are also less active in following lecture instructions, completing online assignments given by instructors, planning their learning, setting goals, monitoring their understanding, and managing their time for learning. This emphasizes that all online learning activities require self-directed learning management from the students' side. This research through a study is essential to be conducted.

Students need to improve their SRL skills to get the most out of their online learning experience (ÖzdemïR & Önal, 2021). However, literature studies show that many students experience difficulties in managing their own learning in the online learning environment. New research indicates that less self-directed students are far less successful in the online learning environment (Lehmann et al., 2014). On the other hand, observations suggest that most physics department LMS platforms used for online learning include short video lectures with embedded questions, automatically graded quizzes, peer reviews or evaluations, and online discussion forums. Through these features, students must realize that they must manage their learning process. However, literature studies show that many groups of online learners struggle to manage their learning and experience difficulties with metacognitive self-directed learning strategies and organization to achieve their goals and plans for time management, seeking Help, and organizing their learning environment (Albelbisi, 2019).

Previous studies have researched SRL in various locations, objects, methods, and even different SRL theories/variables. This study uses several SRL factors, such as metacognition, environmental structuring, Help-seeking, persistence, and time management, that have previously been investigated by researchers in different objects and contexts (R. Jansen et al., 2020; Mayda et al., 2020; Kulusakli, 2022). There is also a need for more research on how to support SRL skills in the online learning environment, specifically in the physics department, and a lack of exploration of the SRL factors in the physics department. Therefore, further research is needed to explore and provide solutions to support the SRL skills of students in the physics department in the online learning environment.

The purpose of this research is to (1) determine the self-regulated learning skills of physics students in an online learning environment; (2) investigate whether there is a significant difference between the self-regulated learning of physics and non-physics students in an online learning environment; and (3) investigate whether there is a significant difference between the self-regulated learning of physics students and gender in an online learning environment.

Online Learning

Both teachers and students highly support online learning systems (Bhuvaneswari & Dharanipriya, 2020; Male et al., 2020). Online learning plays an essential role because the teaching activities and materials in online learning influence the level of motivation and academic achievement of participants. The materials used in online learning can capture students' attention and connect with them, which ultimately improves their self-confidence and satisfaction with positive rewards (Na et al., 2020). Regarding the online learning environment, SRL is crucial in online learning because of the high level of student autonomy arising from the absence of a physical teacher presence (Cobb Jr, 2020). Without the support and guidance of a teacher, the ability to independently manage a student's learning process is essential to achieving their learning goals.

Self-Regulated Learning (SRL)

Self-regulated learning (SRL) is the thoughts, feelings, and actions that are generated and strategically designed to achieve personal goals (Sutarni et al., 2021).. SRL is an integrated learning process guided by a series of motivational beliefs, behaviors, and metacognitive activities planned and adjusted to support personal goals (Schunk & Zimmerman, 2012). SRL is an independent effort of students toward their performance or course activities (Carter Jr et al., 2020). SRL is essential for students who want to succeed in online learning (Kulusakli, 2022). SRL is intended for students to actively build their learning process and be able to set their learning goals while also trying to observe, adjust, and control their cognition, motivation, and behavior to achieve these goals (Lim et al., 2020). These behaviors include but are not limited to goal setting, time management, task strategies, environmental structuring, and Help-seeking (Barnard-Brak et al., 2010). SRL encompasses cognitive process strategy tasks performed by the learner and activities to regulate these cognitive processes (R. S. Jansen et al., 2017). The data collection tool used in this research consists of five factors: metacognitive skills, Help-seeking, persistence, environmental structuring, and time management.

RESEARCH METHOD

Research Design

In order to answer the research questions above, this study is designed using a survey research design with a quantitative method. Participants (students) were informed that their participation in this study is voluntary and will not affect their grades in the course.

Participants

This study recruited participants from the Physics and Non-Physics Department of Universitas Negeri Makassar, Indonesia, who had completed online learning during the second semester of the 2021/2022 academic year. A total of 103 students were selected using simple random sampling.

