Development and Validation of Questionnaire on Self-Regulated Learning Strategies in Online Learning Environment

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Abstract
Covid-19 has resulted in a sudden shift in education settings, from face-to-face to online learning sessions. In view of this major change, it is necessary to study students' self-regulation strategies in an online environment to enable the teachers to develop online materials that will guide students to become successful in their learning. This study aimed to develop and validate a questionnaire on students' self-regulated strategies in an online learning setting. The instrument was named questionnaire on self-regulated learning in an online learning environment (QSROLE). QSROLE consists of 17 items that describe the measure of students' self-regulation strategies in a digital learning environment. A total of 226 students served as respondents. The students' responses were based on a 4-point scale ranging from 1 (Strongly Disagree) to 4 (Strongly Agree). Results from the exploratory factor analysis provided evidence for the four-factor self-regulated learning strategies with KMO coefficient and Bartlett's Sphericity value of .905 and .000, respectively, and total variance of 58.207%. Further, internal reliability had an acceptable level based on the Cronbach's alpha coefficient of .840 for Factor 1 (Establishing Self-Study Strategies); .765 for Factor 2 (Managing Structured Learning Environment); .744 for Factor 3 (Exercising Time Management); and .612 for Factor 4 (Setting Online Learning Goals). Results indicate that QSROLE is an acceptable and valid measure of students' self-regulation in the online learning environment.

Keywords: Self-Regulated Learning Questionnaire, Learning Mathematics, Online Learning

Introduction

The COVID-19 pandemic has changed the globe and has altered many aspects of human activities. Therefore, it resulted in profound effects on the economic, political, cultural, and even educational environments of societies worldwide. There has been a shift from traditional classes into online learning.

The universities in the Philippines had to adapt to the different socioeconomic status of the students. They cannot provide courses on a fully online modality as many Filipino students present many challenges since the reopening of classes due to lack of devices and unreliable internet services. These challenges lead to the promotion of flexible learning to education institutions, both private and public, in the country. The teachers transferred to alternative teaching modalities focusing on both synchronous and asynchronous based on the students' capacity.

Regardless, the rapid promotion of online development provides a supplement to a traditional educational format. The study of Barnard, Lan, To, Paton, and Lai (2009) identified the distinctive role of students' autonomy in the online learning environment. The students in this setting have the freedom to move from one learning matter to another without any limitations in terms of prearranged instruction or sequence. This relates to the self-regulation of students as one of the essential variables for the performance of online learning.

Barry Zimmerman, one of the most prolific researchers on self-regulated learning, defines self-regulation as not a mental ability nor academic skills but more of becoming aware of one's knowledge, motivation, and behavior so that the learner can employ that awareness applicably (Weimer, 2010). The students with self-regulation participate actively in their learning as they become responsible for their learning objectives and appropriate strategies to realize those objectives. That is, the student develops approaches to deal with their learning process.

Academic skills, such as expertise in mathematics, necessitate numerous hours of practice. Students need chances or opportunities to practice and to cultivate their learning strategies on their own. Empirical researches showed that Self-regulatory learning strategies was correlated with students' academic performance. The study Cleary et al. (2017) and Desoete et al. (2003) stated that the SRL intervention increases middle school students' mathematics success and performance. Similarly, Flavel (1971) mentioned that metacognition is one of the components of self-regulation. In the study of Stephens and Underwood (2008), they stated that self-regulation comprises not only regulating the learners' cognitive aspect but also their emotional and motivational practices.

Technology, depending on the types of delivery, plays a crucial role in students' learning progress. That is, when referring to self-regulation for online learning, the impact of technology has been taken into account instinctively. Compared to the conventional teacher-centered classroom setting, online learning is more student-centered, and students take on more responsibilities, especially in asynchronous learning environments.

In online mathematics education, the concept of self-regulated learning is also discussed. The study of Fung. et al. (2021) clearly supports the importance of online learning as a tool for all students of all ages to encourage mathematical progress. They stated that this new way of communicating with mathematics played a crucial role in engaging the students. In particular, students' mastery of mathematical concepts and skills involves students connecting and seeing the relationships of each information to create a deeper understanding (Haylock, 2010). In terms of efficient online classes, the online environment provides an environment to deliver mathematics programs where students will learn by themselves while communicating with their instructors.

However, when students do not have the same capacity to cope with the knowledge they are given or know how to learn with limited instruction, the educational activities in an autonomous learning setting can be daunting for the unprepared learner. If the students cannot self-regulate, the knowledge provided to them, most specifically in Mathematics, might not be adequate. In the online environment, the lack of students' self-regulation may misinterpret the autonomy in digital learning. Therefore, the researcher believed that it is important to study self-regulation in an online setting to allow students to succeed in learning mathematics. This may allow the students to regulate their learning as they utilize their strengths and improve their weaknesses. With this, there have been many attempts to explore how to measure students' self-regulated learning.

