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The construct validity of self-regulated learning questionnaire for senior high school students: a Rasch model analysis

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ABSTRACT

Self-regulated learning (SLR) is a condition in which students actively participate in the process of acquiring knowledge, and it closely relates to students' metacognitive, motivational, and behavioral aspects. In order to measure this variable, an instrument was developed by referring to the Zimmerman cycle in the form of a questionnaire. Therefore, this study aims to analyze the construct validity of SLR questionnaires designed for high school students through Rasch model analysis. The method employed was descriptive quantitative research. The analyzed questionnaire consists of 50 positive statements, rated on 4-point Likert scale, and arranged of forethought, performance, and self-reflection phases. Furthermore, the construct validity was conducted on 235 third grade (XII) high school students in Gunungsitoli City (Indonesia), with a gender distribution of 58.29% female and 41.70% male. The results showed that the questionnaire with 4-rating scales satisfied the criteria for validity, gender inclusiveness, and unidimensionality based on Rasch model analysis for 25 statements. The implication of this research shows that the SLR questionnaire developed is valid and can be used in wider field research, especially in mathematics learning.

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1. INTRODUCTION

Instructional and accompanying impacts are important components in preparing a learning model. Moreover, a successful learning process depends on the model's ability to provide these components for students. The instructional implications are related to cognitive abilities that are explored through the application of the learning model, while the accompanying impact pertains to the affectiveness that follows the improvement of cognitive abilities. Self-regulated learning (SRL), a technique whereby students use self-awareness and self-reflection to monitor and regulate their own capacities and responses to internal and external contexts, is one of the student outcomes [1]–[3]. Cognitive, metacognitive, behavioral, motivational, and emotional aspects of learning are all included in SRL [4]. It is a broad field that comprehensively explains variables such as self-efficacy, willpower, and cognitive strategies, affecting student learning outcomes [5]. Alvi and Gillies [6] reported SRL as a proactive process in which students activate, change, and maintain their learning, incorporating both formal and informal experiences. It was further elaborated that learning is not passive but an active process that students need to engage in proactively. Furthermore, SRL is part of students' proactive process to acquire academic skills.

SRL can be viewed as a constructive process in which students set learning goals. The process involves guiding students in monitoring, regulating, and controlling their cognitive abilities, motivation, and behavior according to pre-determined learning goals and environment [7]. Wang and Sperling [8] stressed the role of student-directed behavior, motivation, and cognition in managing issues relating to academic goals. Therefore, this becomes one of the important sub-factors contributing to learning outcomes [9]–[13]. Students' SRL can be measured using non-test instruments, such as a questionnaire developed with reference to the Zimmerman cycle [14]. The questionnaire was divided into the forethought, the performance, and the self-reflection phases. Furthermore, it was based on the Zimmerman cycle oriented towards motivation and strategy and included six subscales: planning, self-monitoring, self-evaluation, self-satisfaction, self-efforts, and self-efficacy [15]. The forethought, performance, and self-reflection phases include planning and self-efficacy, self-monitoring and self-efforts, as well as self-evaluation and self-satisfaction, respectively.

The developed questionnaire cannot be applied directly in measuring students' SRL. It should first undergo the construct validity to assess its suitability, precision, and absence of gender bias in measuring SRL. The construct validity of the SRL questionnaire intended for high school students was determined using item response theory (IRT) and Rasch model measurement analysis [16], [17]. The Rasch model is an IRT-based measurement analysis developed by George Rasch, and the joint maximum likelihood estimation (JMLE) equation was used to convert raw data into interval data (logit) [18], [19]. The results were represented using a Wright map, which provides information on the individual student abilities and the difficulty of SRL statement items. Furthermore, the Wright map indicates the ability level of each student in responding to the questionnaire and the difficulty level of statement items. Therefore, this study aims to analyze the construct validity of SRL questionnaire developed for high school students using the Rasch model analysis.