Instrument and Data Collection

Data collection for this study utilized observation and questionnaires. The questionnaires were used to elicit respondents' perceptions of SRL in an online learning environment, while observations were used to monitor students' asynchronous and synchronous online learning conditions. The Self-Regulated Online Learning Questionnaire (SOL-Q) was used, which had previously been developed by (R. S. Jansen et al., 2017) and then adopted by Kulusakli (2022) & Mayda et al. (2020). The questionnaire comprises five

sub-dimensions: metacognitive skills, help-seeking, time management, persistence, and environmental structuring. Specifically, it includes 18 items for metacognitive skills, 3 for time management, 5 for environmental structuring, 5 for persistence, and 5 for Help-seeking. The overall Cronbach's alpha value for this study was found to be 0.70. The SOL-Q scale was designed to be assessed on a 5-point Likert scale. According to this format, 1 represents "strongly disagree," and 5 represents "strongly agree".

The survey was conducted online, and participants were sent an invitation and a link to a Google Form to complete the SOL-Q. The invitations were sent in the 12th week to ensure students could reflect on their SRL behaviors and were open for two weeks. This study focuses on gender and department, as these variables can contribute to SRL in the physics department. This study took participants from students from the Department of Physics and Non-Department of Physics at Universitas Negeri Makassar, Indonesia, who have participated in online learning in the even semester of 2021/2022. One hundred three participants were selected by simple random sampling.

Data Analysis

Quantitative data analysis was used to analyze data collected from the students. Data were analyzed through the Jamovi program. Data is stated as mean, median, mode and standard deviation. The Kolmogorov-Smirnov test was used to check the normality of the data. An independent t-test and one-way analysis of variance (ANOVA) were used to determine the differences between separate sample groups. Significance was defined as $p < 0.05$.

RESULTS AND DISCUSSION

Results

In this study, the level of self-regulated learning (SRL) among students in the Faculty of Science at Universitas Negeri Makassar is measured using the SOL-Q instrument. The values from all the items will be averaged and normalized to a range of 0-100. The normalization process is done using the following formula:

$$SRL = \frac{Mean}{Maximum\ Mean} \times 100$$

Descriptive Statistics of SRL and Its Components

Before calculating statistics for SRL and its subcomponents, it is important to investigate the instrument's reliability. One measure of reliability that can be used is Cronbach's alpha (Sarstedt et al., 2022). Cronbach's alpha is a popular reliability measure and has relatively non-strict requirements (Sarstedt et al., 2021). However, Cronbach's Alpha can still be used and is considered a lower limit for the reliability of an instrument (Hair et al., 2021; Trizano-Hermosilla & Alvarado, 2016). A particular instrument is considered reliable if Cronbach's alpha value of the instrument is more significant than 0.708 (Hair et al., 2018, 2019). Overall, the SRL instrument used has good reliability ($\rho_c = 0.906$) although the subcomponent of time management showed a less good reliability value ($\rho_c = 0.094$). Persistence also led to a reliability value of less than 0.708 ($\rho_c = 0.627$), but Cronbach's alpha greater than 0.6 is still acceptable (Nunally & Bernstein, 1994).

Table 1. Descriptive Statistics and Measurement Model of SRL and Its Components

Variable	Mean	SD	Cronbach Alpha
Self-Regulated Learning (SRL)	75.87	7.92	0.906
Metacognitive skill (META)	75.73	10.23	0.911
Time management (TIME)	68.16	11.54	0.094
Environment Structure (ENVI)	79.38	11.48	0.774
Persistence (PERSIS)	74.25	10.43	0.627
Help-Seeking (HELP)	79.15	11.27	0.774

Self-regulated learning (SRL) is a construct composed of five subcomponents: (1) metacognitive skills, (2) Time Management, (3) Environmental Structure, (4) Persistence, and (5) Help Seeking. As shown in Table 1, descriptive statistics of each component indicate that the highest mean value is obtained for environmental structure ($\mathrm{M} = 79.38, \mathrm{SD} = 11.48$), and the lowest mean for time management ($\mathrm{M} = 68.16, \mathrm{SD} = 11.54$). The discussion of each component of the SRL construct is described below.