There are various ways in which self-regulated learning has been measured empirically. The Motivated Strategies for Learning Questionnaire (MSLQ) was developed to assess the types of learning strategies and students' academic motivation. However, Cho and Summers (2012) discussed that additional works are needed to use this instrument for distance learning as it was designed for face-to-face education. Barnard et al. (2009) addressed the need for measuring self-regulation in a blended learning environment. Their instrument is named Online Self-Regulated Learning Questionnaire (OSLQ) and comprises 24 items under six different factors; Goal setting, Environment Structuring, Task Strategies, Time Management, Help-Seeking, and Self-evaluation. This study also examined the relationship between self-regulated learning and academic performance in pure online courses. Similarly, Kocdar et al. (2018) aimed to measure self-regulation in self-paced, open, and distance learning environments. Their instrument involves five factors: goal setting, Help-Seeking, Self-study strategies, Managing physical and environment, and Effort regulation on a 30-item scale.

Nevertheless, it is also important to better understand students' SRL strategies in a flexible digital learning environment in learning mathematics. Since students learn not only in one setting but in an environment containing different possibilities covering the teaching and learning process; specification of the task, support in the learning process, and giving feedback (Schunk & Ertmer, 1999; Perry, Fisher, Caemmerer, Keith, & Poklar, 2015; Pérez-Álvarez, Maldonado-Mahauad, Sapunar-Opazo, & Pérez-Sanagustín,2017) may be assimilated either in synchronous or asynchronous online settings, as some of the online activities may be accessed with the Internet and some activities are for asynchronous or self-paced learning, the notion of learning self-regulation concentrates on the students' activities, planning, monitoring, and evaluating their learning (Stephens and Underwood 2008). The literature confirmed different attributes of learning self-regulation. These defined points enable the researchers to

expedite an instrument that will measure the learners' self-regulatory strategies in a flexible online learning environment.

In this regard, this research aims to develop and validate the Questionnaire on Self-Regulation in Online Learning Environment (QSROLE). This study was conducted to address the students' self-regulation strategies in learning mathematics under flexible online settings. This research aimed to measure the learners' self-regulated strategies in a flexible online mathematics course. With this, educators can promote self-regulation strategies and develop more comprehensive online students' programs in the flexible online learning environment.

Methods

This study aimed to validate a questionnaire to measure students' self-regulation in learning mathematics in a digital environment. The researchers used Exploratory Factor Analysis. This statistical method is used to increase the observed scale's reliability by classifying unfitting items removed from the instrument. The dimensionality of constructs is also identified by analyzing relations among the items (Yu & Richardson, 2016). Yong and Pearce (2013) mentioned that EFA is useful to recapitulate relationships and patterns in the data. The instruments' items were based on literature that defined the key attributes for supporting self-regulation in an online environment. Some selected items were adapted from the instruments developed by Barnard et al. (2009) and Kocdar et al. (2018).

Participants

Two hundred twenty-six students participated in this study, and their level of education included Basic Education (37.6%), Tertiary Level (54%), and Graduate School Level (8.4%). One hundred and sixty-two female students (71.7%) and sixty-four (64%) male students participated. The majority of the participating students in this study were between 18-20 years old (74.3%).

Concerning the number of hours allotted for online learning, 39.4% answered between 0.5-2 hours of studying. Therefore, from the descriptive statistics, one may conclude that most of the students are doing their activities both in synchronous and asynchronous systems.

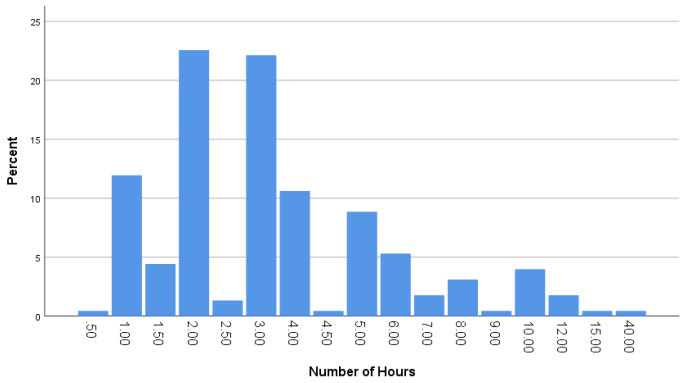

Figure 1: Number of Hours allotted for Online Learning in Mathematics

Measures

The Questionnaire on self-regulation in the online learning environment (QSROLE) is initially a thirty-item self-report measure specifically developed to measure the students' self-regulated strategies, emphasizing learning mathematics in a digital learning setting. The QSROLE is scored by a four-point Likert scale (4=Strongly Agree, 3=Agree, 2=Disagree, and 1= Strongly Disagree). A high score signifies a better evaluation of self-regulation in an online learning environment than low scores.