2. RESEARCH METHOD

This study used a descriptive quantitative method by developing a SRL questionnaire consisting of six subscales and 50 positive statements referring to the Zimmerman phase. The rating was conducted using a 4-point scale ranging from strongly agree to disagree. The questionnaire was tested on 235 high school students in Gunungsitoli City, Nias Island, Indonesia in August 2022. Furthermore, the content validity of the statement was assessed by experts and deemed appropriate for the construct validity. The statement items of SRL questionnaire developed in this study are presented in Table 1.

Table 1. Details of the number of statement items in SRL questionnaire using six sub-scales

No.	SRL phase	Phase description	Sub-scale	Questionnaire item code
1.	Forethought phase	The phase where students analyze tasks, set goals, plan how to achieve them, and several motivational beliefs in providing positive energy to the learning process, as well as influencing the activation of learning strategies provided by the teacher.	Planning	PLAN1, PLAN2, PLAN3, PLAN4, PLAN5, PLAN6, PLAN7, PLAN8, PLAN9
			Self-efficacy	SE1, SE2, SE3, SE4, SE5, SE6, SE7, SE8, SE9, SE10
2.	Performance phase	The phase where students carry out the task while monitoring their learning progress and using self-control strategies to keep themselves engaged and motivated to complete the task.	Self-monitoring	SM1, SM2, SM3, SM4, SM5, SM6, SM7
			Self-efforts	SF1, SF2, SF3, SF4, SF5, SF6, SF7, SF8, SF9, SF10
3.	Self-reflection phase	The phase where students assess how satisfied they are with completing the task and make attributions about their success or failure in the learning process.	Self-evaluation	SV1, SV2, SV3, SV4, SV5, SV6, SV7, SV8
			Self-satisfaction	SS1, SS2, SS3, SS4, SS5, SS6

The criteria utilized to assess the validity of SRL questionnaire, as determined by Rasch model analysis, include i) the accepted outfit mean square (MNSQ) value of $0.5 < \text{MNSQ} < 1.5$; ii) the accepted Z-standard (ZSTD) outfit value of $-2.0 < \text{ZSTD} < +2.0$; and iii) the point measure correlation (Pt. mean corr) value of $0.4 < \text{Pt. Mean Corr} < 0.85$ [20]–[22]. Non-compliance with these criteria ascertained that the questions and statement items were not good enough and needed to be corrected or replaced. This will ensure that the level of SRL is indeed tested through appropriate and quality statement items. It should be noted that the ZSTD value is strongly affected by the sample size or study subject. In studies with a large sample size or participant pool, it is common for the ZSTD value to always be above 3 (ZSTD>3). Therefore, some experts recommend not using this value criterion when the study subject used is large ($N > 500$) [17], [22].

Proof of the construct validity on the SRL questionnaire was also conducted using the item, such as dimensionality with the criterion that the non-test instrument developed, can measure a range of variables or subjects' responsiveness to the question items when the raw variance explained by measures is above 40% [16], [23]. The reliability of the questionnaire was determined through the Cronbach alpha value (KR-20), which is the interaction between the person and the whole item. The alpha Cronbach reliability value in the

interval $0{,}70 \leq \text{KR20} \leq 0{,}80$ or with a reliability measurement interpretation value of "Good" indicates that the non-test instruments are suitable for study purposes [16], [21].

3. RESULTS AND DISCUSSION

The SRL questionnaire, which had undergone expert content validity, was further revised according to the suggestions and input. A sample of 235 students participated in the construct validity by responding to the 50 positive statements with four rating scales. Furthermore, this analysis was conducted with the assistance of the WINSTEPS application. The summary of the Rach model analysis on the SRL questionnaire is presented in Table 2. The results of the construct validity analysis for each statement on SRL questionnaire are presented in Table 3.

