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Construction and identification of psychometric property self-regulated learning scale for university students

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Muhammad Hidayat¹, Difa Ardiyanti², and Siti Muthia Dinni³

Abstract

Previous studies state that self-regulated learning is a pivotal component in predicting students' learning outcome. The present study aims to test the psychometric property of self-regulated learning scale to obtain a sound instrument. The procedure in this study included the scale construction, followed by psychometric property identification covering the content validity (using Aiken's V and reliability test (Cronbach's Alpha) of the data obtained from 203 respondents. The reliability coefficient of the final scale was 0.908, its discriminating power ranged between 0.307 and 0.626 with a mean score of 0.462. In other words, the self-regulated learning scale exhibit adequate psychometric property to measure university students' self-regulated learning.

Keywords

reliability, scale, self-regulated learning, student, validity

Introduction

Academic achievement still become a relevant and important topic in the field of psychology, especially the field of educational psychology. Based on Google Scholar search, the phrase "academic achievement" leads to more than 20,000 published research between 2015-2020. Academic achievement is among the indicators of an individuals' academic success. For university students, it can be seen from their GPA. Students' GPA can be predicted since the student admission process by understanding the predictors of academic achievement. Based on Google Scholar search, the phrase "academic achievement predictor" yields about forty published research between 2015-2020. These works report that one's academic achievement is affected by internal and external factors (Gustina & Rahayu, 2020; Kurniawan *et al.*, 2017; Suddin, 2019). Although both factors are equally important, the internal factors appears to play more significant role within the context of student candidate's academic achievement prediction.

Previous studies show that self-regulated learning is among the internal factors contributing to the students' academic achievement (Pamungkas & Prakoso, 2020; Sukmawansyah *et al.*, 2019; Puspita & Rustika, 2018; Sarirah *et al.*, 2017; Darmiany, 2016). Higher self-regulated learning skill is reported to allow individuals achieve their academic goals more easily. According to Pintrich (2000), self-regulated learning refers to an active and constructive process in which students determine their learning goal, monitor, manage, and control their cognition, motivation, and behaviors, directed by their goals and environments. Schunk & Zimmerman (2011) It can also be defined as an individual's effort to regulate himself by involving metacognitive ability, motivation, and active behaviors, three important aspects of self-regulated learning. Siddaiah-Subramanya *et al.* (2017) States that self-regulated learning emphasizes individuals' autonomy and

control that direct and maintain individuals to achieve the learning goal.

Self-regulated learning comprises four aspects (Pintrich, 2000): (1) Cognitive control, involving cognitive and metacognitive activities, (2) Motivation, involving efforts to maintain one's motivation. (3) Behavior, involving one's effort to control his/her behaviors. (4) Context, involving one's effort control the context when engaging with the classroom learning activities. Furthermore, Pintrich (2000) state that individuals with proper self-regulated learning skill are able to set their learning goal and plan, monitor and control their cognitive aspects, motivation, and behaviors to achieve the goal.

DiFrancesca *et al.* (2016) State that the important difference between high and low achievers lies in their self-regulated learning skills, (e.g., their ability to perform metacognitive control, use learning strategy, and self-efficacy). The study conducted by Dörrenbächer & Perels (2016) reports that self-regulated learning is significantly associated with students' high achievement and low test anxiety, lower neurotic level, and represent a readiness to actively receive the learning process.

Considering the important role of self-regulated learning in academic achievement, it is necessary to develop a quality instrument. There are currently two widely used SRL instruments, Motivated Strategies for Learning Questionnaire (MSLQ) and Learning and Study Strategies Inventory (LASSI). To date, MSLQ has been adapted in many countries (Segura-Robles *et al.*, 2021; Khosim & Awang, 2020; Rosito, 2018; Aziz, 2016; Saks *et al.*, 2015; Feiz *et al.*, 2013). This

^{1,2,3} Faculty of Psychology, Universitas Ahmad Dahlan, Indonesia

¹ Corresponding author:
Hidayat¹ Faculty of Psychology, Universitas Ahmad Dahlan, Indonesia
Email: muhammad.hidayat@psy.uad.ac.id

instrument measures different motivational components and learning strategies. Another popular SRL instrument was LASSI (Abdelsamea & Bart, 2019; Abulela & Davenport, 2020; Khalil et al., 2017, 2020; Van Wyk & Mason, 2021). There is also Writing Strategies for Self-Regulated Learning Questionnaire (Teng & Zhang, 2016). Similar to MSLQ, LASSI and Writing Strategies for Self-Regulated Learning Questionnaire is to see the learning strategies.