Metacognitive Skill

Table 2. Descriptive Statistics of Items in Metacognitive Skill

Item	Mean	SD	Category
META1	3.84	0.883	High
META2	3.84	0.883	High
META3	3.46	0.937	High
META4	3.72	0.994	High
META5	3.80	0.784	High
META6	4.00	0.728	Very High
META7	3.60	0.867	High
META8	3.75	0.789	High
META9	3.73	0.831	High
META10	3.88	0.832	High
META11	3.67	0.733	High
META12	3.63	0.767	High
META13	4.00	0.672	Very High
META14	3.93	0.744	High
META15	4.03	0.720	Very High
META16	3.74	0.863	High
META17	3.56	0.763	High
META18	3.97	0.747	High

Table 2 shows the descriptive statistics of each item on metacognitive skill. Item 15 shows the highest mean response ($\mathrm{M} = 4.03, \mathrm{SD} = 0.72$), and the lowest mean response is indicated by item 3 ($\mathrm{M} = 3.46, \mathrm{SD} = 0.94$). The average response category of all items falls in the high and very high categories.

Time Management

Table 3. Descriptive Statistics of Items in Time Management

Item	Mean	SD	Category
TIME1	2.96	1.075	Moderate
TIME2	3.86	0.701	High
TIME3	3.40	1.079	High

The items in the time management subcomponent in Table 3 show a lower category than metacognitive skills—the types of time management subcomponent range from moderate to high. TIME1, the first item in time management, offers the lowest mean response $(\mathrm{M} = 2.96, \mathrm{SD} = 1.08)$. The highest mean response is demonstrated by TIME2 $(\mathrm{M} = 3.86, \mathrm{SD} = 0.70)$.

Environment Structure

Table 4. Descriptive Statistics of Items in Environment Structure

Item	Mean	SD	Category
ENVI1	4.26	0.700	Very High
ENVI2	3.97	0.923	High
ENVI3	4.15	0.692	Very High
ENVI4	3.69	0.875	High
ENVI5	3.78	0.740	High

Table 4 shows the environmental structure subcomponent consisting of 5 items. The mean response of each item falls in the high to very high category. Respondents' answers show the lowest mean at ENVI4 (M=3.69, SD=0.88) and the highest at ENVI1 (M=4.26, SD=0.70). The mean of ENVI1 is also the highest among all items in all subcomponents.

Persistence

Table 5. Descriptive Statistics of Items in Persistence

Item	Mean	SD	Category
PERSIS1	3.44	0.977	High
PERSIS2	3.72	0.797	High
PERSIS3	3.55	0.883	High
PERSIS4	3.83	0.772	High
PERSIS5	4.03	0.649	Very High

Table 5 shows the descriptive statistics for the persistence items, which show that all items are in the high category except for PERSIS5, which is in the very high category. PERSIS5 shows the highest mean $(\mathrm{M} = 4.03, \mathrm{SD} = 0.65)$, while the lowest standard is demonstrated by PERSIS1 $(\mathrm{M} = 4.03, \mathrm{SD} = 0.65)$.

Help-Seeking

Table 6. Descriptive Statistics of Items in Help-Seeking

Item	Mean	SD	Category
HELP1	4.08	0.763	Very High
HELP2	3.96	0.839	High
HELP3	3.59	0.834	High
HELP4	4.14	0.672	Very High
HELP5	4.02	0.767	Very High

Table 6 shows that Help is seeking consists of 5 items. All five things are in the high and very high category. The fourth item (HELP4) offers the highest mean response (M=4.14, SD=0.67), while the lowest mean response is demonstrated by HELP3 (M=3.59, SD=0.83).

Comparison test of SRL subcomponents

The differences of gender and respondents' major in relation to these five subcomponents will be investigated with a comparison test, specifically the independent t-test (if the data meets the assumptions) and the Mann-Whitney test (if the data does not meet the premises).