Table 2. Statistical summary based on Rasch parameters

	Person	Item
N	235	50
Mean	165.1	776
Mean measure	0.34	0.00
SD	0.99	0.84
SE	0.06	0.12
Mean outfit ZSTD	−0.53	0.19
Mean outfit MNSQ	1.00	1.05
Separation	4.56	8.81
Reliability	0.95	0.99
Cronbach's alpha	0.96	

Table 3. The construct validity test results of non-test SRL instruments using IRT-Rasch model analysis

SRL statement code	MNSQ outfit	ZSTD outfit	PT measure corr.	SRL statement code	MNSQ outfit	ZSTD outfit	PT measure corr.
PLAN1	0.90	−1.09	0.52	SF1	0.69	−3.78	0.61
PLAN2	0.61	−4.92	0.59	SF2	0.73	−3.33	0.67
PLAN3	1.01	0.16	0.50	SF3	0.84	−1.84	0.63
PLAN4	0.88	−1.42	0.57	SF4	0.82	−2.08	0.55
PLAN5	1.01	0.16	0.52	SF5	0.81	−2.30	0.62
PLAN6	1.22	2.13	0.47	SF6	0.70	−3.64	0.61
PLAN7	1.10	1.08	0.54	SF7	0.84	−1.94	0.62
PLAN8	0.65	−4.45	0.64	SF8	0.83	−2.03	0.61
PLAN9	1.15	1.61	0.52	SF9	1.43	3.95	0.58
SE1	0.80	−2.45	0.62	SF10	1.19	1.87	0.62
SE2	0.75	−3.03	0.62	SV1	1.77	6.44	0.49
SE3	0.72	−3.37	0.60	SV2	1.31	2.94	0.59
SE4	0.99	−0.09	0.49	SV3	1.93	7.60	0.55
SE5	1.00	0.00	0.57	SV4	3.27	9.90	0.27
SE6	1.33	3.43	0.53	SV5	1.03	0.30	0.68
SE7	1.02	0.27	0.58	SV6	1.07	0.72	0.69
SE8	1.00	0.03	0.57	SV7	1.07	0.72	0.69
SE9	0.70	−3.53	0.54	SV8	1.22	2.10	0.56
SE10	0.66	−4.18	0.56	SS1	1.23	2.18	0.57
SM1	0.77	−2.67	0.58	SS2	1.18	1.72	0.63
SM2	0.93	−0.81	0.53	SS3	1.19	1.89	0.64
SM3	1.02	0.27	0.54	SS4	1.27	2.58	0.64
SM4	0.77	−2.78	0.60	SS5	1.19	1.85	0.63
SM5	0.62	−4.64	0.59	SS6	1.03	0.36	0.70
SM6	0.96	−0.47	0.54				
SM7	0.78	−2.67	0.62				

Table 3 shows that 25 out of 50 statements failed to meet the valid criteria based on IRT analysis using Rasch model measurement analysis. The unmet criteria appear in the ZSTD outfit value, where the accepted intervals are $-2.0 < \text{ZSTD} < +2.0$. Statement items coded PLAN2, PLAN6, PLAN8, SE1, SE2, SE3, SE6, SE9, SE10, SM1, SM4, SM5, SM7, SF1, SF2, SF5, SF6, SF9, SV1, SV2, SV3, SV4, SV8, SS1, and SS4 have ZSTD outfit values outside the accepted interval. Furthermore, SV4 does not meet the requirements of outfit MNSQ and PT measure corr., where the acceptance criteria are $0.5 < \text{MNSQ} < 1.5$ and $0.4 < \text{Pt}$. Table 3 shows that the ZSTD outfit values on statement codes SF4 and SF8 exceed the criteria. However, they are still valid since the value is close to the accepted interval.

The results of the construct validity analysis on SRL non-test instrument are in line with the content validity provided by the raters. Invalid statements tend to have ambiguous meanings, difficulty understanding, and overlap with other statements. The experts also recommended reducing the number of statements, as 50 is quite a large number and can cause discomfort in providing an answer that matches their feeling and experience [24]. The number of statements in one questionnaire should be around 25-30 [25]. The raters' recommendations regarding some ambiguous statements were reinforced by the results of the construct validity analysis, which also provided information related to the reliability value of the instrument, as measured by the Cronbach's alpha value (KR-20), calculated to be in the "Excellent" category [21].

Further analysis showed that the person separation index on the construct validity of SRL non-test instrument yielded a value of greater than 2 (4.56). As stated by several researchers [26], [27], the person separation value should be more than 2 logits, with the greater value indicating higher test quality. The results of the construct validity analysis showed that the questionnaire could measure the range of variables or the responsiveness to question items. This is because the value of raw variance explained by measures on item-dimensionality is above 40%. The level of difficulty of SRL questionnaire statement can be visualized in the Wright map presented in Figure 1.