In Indonesian context, several studies on self-regulated learning report that the SRL is measured using Self-Regulated Learning developed based on Zimmerman's SRL theory (Retnawati, 2016; Sukmawansyah et al., 2019). However, studies on SRL involving Indonesian university students do not provide detail information related to the theory used in SRL scale development process (Efendi et al., 2020; Hasanah et al., 2019; Oktariani, 2018; Rohmaniyah, 2018), as most of them merely show the reliability coefficient. Studies focusing on self-regulated learning scale development for Indonesian university students are still limited. To our knowledge, there is only one study that focuses on self-regulated learning scale development for university students, conducted by Arbiyah & Triatmoko (2016). It is necessary to conduct a study that focuses on SRL scale development in order to carefully construct the scale, ensuring a high quality, accurate measurement quality. In this regard, the present study attempts to develop self-regulated learning scale for university students with adequate psychometric properties, i.e., high validity and reliability coefficients, to obtain accurate depiction of university students' self-regulated learning.

In this study, we developed the SRL scale based on the construct proposed by Pintrich (2000). Items in the study were developed based on four aspects of SRL: cognition, motivation, and context. Pintrich's SRL construct was selected because it specifically suits the learning context and contains behavioral and contextual aspects, which is different from other SRL theories. We consider contextual aspects important because it supports the SRL construct, which is related to the learning environment. Panadero (2017) states that Pintrich's SRL construct is unique when compared to other SRL constructs, as involves individuals' effort to control their own overt behavior. Instead of modifying the existing SRL instruments (e.g., MSLQ, LASSI, SRLI, and Writing Strategies for Self-regulated Learning Questionnaire) because these instruments are directed toward learning strategies instead of self-regulated learning.

This study is expected to yield a psychometrically sound SRL scale to measure university students SRL. In the future, it is expected that this "Self-Regulated Learning Scale for University Students" can be further developed to obtain predictive functions. In other words, individuals with high SRL score are predicted to have high academic achievement.

Method

The SRL scale in this study was developed following stages proposed by Azwar (2012), including measurement goal identification (determining psychological construct), concept operationalization (behavioral indicators), scaling, stimulus format selection, item writing and review, item analysis, item selection, reliability test, construct validation, and final compilation. The scale was developed based on

Pintrich's (2000) SRL theory that comprises four aspects: cognition, motivation, behavior, and context. The first step of the development was constructing the blueprint. The Spearman-Brown formula was applied to estimate the required number of items based on the expected reliability coefficient and average discriminating power index (Suryabrata, 2005). Since the expected reliability coefficient of the blueprint was 0.85 with discriminating power of 0.40, thirty items were required. As the construct comprises four aspects, each aspect should be represented by eight items, divided into favorable and unfavorable item groups. The total constructed items were 32 items. This number of items were doubled to be 64 items to anticipate being dropped during the test. The blueprint of developed SRL scale is displayed in Table 1. After constructing the blueprint, the next step was to write down the sixty-four items based on the indicators. The scale was developed using 4-point likert scale (Strongly agree, agree, disagree, strongly disagree). These items were assessed by five professional judgments for its relevance, these experts have adequate experiences related to SRL study and hold at least Master degree in Psychology. The expert judgment was used as the basis to calculate the content validity coefficient of each item using Aiken's V formula. The next stage was trial stage. In this stage, respondents were recruited using purposive sampling technique. They were 203 students (11.8% male, 88.2% female) pursuing vocational education (1%), undergraduate degree (92%), and postgraduate degree (7%). The data were collected using Google Forms distributed through social media. The data were analyzed using SPSS 23 to examine the psychometric properties (discriminating power and reliability coefficient). The factor analysis was done to see its construct validity prior to the final compilation stage.