Gender

Table 7. Comparison Test of SRL Subcomponents based on gender

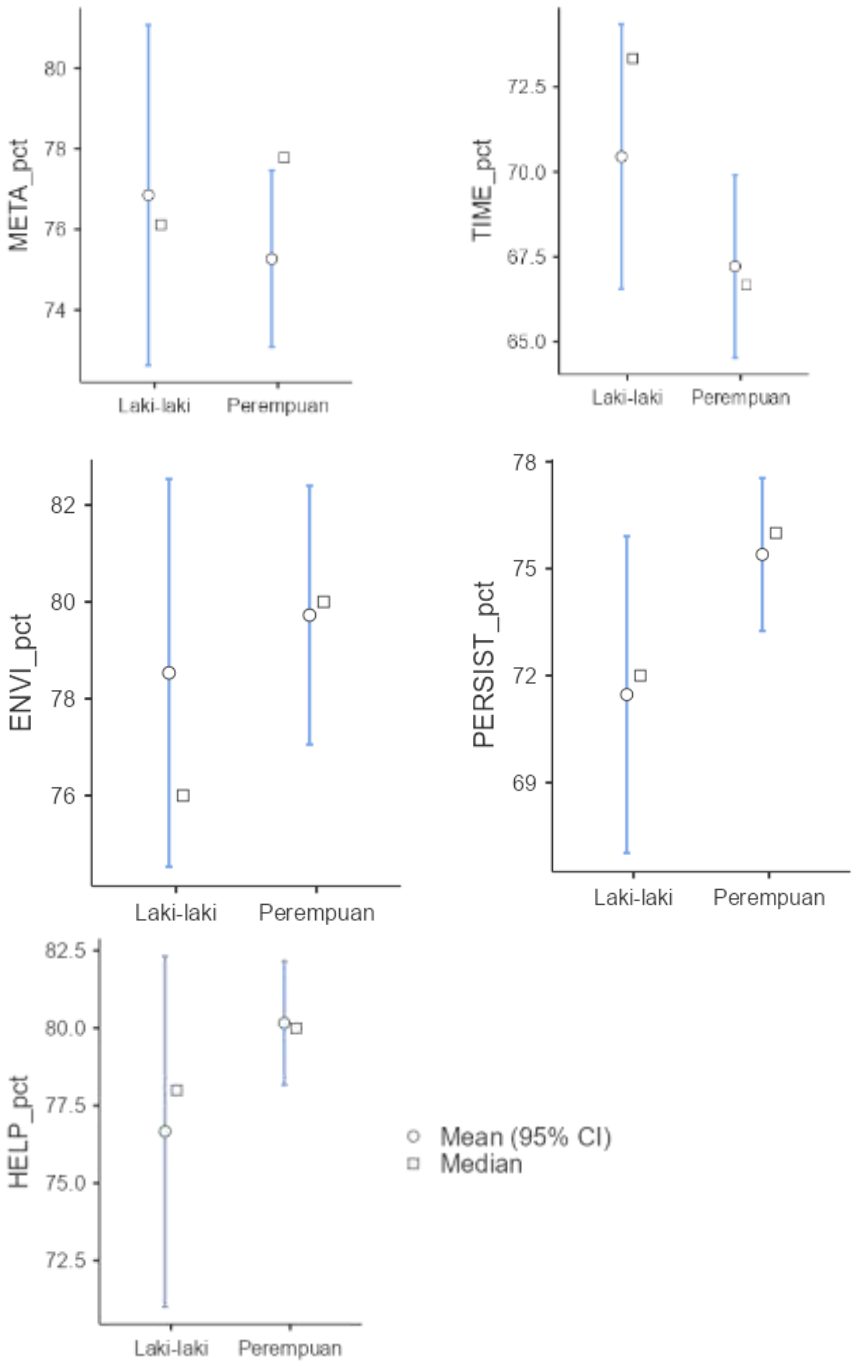
	Descriptive Statistics		
	Mean	SD	p
Metacognitive Skill			
Male	76.9	11.8	0.477*
Female	75.3	9.55	
Time Management			
Male	70.4	10.9	0.199*
Female	67.2	11.75	
Environmental Structuring			
Male	78.5	11.2	0.634*
Female	79.7	11.65	
Persistence			
Male	71.5	12.4	0.11**
Female	75.4	9.35	
Help-Seeking			
Male	76.7	15.8	0.397**
Female	80.2	8.7	

*) Independent t-test

**) Mann-Whitney U test

Table 7 shows that the comparison test results indicate that males' metacognitive skills ($M = 76.9, SD = 11.8$) are not significantly different from females ($M = 75.3, SD =$

$9.55, p = 0.477$). The time management abilities of male students ($M = 70.4, SD = 10.9$) are not significantly different from females ($M = 67.2, SD = 11.75, p = 0.119$).