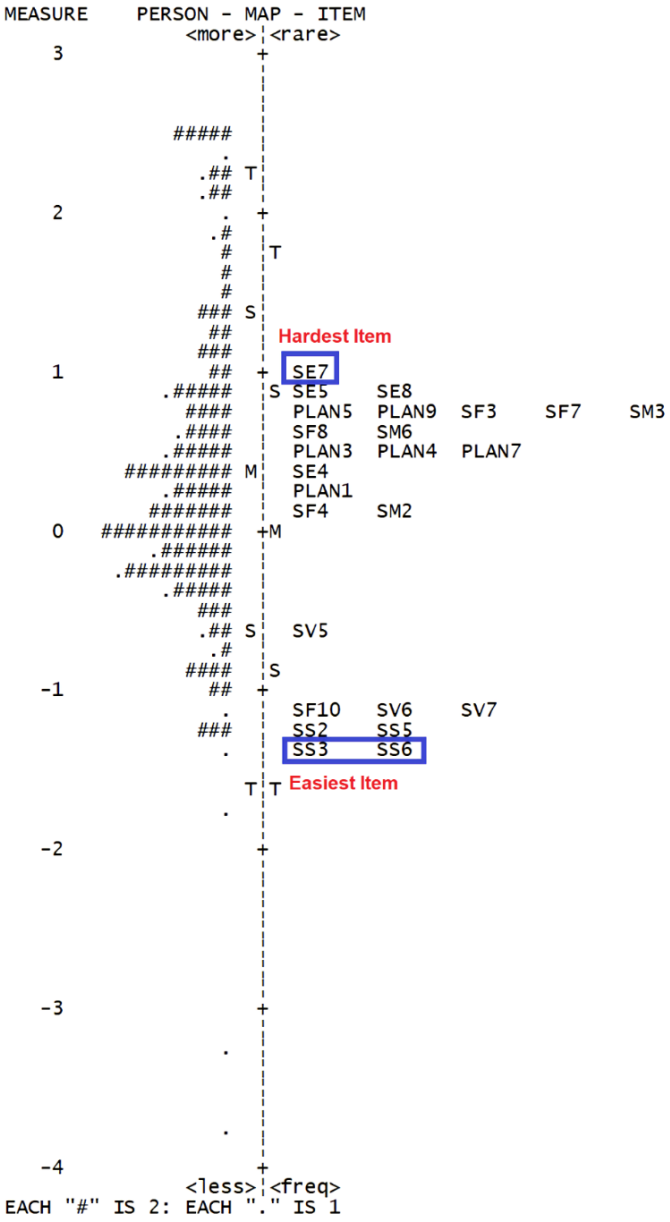

Figure 1. Wright map of SRL questionnaire

Differential item functioning (DIF) analysis is an analysis to check whether the statement items in the developed questionnaire have a bias towards the gender of the students or not [28]. DIF analysis provides advice on the responses given by students for each statement item that measures SRL. DIF analysis has three categories: negligible, slight to moderate ($|D| \geq 0.43$ logits), and moderate to large ($|D| \geq 0.64$ logits) [29], [30]. The DIF analysis presented in the Figure 2 shows that the statement items coded SM5 and SE6 are proven to have gender bias in the moderate to large. The researcher then confirmed again what underlies the two statement items have gender bias. The confirmation results show that both statement items are included in the misfit item group, so gender bias is possible in both statement items. Statement items code SM5 and SE6 show that the two statement items are more difficult to respond to both male and female students.