Result

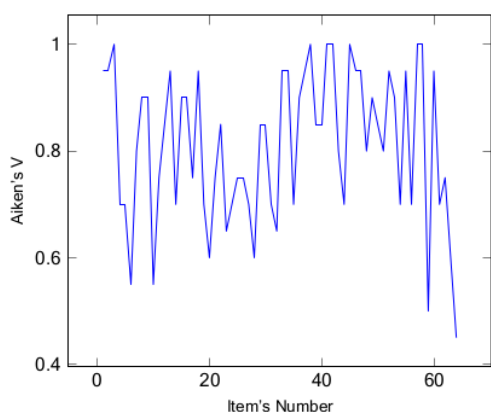
Content Validity

The content validity test was performed to see the relevance of each items (Azwar, 2014). Aiken's V formula was applied to see the content-validity coefficient based on the panel judgment of the item relevance with the measured construct. The score ranged between 1-5 (1 = not relevant with the theoretical construct); 5 = highly relevant with the theoretical construct) The five expert judgments were analyzed using Aiken's V formula ($V = \sum S / [n(c - 1)]$), and in order to find $\sum S$, the formula of $\sum S = S_1 + S_2 + S_3$ was applied (Azwar, 2017). Any V higher than 0.50 indicates a high content validity (Azwar, 2017). Aiken's V estimation result is presented in Figures 1.

As displayed in Figure 1, items no.1 to 30 exhibited an Aiken's V value higher than 0.5, indicating a good content validity. Meanwhile, figure 1 also shows two items with Aiken's V value equal to and lower than 0.5 (i.e., item no. 59 ($V = 0.5$) and item 64 ($V=0.45$)). This shows that there were sixty two items (96.875%) with V coefficient value higher than 0.5. Items no. 59 and 64 were dropped because their values equal and lower than 0.5. Considering that there were too many items left, those with V value lower than 0.6 was also dropped (i.e., item 6 and item 10, $V = 0.55$, respectively), leaving sixty items with good content validity coefficient. The average content validity coefficient of these 60 items was 0.831, indicating good relevance with the measured construct.

Table 1. Initial Blueprint

Aspects	Indicator	No. of item			Loading
		Fav	Unfav	Total	
Cognition	Applying metacognitive strategy to develop a plan	3	3	16	25%
	Applying metacognitive strategy to monitor	3	2		
	Able to modify one's cognition	2	3		
Motivation	Believe in learning goal	2	2	16	25%
	Understand the materials and finish the given tasks	2	2		
	Able to maintain motivation	2	2		
	Able to choose and build strategies to maintain motivation.	2	2		
Behavior	Managing the study time	2	2	16	25%
	Able to monitor learning efforts	2	2		
	Preparing the study needs	2	2		
	Improving and maintaining learning behaviors	2	2		
Context	Having a positive perception of the given tasks.	4	4	16	25%
	Able to control, regulate, and control the context and the surroundings.	4	4		
Total		32	32	64	100%

**Figure 1.** Coefficient validity test result (item no. 1-64)

Instrument Test

The instrument was tested after performing the content validity test, 60 items were considered having a good content validity. All items were renumbered. The test blueprint was displayed in Table 2.

The test was performed online using Google form (<https://bit.ly/risetmahasiswa2020>), involving university students. Prior to giving their responses, respondents were asked to fill the consent form and make sure that they suit the respondent criteria. The test was done between 30 November and 12 December 2020. During the test, 203 students gave their responses and gave their consent to participate in this study. The obtained data were analyzed to see the discriminating power of the items and the scale reliability coefficient.