Picture 1. SRL Components on Participants based on gender

Picture 1 shows that there is no significant difference in Environmental structuring between male students ($M = 78.5, SD = 11.2$) and female students ($M = 79.7, SD = 11.65, p = 0.634$). The persistence of male students (M=71.5, SD=12.4) is also not significantly different from that of female students ($M = 75.4, SD = 9.35, p = 0.11$). The Help Seeking subcomponent also shows similar results to the other subcomponents. The

ability to seek help in learning among male students ($M = 76.7, SD = 15.8$) is not significantly different from that of female students ($M = 80.2, SD = 8.7, p = 0.119$).

Origin Study Program

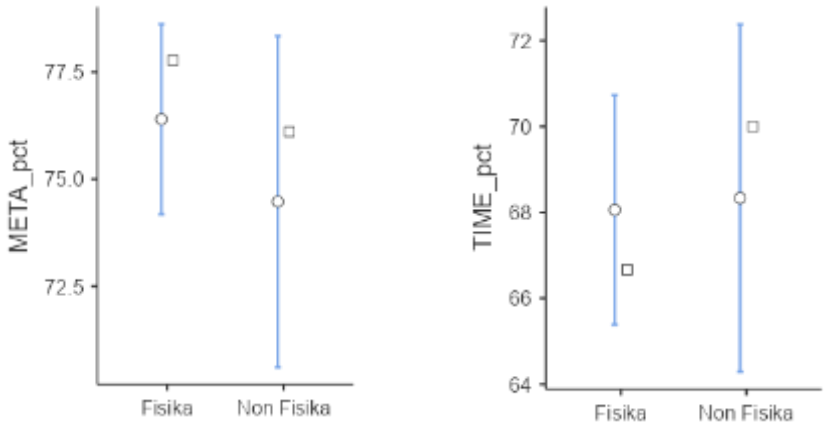
Table 8. Comparison test results on SRL Subcomponents based on student's major

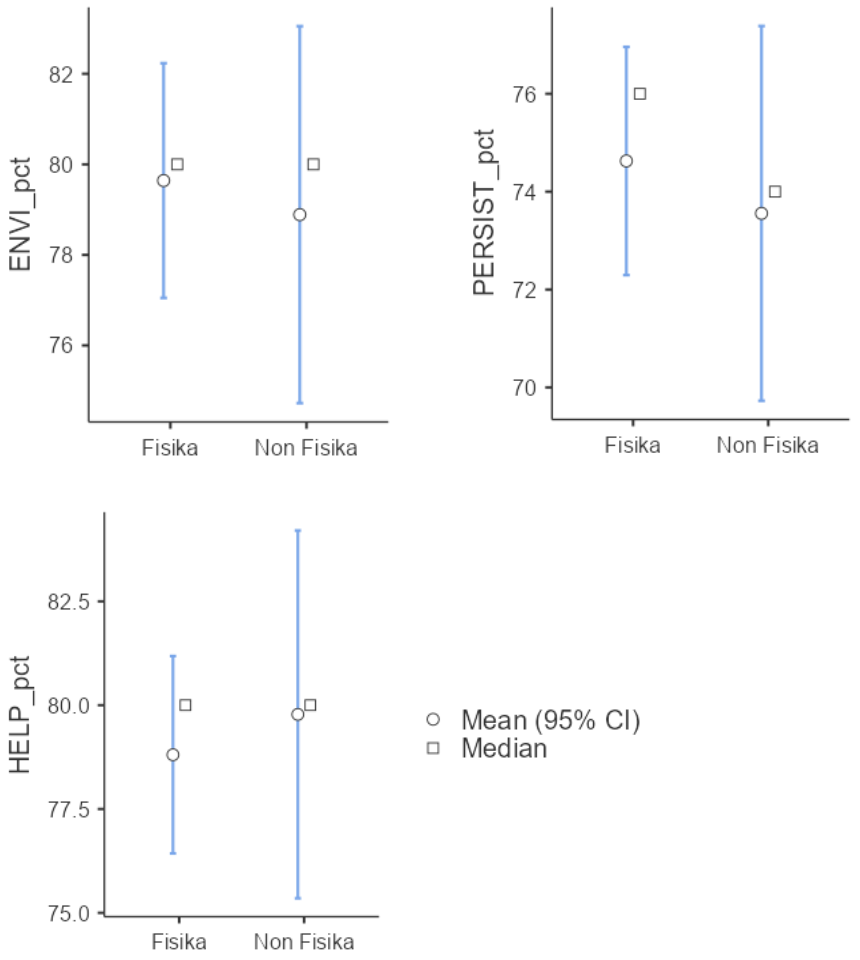
	Descriptive Statistics		
	Mean	**SD**	**p**
Metacognitive Skill			
Physics	76.4	9.28	0.365*
Non- Physics	75.3	11.8	
Time Management			
Physics	68.3	11.16	0.909*
Non- Physics	68.1	12.4	
Environmental Structuring			
Physics	79.6	10.83	0.753*
Non- Physics	78.9	12.7	
Persistence			
Physics	74.6	9.74	0.621*
Non- Physics	73.6	11.7	
Help-Seeking			
Physics	78.8	9.92	0.679*
Non- Physics	79.8	13.6	