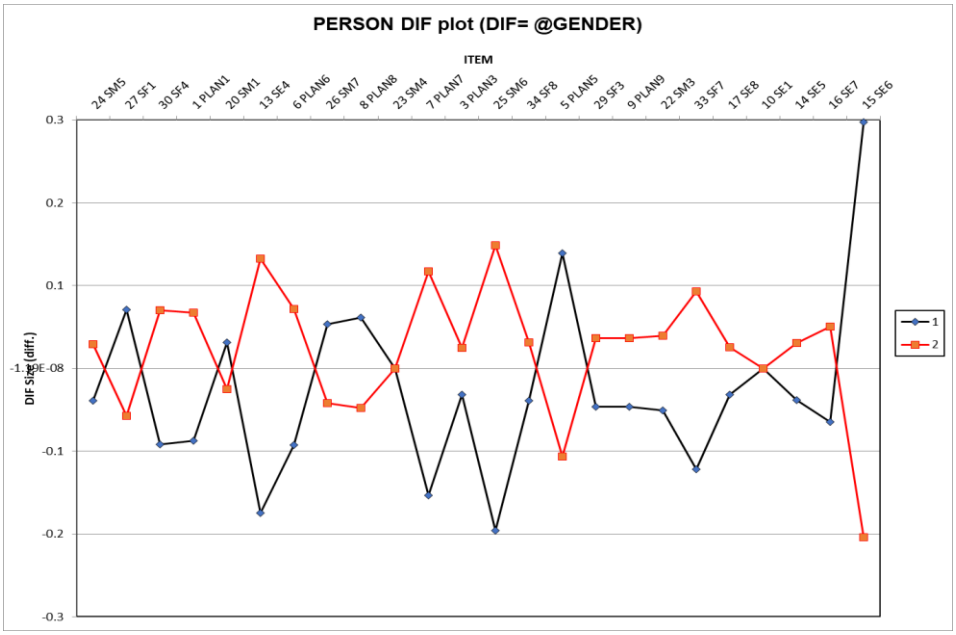

Figure 2. DIF based on gender

The construct validity of SRL questionnaire is crucial to ensure its effectiveness in measuring students' SRL precisely and without gender bias. An instrument free from gender bias will facilitate students' response to the statement item given [31]. The statement is not difficult, as the sentences have clear meanings. The construct validity of SRL questionnaire has been conducted before applying the questionnaire in the field study and the learning process. Studies by Jansen *et al*. [32] performed construct validity on SRL instruments developed for online learning. The results showed that all the statements were valid and could measure students' metacognition activities. Broadbent *et al*. [33] validated the online-based SRL instrument. The findings indicated that the ten aspects-including online self-efficacy, intrinsic motivation, extrinsic motivation, online negative achievement emotions, planning and time management, metacognition, learning environment, effort regulation, online social support, and ten online task strategies-were useful and valid. Khampirat [34] validated SRL instrument using three different methods. Furthermore, the instrument analyzed was the motivated strategies for learning questionnaire (MSLQ). The results showed that the original version of this questionnaire was valid and reliable, hence, it could be used. Previous studies concerning the validity of instruments, particularly those for SRL, have emphasized the significance of validity before measurement. This ensures that the results are reliable and valid, providing accurate response data.

4. CONCLUSION

The construct validity of SRL questionnaire using Rasch model analysis showed that 25 out of 50 positive statements were valid and reliable. Some of the invalid items include codes PLAN2, PLAN6, PLAN8, SE1, SE2, SE3, SE6, SE9, SE10, SM1, SM4, SM5, SM7, SF1, SF2, SF4, SF5, SF6, SF8, SF9, SV1, SV2, SV3, SV4, SV8, SS1, and SS4. The ZSTD Outfit value in SF4 and SF8 exceeds the criteria. However, they

were still included in the valid criteria because the outfit ZSTD value is close to the accepted interval. The construct validity results of the questionnaire yielded 25 valid, reliable, did not have gender bias, and met the criteria of unidimensionality statement items to be used in measuring students' SRL. Therefore, teachers and other study analysts who want to measure students' SRL in any subject should use this valid and reliable questionnaire. This study is limited to construct validation of the developed SRL questionnaire. The developed questionnaire is also specifically for use in measuring students' SRL during the mathematics learning process. Therefore, this questionnaire can be developed more widely to measure students' SRL during other learning processes, such as science, social, and other learning. The SRL questionnaire that has been constructively valid based on the results of this study can then be used in wider field research.

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