Instrument Reliability

The reliability test was performed to see the reliability of a measurement (Azwar, 2014). Items with discriminating power lower than 0.30 (rit) were dropped, because items with good discriminating power should have at least a value of (rit) 0.30 (Azwar, 2017). Two-stage analysis was performed to obtain the best Cronbach's Alpha coefficient with rit value of

≥ 0.30 and to obtain an item composition that suits the initial research goal. At the first stage, sixty items were analyzed and results in a Cronbach's Alpha of 0.931 with discriminating power ranging from -0.11 to 0.635. Eleven items with rit < 0.30 were dropped, leaving 49 items with discriminating power higher than 0.30. At the second stage, the cronbach alpha coefficient of 49 items was 0.933 with discriminating power ranging between 0.321 and 0.627. By considering item proportionality of each aspect (25% for each aspect), the number of items were adjusted to that of initial blue print. The process resulted in 32 items with reliability coefficient of 0.908 and discriminating power ranging between 0.307 and 0.626 (average discriminating power: 0.462) (Table 3).

The final version of the scale consists of 32 items with content validity coefficient ranging from 0.6 to 1 and average V value of 0.8326 (Table 3). The validity and reliability tests showed that the developed SRL scale exhibited an adequate psychometric properties, indicated by reliability coefficient of 0.908, average discriminating power of 0.642, and content validity coefficient of 0.836. The blueprint of final version of the scale is presented in table 4.

Construct Validity

In this study, the construct validity of the scale was examined using the exploratory factor analysis, an analysis aiming to see whether the items of the scale presents the aspects intended to to measure, and whether there is a relationship between these aspects. Self-regulated learning theoretically comprises four aspects: cognition, motivation, behavior, and context (Pintrich, 2000) and we tested the final version of the scale to see whether these 32 items represent those four aspects.

The KMO value was 0.834 and the Bartlett's test of sphericity significance was 0.000, allowing us to proceed to the factor analysis. The 32 items were extracted into four factors, considering that SRL is theoretically comprises 4 aspects. The total variance explained indicate that reducing 32 items into four factors allow the scale to account for 46.696% variance. The factor loading of each factor is displayed in Table 5.

Table 2. Test Blueprint

Aspects	Indicator	No. of item		Total	Loading
		Fav	Unfav		
Cognition	Applying metacognitive strategy to develop a plan	3	2	14	23.33%
	Applying metacognitive strategy to monitor	3	1		
	Able to modify one's cognition	2	3		
Motivation	Believe in learning goal	2	2	16	26.67%
	Understand the materials and finish the given tasks	2	2		
	Able to maintain motivation	2	2		
	Able to choose and build strategies to maintain motivation.	2	2		
	Improving and maintaining learning behaviors	2	2		
Behavior	Managing the study time	2	2	16	26.67%
	Able to monitor learning efforts	2	2		
	Preparing the study needs	2	2		
	Improving and maintaining learning behaviors	2	2		
Context	Having a positive perception of the given tasks.	4	4	14	23.33%
	Able to control, regulate, and control the context and the surroundings.	3	3		
Total		31	29	60	100%

Table 3. Discriminating Power and Aiken's V of Final SRL Scale items

Aspects	Items	Discriminating power	Aiken's V
Cognition	A1	0.523	0.95
	A3	0.358	1
	A5	0.352	0.7
	A8	0.376	0.9
	A9	0.543	0.75
	A10	0.483	0.85
	A11	0.369	0.95
Mean		0.436	0.85
Behavior	A31	0.553	0.95
	A32	0.563	0.95
	A34	0.626	0.9
	A35	0.307	0.95
	A39	0.435	1
	A42	0.349	0.7
	A44	0.451	0.95
	A45	0.544	0.95
Mean		0.479	0.919
Motivation	A15	0.406	0.75
	A17	0.322	0.7
	A20	0.444	0.85
	A21	0.415	0.65
	A24	0.561	0.75
	A26	0.541	0.6
	A28	0.612	0.85
	A30	0.459	0.65
Mean		0.47	0.725
Context	A48	0.478	0.85
	A49	0.372	0.8
	A50	0.525	0.95
	A53	0.403	0.95
	A54	0.469	0.7
	A56	0.499	1
	A57	0.414	0.95
	A60	0.544	0.6
Mean		0.463	0.85
Average discriminating power		0.462	
Average Aiken's V			0.836

Three items with factor loading lower than 0.4 (i.e., A28, A39, and A42) were dropped. We see that the group of items in Component1 can be grouped into items measuring behavior, those in component 2 measures the contextual aspect, component 3 measures the cognitive aspect, while those in component 4 measures the motivation.