*) Independent t-test

**) Mann-Whitney U test

Table 8 shows the comparison test results showing that the metacognitive skills of physics students (M = 76.4, SD = 9.28) were not significantly different from non-physics students (M = 75.3, SD = 11.8,p = 0.365). The time management skills of physics students (M = 68.3, SD = 11.16) were not significantly different from non-physics students (M = 68.1, SD = 12.4,p = 0.909).





Picture 2. SRL Components between Physics and Non-Physics students

Picture 2 shows that Environmental Structuring in physics (M=79.6, SD=10.83) is not significantly different from non-physics (M=78.9, SD=12.7, p=0.753). The persistence of physics students (M=74.6, SD=9.74) was not significantly different from that of non-physics students (M=73.6, SD=11.7, p=0.621). The help-seeking subcomponent also shows the same results as the other subcomponents. The ability to seek help studying physics students (M=78.8, SD=9.92) was similar to non-physics students (M=79.8, SD=13.6,p=0.679).

Effect of Gender and Major on SRL

To investigate the influence of gender and major on the level of Self-Regulated learning, the SRL values of each respondent will be categorized into 3 categories, namely.

Table 9. Category of Participant's SRL

Category	SRL
Low	<33.33
Moderate	<66.66
High	66.66 - 100

Subsequently, the relationship between the SRL category and gender and major will be examined using the chi-square test. Table 10 shows the chi-square test results, indicating that gender does not affect the SRL category ($\chi^2 = 0.116, p = 0.733$). The respondents' major of study also does not significantly affect the SRL category ($\chi^2 = 0.269, p = 0.604$).

Table 10. Chi-Square test results

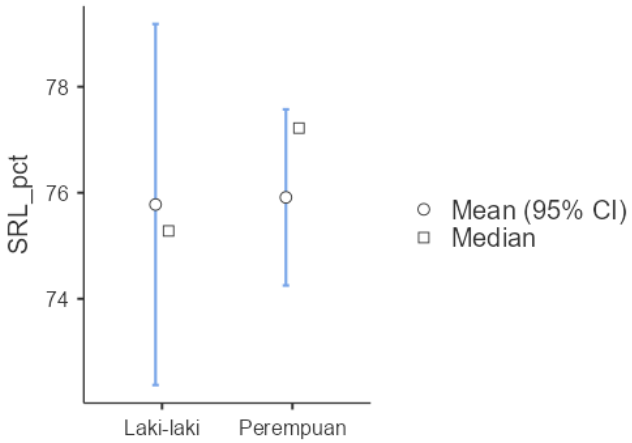
	Frequency (n)		χ^2	
Variable	Moderate	High		p
Gender				
Male	4	26	0.116	0.733
Female	8	65		
Major				
Physics	7	60	0.269	0.604
Non- Physics	5	31		

The results of this normalization will serve as a benchmark in comparing the SRL values of the respondents based on characteristics of the sample such as gender and major.