Research Question

The study set out to answer the following question:
What are the underlying dimensions of the Questionnaire on self-regulation in the online learning environment (QSROLE)?

Results

An Exploratory Factor Analysis was performed on the 30-items with a Promax Rotation using SPSS Version 25. A total of 226 students participated in the survey. There are no missing values from the gathered data.

The researchers run the initial analysis to obtain the eigenvalues for each factor in the data. The Kaiser-Meyer-Olkin (KMO) and Bartlett's test establishes if the obtained data are appropriate for the factor analysis. The KMO coefficient indicated whether the sample size was suitable. While Bartlett's test results, if found to be significant, denote that the obtained data set was suitable for Exploratory Factor Analysis.

The Promax Rotation is a non-orthogonal rotation that allows correlated factors. As a result of the initial rotation, eight obtained factors were 63.635% of the total variance. Then, the communalities lower than 0.40, and the cross-loadings with primary loadings lower than 0.20 than the secondary on the other factors were noted (Howard, 2015). The items excluded from the measures were 2nd,3rd, 4th, 5th, 6th,7th, 9th,18th, 22nd, 25th, 26th,27th,29th. The factor analysis again observed the changes where the KMO and Bartlett Sphericity significant values of the scale (four factors) then became .905 and .000, respectively, and the total variance was 58.207%. The Bartlett's test and the KMO value results are presented in Table 1.

Table 1: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.905
Bartlett's Test of Sphericity	Approx. Chi-Square	2842.733
	df	435
	Sig.	0.000

Meanwhile, the figure below shows that the breakpoint appeared after the 4th factor, hence this implies that there will be a four-factor scale.

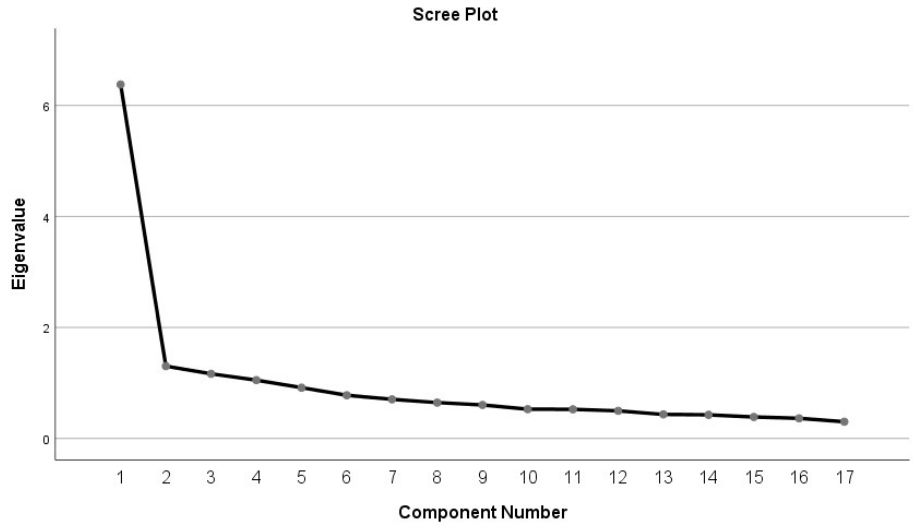

Figure 2: The Scree Plot indicating the number of factors

Table 2: Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	6.377	37.511	37.511	6.377	37.511	37.511	5.302
2	1.303	7.663	45.173	1.303	7.663	45.173	4.279
3	1.165	6.850	52.024	1.165	6.850	52.024	3.203
4	1.051	6.183	58.207	1.051	6.183	58.207	3.567
5	0.915	5.380	63.587				
6	0.778	4.577	68.164				
7	0.705	4.146	72.310				
8	0.646	3.799	76.109				
9	0.603	3.548	79.658				
10	0.527	3.102	82.760				
11	0.525	3.086	85.846				
12	0.497	2.925	88.770				
13	0.433	2.546	91.316				
14	0.425	2.501	93.818				
15	0.387	2.278	96.096				
16	0.363	2.134	98.230				
17	0.301	1.770	100.000				

Correspondingly, Table 2 shows that a four-factorial structure explained 58.207% of the total variance. Broadbent and Poon (2015) confirmed in SRL meta-analysis in online learning settings that academic achievement is strongly and positively related to SRL strategies. They have concluded that students with good Time Management, who are aware of their learning behaviour, who are logical thinkers in the class content, and who persevere in their comprehension of the course materials are more likely to succeed in the online learning world.