Discussion

The final version of the scale comprises 32 items with average content validity coefficient of 0.836, indicating a relatively high content validity. As shown in table 3, these 32 items exhibited a discriminating power index ranging between 0.307 and 0.626 with an average score of 0.462. The discriminating power index is an important parameter in selecting the items, as it represents the item's ability to separate individuals with the measured psychological attributes from those lack of the measured psychological attributes (Azwar, 2012). In other words, these 32 items have sufficient ability to separate individuals with high SRL from those with low SRL. Overall, items of the scale exhibited a good quality.

Considering the discriminating power index and Aiken's V (Table 3), Items with high content validity coefficient do not necessarily exhibit high discriminating power. However, the selected 32 items possess content validity coefficient and discriminating power higher than minimum requirement, in other words, they have an adequate psychometric properties. Furr & Bacharach (2013) state that discriminating power is the most common concept to evaluate the degree to which an item affect the internal consistency of a measure. Items with high discriminating index represent a strong relationship with the measured construct. Therefore, from reliability perspectives, selected items are those with higher discriminating power.

Item A34 exhibits the highest discriminating power index, i.e., 0.626. According to Finch et al. (2016), discriminating power of an item refers to the extent to which an item is able to separate respondents with lower trait from those with higher trait.. In this regard, item A34 possesses the best ability to separate individuals with low SRL from those with high SRL. This unfavorable item represent the behavioral aspect, which reads: "I only study when I want to". Finch et al. (2016) argue that item's discriminating power indicates

Table 4. Final Blueprint

Aspects	No. of item		Total item	Loading	Items
	Fav	Unfav			
Cognition	1, 3, 8, 10, 11	5, 9, 12	8	25%	I always avoid procrastinating to do the given task (A10).
Motivation	15, 20, 24, 28	17, 21, 26, 30	8	25%	I can encourage myself when I lack learning spirit (A28).
Behavior	31, 32, 35, 39, 44	34, 42, 45	8	25%	I read some additional literature to extend my understanding (A44).
Context	48, 49, 50, 56, 57	53, 54, 60	8	25%	There is always a surprise that draw my interest to finish the given task (A50).
Total			32	100%	

Table 5. Items Component

Items	Component			
	1	2	3	4
A44	.711			
A48	.689			
A50	.567			
A34	.545			
A35	.518			
A45	.512			
A49	.502			
A21	.429			
A28	.349			
A39	.332			
A42	.274			
A56		.684		
A57		.644		
A1		.628		
A31		.615		
A32		.580		
A3		.562		
A60		.533		
A8		.461		
A24		.403		
A12			.710	
A30			.680	
A54			.614	
A9			.579	
A5			.552	
A53			.505	
A10			.483	
A15				.780
A17				.721
A11				.588
A20				.513
A26				.407

a relevance with the trait being measured. This shows that item A34 in this scale measures one's self-regulated learning from different direction. Respondents with low score on this item indicates high self-regulated learning. However, it is necessary to sum up the total score of the items before drawing a conclusion. Item A34 also exhibits high content-validity coefficient ($V=0.9$). Experts view this item highly relevant with the measured construct, i.e., self-regulated learning. In other words, Item A34 possesses good quality in terms of content validity and the discriminating power.

Item A35's discriminating power was slightly above the minimum requirement, i.e., 0.307, however, it is still considered adequate, as the minimum discriminating power is 0.30 (Azwar, 2017). According to Furr & Bacharach (2013), content validity (not including the face validity) serves as

the important evidence when evaluating a construct validity. It means that the content validity of a measure is likely to determine its construct validity. In this regard, Azwar (2014) states that a scale's content validity coefficient is affected by the content validity of each item. Item A35 is a positive-worded item reads: "I know the efforts I have made in learning". It has a high content validity ($V=0.95$). Four of five experts scored this item 5, while an expert scored this item 4. This judgment indicates that four experts agree that A35 is relevant to measure SRL, especially the behavioral aspect (2nd behavioral indicator: able to monitor learning efforts). Overall, the discriminating power and the content validity coefficient of item A35 is quite good.