Table 11. Descriptive and Comparative Statistics

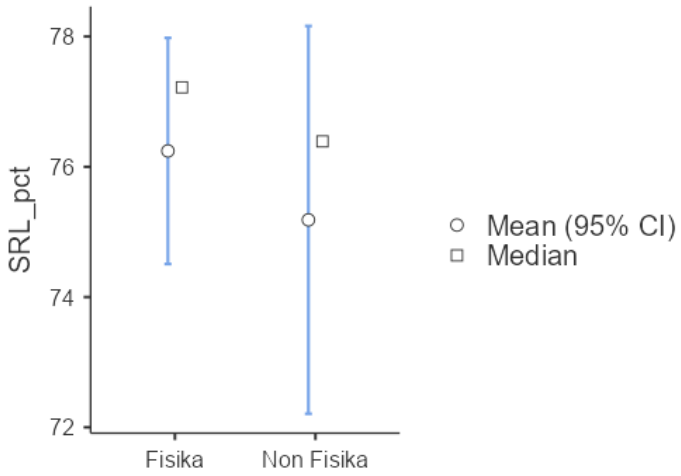
Variable	Mean	SD	t	p
Gender				
Male	75.8	9.52	-0.078	0.938
Female	75.9	7.24		
Major				
Physics	76.2	7.25	0.645	0.521
Non- Physics	75.2	9.11		

Picture 3 illustrates the results of the comparison of SRL with gender as the grouping variable, showing no significant difference between males ($M = 75.8, SD = 9.52$) and females ($M = 75.9, SD = 7.24, p = 0.938$).



Picture 3. Student's SRL based on their gender

The variable of major also shows the same result. Picture 4 illustrates the SRL values of students who come from the Physics major ($M = 76.2, SD = 7.25$) do not differ significantly compared to students who do not come from the Physics major ($M = 75.2, SD = 9.11, p = 0.521$).



Picture 4. Student's SRL based on their major

Discussion

This study aims to investigate self-regulated learning (SRL) and its subcomponents based on the gender and program of origin of students. There are 4 subcomponents of SRL: metacognitive skill, time management, environmental structuring, persistence, and Help-seeking. The study results showed that the self-regulated learning of male students is not significantly different from female students. In other studies, SRL also showed no significant difference between males and females (Aziz et al., 2017; Guo, 2020; Stanikzai, 2020; Susilowati et al., 2020). However, other studies also showed different results that indicate that females have higher SRL than males (Bidjerano, 2005; Pajares, 2002; Putarek & Pavlin-Bernardić, 2020; Virtanen & Nevgi, 2010). Differences in SRL between males and females are driven by several factors, such as phased feedback (Guo, 2020) and higher intrinsic interest in learning in females (Niemi et al., 2003). In addition, females are aware of their learning needs and desire to learn to improve their learning achievements (Guo, 2017; Salahshour et al., 2013). In this study, the conditions that cause this difference may indicate relatively equal values between the two genders.

This study also showed that the subcomponents of SRL also did not show a significant difference based on gender. Metacognitive skills, time management, environmental structuring, persistence, and Help-seeking in males were not significantly different from females. The program of study also did not affect SRL. These results are consistent with the study of (Virtanen & Nevgi, 2010), which showed that students from science, engineering, social and economic programs have no difference in SRL.

CONCLUSIONS

This study examined Self-Regulated Learning (SRL) using five components: metacognitive skill, time management, environmental structure, persistence, and help-

seeking. Among these components, the environmental structure received the highest value, indicating that it significantly contributed to SRL in online learning for physics and non-physics majors. Conversely, time management received a low value, indicating that it made a minimal contribution to SRL. There were no significant differences in each SRL component based on gender and major. Additionally, there were no significant effects of gender and major on SRL levels.

This study was limited to physics and non-physics majors at Universitas Negeri Makassar, Indonesia. The results may differ if students from different majors across faculties and universities were included, even high school students. The study also recommends further development and investigation of SRL components in various subjects and objects, not just university students but also high school students, and not just in the context of online learning but also in other learning modes.

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