Moreover, Artino (2007) and Puzziferro (2008) revealed that Task value, Metacognition, Rehearsal, and Study environment were one of the predictors for self-regulated learning in online settings.

Hence, the identified four factors in the QSROLE were Establishing Self-Study Strategies, Managing Structured Learning Environment, Exercising Time Management, and Setting Online Learning Goal. The intercorrelations among their values and the distribution of 17 items across the four factors were presented in the table below.

Table 3: Rotation of the variables

	1 (Establishing Self-Study ...	2 (Managing Structured	3(Exercising Time Manage...	4(Setting Online Learning Goals)
21. I draw up draft of reading material to be able to organize my thoughts.	0.888			
16. I summarize my learning in the subjects to understand what I have learned from the lessons.	0.704			
24. I think of the questions on the subject while reading the material.	0.696			
28. I ask myself questions about what I am to study before I begin to learn.	0.686			
23. I organize my study time to accomplish my goals to the best of my ability.	0.652			
19. I have a regular place to study.	0.487			
30. I know when I need to learn more about something.	0.474			
15. I find someone who is knowledgeable in course content so that I can consult with him or her when I need help.		0.778		
12. I communicate with my classmates to find out what I am learning that is different from what they are learning.		0.740		
11. I choose the location where I study to avoid too much distraction.		0.716		

17. I choose a place with few distractions for studying for my online courses.	0.666		
14. I try to schedule the same time every day or every week to study for my online courses, and I observe the schedule.		0.871	
13. Although we don't have to attend daily classes, I still try to distribute my studying time evenly across days.		0.666	
10. I allocate extra studying time for my online courses because I know it is time-demanding.		0.526	
1. I set standards for my assignments in online courses.			0.814
8. I keep a high standard for my learning in my online courses.			0.708
20. I determine what I will ask before receiving help.			0.573

The researchers performed item analysis to identify the internal reliability of each four factors. Taber (2016) and Ahdika (2017) stated that reliability coefficients higher than 0.70 could be regarded as reasonable and adequate and 0.40-0.60 as quite reliable. The Cronbach's alpha coefficient of each factor in this study was found close to be .840 for Factor 1 (Establishing Self-Study Strategies); .765 for Factor 2 (Managing Structured Learning Environment); .744 for Factor 3 (Exercising Time Management); and .612 for Factor 4 (Setting Online Learning Goals). Considering the following coefficients, it was clear that the scale also had an acceptable level of reliability based on the factors.

Table 4: Cronbach's Alpha for Factor of the QSROLE

	Cronbach's alpha	Number of items
Establishing Self-Study Strategies	0.840	7
Managing Structured Learning Environment	0.765	4
Exercising Time Management	0.710	3
Setting Online Learning Goals	0.612	3

Conclusion

Online learning created an immense impact for Filipino students. Environmental and learning autonomy as a form of educational changes relates to support for students' self-regulatory ability. Considering the potential advantages of learning online, the assurance of the digital learning settings indicates a need to measure students' self-regulation in learning mathematics. This helps teachers develop online resources and materials that will guide learners to become effective in their online learning.

The study resulted in the Exploratory Factor Analysis, which gives a four-factor structure of the instrument measuring the students' self-regulation in the Online Learning Environment. Seventeen items have remained, and each factor has some acceptable reliabilities.

As a direction for future research, it is proposed to do this study with students from other universities across the country to overcome statistical sampling bias for further validation. The Confirmatory Factor Analysis is also recommended as the second phase of this instrument.

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Appendices

Questionnaire on Self Regulation in Online Learning Environment (QSROLE)

Establishing Self-Study Strategies

1. I summarize my learning in the subjects to understand what I have learned from the lessons.
2. I have a regular place to study.
3. I draw up draft of reading material to be able to organize my thoughts.
4. I organize my study time to accomplish my goals to the best of my ability.
5. I think of the questions on the subject while reading the material.
6. I ask myself questions about what I am to study before I begin to learn.
7. I know when I need to learn more about something.

Managing Structured Learning Environment

1. I choose the location where I study to avoid too much distraction.
2. I communicate with my classmates to find out what I am learning that is different from what they are learning.
3. I find someone who is knowledgeable in course content so that I can consult with him or her when I need help.
4. I choose a place with few distractions for studying for my online courses.

Exercising Time Management

1. I allocate extra studying time for my online courses because I know it is time-demanding.
2. Although we don't have to attend daily classes, I still try to distribute my studying time evenly across days.
3. I try to schedule the same time every day or every week to study for my online courses, and I observe the schedule.

Setting Online Learning Goals

1. I set standards for my assignments in online courses.
2. I keep a high standard for my learning in my online courses.
3. I determine what I will ask before receiving help.