Item A39 exhibited Aiken's V of 1, indicating a very high content validity and considered highly relevant to measure the behavioral aspect, particularly the third indicator, i.e., preparing the needs during study. This item is a positive-worded statement reads: "I collect sufficient literature to do my tasks." The discriminating power of this item was 0.435. In other words, Item A39 exhibit a good psychometric property.

Item A26 was a negatively-worded statement measuring motivation with V value of 0.6. It reads "When I feel the task is too difficult, I choose not to do it." Four of five experts scored this item 4 (score range 1-5), while one expert gave a lower score. This item is quite relevant to measure the third indicator of SRL, i.e., motivation because it depicts one's inability to control or manage his/her motivation. This is supported by discriminating power of 0.541, indicating a good psychometric property. Furr & Bacharach (2013) explains that high item-total correlation indicates that the item is consistent with overall measurement. In this regard, Item A26's relatively high discriminating power shows its relatively high consistency with the scale.

Since the item in this scale was selected based on its discriminating power index, the quality of the item is guaranteed, represented by its reliability coefficient. The reliability analysis showed a reliability coefficient of 0.908, and a reliability coefficient of at least 0.8 is considered significant (Urbina, 2004; De Vaus, 2002). Self-Regulated Learning measurement like MSQL is reported to have a reliability coefficient around 0.9 (Saks et al., 2015). It shows that the scale developed in this study possess an equally high reliability when compared to other existing measures. According to Azwar (2014), higher reliability (closer to 1) indicates consistency of the measurement result, indicating a higher accuracy. The final version of the scale exhibited a reliability coefficient of 0.908, indicating a relatively high reliability.

Table 6. Item Distribution based on Exploratory Factor Analysis Result

Factor	Aspect	No. of item	Total of item	Loading
1	Behavior	44, 48, 50, 34, 35, 45, 49, 21	8	25%
2	Context	56, 57, 1, 31, 32, 3, 60, 8, 24	9	25%
3	Cognition	12, 30, 54, 9, 5, 53, 10	7	25%
4	Motivation	15, 17, 11, 20, 26	5	25%
Total			29	100%

In terms of construct validity, the distribution of 32 items (Table 6) is different from the blueprint (Table 5), three items of the final version even exhibited a factor loading lower than the recommended values (i.e., A28, A39, and A42). As shown in Table 5, item A50 (There is always a surprise in a task that draw my interest to do it) was intended to measure the context aspect, yet the exploratory factor analysis (Tables 5 and 6) showed that it tends to measure the behavioral aspect, like item A44 (“I read some additional literature to extend my understanding in the classroom.”) and A45 (“I only study in the classroom”). In addition to item A50, other items were also repositioned, indicating that the construct validity of this scale is not strong enough and requires factor structure improvements. Kurniastuti & Azwar (2014) report that the factor structure of their student well-being scale also needs further improvement. Although they developed a different measurement, they use the same construct validity test method, i.e., exploratory factor analysis. Their study reports the factors affecting the factor analysis result, including items that are not in line with their place due to inter-item correlation that does not suite the measured construct. Similar condition appears to occur in the present study, as writing an item is challenging as it should matches the construct. In order to construct an item, it is necessary to formulate the indicator of each aspect. In the present study, the four SRL aspects were derived into different indicators. However, the factor analysis result showed that some items overlapped, despite the professional judgment done to ensure the relevance. This should be valuable reminder for future studies regarding the item relevance with the measured construct.

The validity and reliability tests showed that the developed SRL scale exhibited adequate psychometric properties, indicated by reliability coefficient of 0.908, average discriminating power of 0.642, and content validity coefficient of 0.836. However, its construct validity requires further evaluation. The scale’s poor empirical evidence of the construct validity emerges as the limitation of the present study, in addition to the respondents’ factor who were mostly undergraduate students (92%).

Conclusion

Overall, the developed self-regulated learning scale exhibited adequate psychometric properties, indicated by its reliability coefficient, average discriminating power, and content validity, yet it lacks strong empirical evidence of the construct validity. In this regard, future studies are recommended to strengthen the empirical evidence of the construct validity while involving more diverse respondents.

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