Article

DEVELOPMENT AND VALIDATION OF THE SELF-REGULATED LEARNING BEHAVIOUR SCALE (SRLBS) TO MEASURE THE IMPACT OF STUDENT SELF-ASSESSMENT

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ABSTRACT

Student self-assessment is one of the strategies that can be used to foster self-regulated learning. However, not all students are ready to be empowered in their learning and the different self-assessment implementations may have differential effects. The existing measures of self-regulated learning were mainly based on generic contexts and may not be adequate to measure the impact of a self-assessment intervention. This calls for the need to develop an instrument that may help examine the extent to which self-assessment influences students' self-regulated learning behaviour.

In this study, a 14-item instrument coined as a self-regulated learning behaviour scale was developed. This process involved perusing the literature to gather a list of self-regulated learning behaviours which in turn were used to craft the instrument items. Face validity and content validity were then established by an expert panel using the modified Delphi technique.

The instrument was piloted in a sample of 306 polytechnic students and instrument validation was performed using exploratory factor analysis. Results of the analyses revealed three subscales and the instrument was homogeneous. Validity of the instrument was confirmed by the expert panel.

Keywords: Self-assessment, self-regulated learning, instrument validation

STUDENT SELF-ASSESSMENT AND SELF-REGULATED LEARNING

Self-regulated learning is "an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behaviour, guided and constrained by their goals and the contextual features in the environment" (Pintrich, 2000, p. 453). Self-assessment is a process in which the learners judge the extent to which their performance is aligned to the criteria, and this input could guide their subsequent improvement of work (Andrade & Du, 2007).

The relationship between self-regulated learning and self-assessment has been described as intricate and reciprocal as both constructs are oriented towards involving learners in the assessment of their own performance (Panadero, Jonsson, & Botella, 2017). Panadero and Alonso-Tapia (2013) construe student self-assessment as a pedagogic strategy that facilitates self-regulated learning, as it heightens students' awareness of the objectives of the task and provides opportunities to monitor their own progress.

However, the effectiveness of student self-assessment has often been challenged due to concerns about students' readiness to take on this activity (Brown & Harris, 2012). For self-assessment to be effective in promoting self-regulated behaviour among learners, Andrade and Du (2007) asserted that students need to recognise themselves as active and authentic participants in the assessment of their own work, so that they can make adjustments to their performance based on self-monitored outcomes. Furthermore, Panadero, Jonsson, and Botella (2017) highlighted that differences in self-assessment practices as well as the agents who implement the self-assessment interventions (i.e. the teachers) may also bring about differential effects. It is therefore our interest to gather empirical data on students' perceptions of the extent to which their self-assessment experiences influence their behaviour, particularly their ability to regulate their own learning.

INSTRUMENTS TO ASSESS SELF-REGULATED LEARNING BEHAVIOUR

The theoretical models of self-regulated learning address three key domains—motivation, cognition, and behaviour (Pintrich, 2012; Zimmerman, 2002). However, cognitive theorists argue that one can be motivated but not learn, so it might be challenging to examine the association of motivation with self-regulated learning. Cognitive studies involve the examination of learner's thoughts, beliefs, and attitudes; and cognitive activities, being highly complex and abstract, can be difficult to assess.

Student self-regulation involves deliberate attention to their own behaviour, establishment of the relationship between their behaviour, and the outcomes and modification of their subsequent behaviour strategically. Students' behaviour, ranging from the way they select and acquire knowledge, check for comprehension and learning progress, to how they make plans to assess learning goals, are conceptualised as learning strategies (Tock & Moxley, 2017; Weinstein & Mayer, 1983). This study focuses on overt self-regulated behaviours which include metacognitive self-monitoring behaviours as evident by artefacts.

Instruments such as self-reported questionnaires, observations of overt behaviour, interviews, and keeping diaries were employed to measure self-regulation in education (Boekerts & Corno, 2005). Of the various instruments, the self-reported questionnaire was found to be relatively easier to design, administer, and score (Winnie & Perry, 2000). The Motivated Strategies for Learning Questionnaire (MSLQ) is an 81-item instrument that is used to determine the student's motivational orientation and learning strategies based on a self-regulation model (Pintrich, Smith, Garcia, & McKeachie, 1991). As self-regulated learning is context-specific, Credé and Phillips (2011) have critiqued that MSLQ may not be able to accurately assess the learning behaviours which tend to vary across tasks. Since our study intends to investigate the impact of self-assessment on self-regulated learning and MSLQ seems generic for our context, this reveals a need to develop a new instrument that is grounded on the context of self-assessment. The Learning and Strategies Study Inventory (LASSI) is a 77-item instrument developed by Weinstein, Schulte, and Palmer (1987) to measure use of learning strategies. LASSI is constructed based on a model of learning and cognition (Simon, 1979) as well as on a model of strategic learning (Weinstein, 1994). The latter model is grounded on the following three key components of strategic learning: skill, will, and self-regulation. However, Cano (2006) criticises LASSI for being a "complex measurement tool that assesses three interrelated but somewhat vague, latent constructs" (p. 1036). This calls for additional research to explore potential use of its subscales as an evaluation tool. Winnie and Perry (2000) also observe that LASSI was normed on undergraduates in a university. It is noteworthy that the average age of these undergraduate students was 22 years old, hence they may be more equipped with different metacognitive or learning strategies. As such, the generalisability of LASSI for other educational contexts was questionable. This further suggests a need to explore beyond this instrument to ensure validity of measurement in other contexts, such as tertiary level education in polytechnics.

This study aims to develop and validate a concise instrument that assesses the extent to which self-assessment affects the self-regulated learning behaviour in polytechnic students in Singapore. Many of these existing instruments comprise a long list of items and their extensiveness may increase the risk of respondent fatigue which could in turn compromise the quality of self-reported data. It is hoped that a more concise instrument not only helps to improve respondents' motivation to complete the questionnaire, but when used in classrooms, it could also encourage teachers to adopt the instrument to help them determine the effectiveness of instructional strategies to hone self-regulated learning behaviour.

METHOD

This study comprised two stages. The first stage involved instrument development using the modified Delphi technique. The next stage involved instrument validation to establish scale construct validity and internal consistency. The instrument was administered to a sample of 306 students from four subjects that employed self-assessment. These students were from the applied sciences, design, and business courses in a polytechnic. The next segment describes the instrument development which includes questionnaire design and item generation.

Instrument development: Self-regulated Learning Behaviour Scale (SRLBS)

Design of questionnaire and item generation

A literature survey was performed to gather a list of self-regulated learning behaviours. The pool of questionnaire items was developed by drawing from the work of Schunk and Ertmer (1999), Zimmerman (2002) as well as Pintrich (2012). Some of the items in the questionnaire developed by Schunk and Ertmer (1999) were adapted—specifically, two items pertaining to social-environmental resources were rephrased and included in the instrument to assess the participants' help-seeking behaviour. Of these two items, one sought to examine the participants' tendency to seek help from peers when unsure, while another item examined the participants' tendency to find peers who will give critical feedback. Descriptors on the behavioural regulatory strategies, such as intentional planning through goal-setting and self-monitoring, were adapted from Pintrich's (2012) conceptual framework and Zimmerman's (2002) self-regulatory process. These items were chosen in view of their perceived relevance in our context.

The original item pool comprised 22 items that describe the learning behaviours of self-regulated learning. The instrument took reference from MSLQ in that a 7-point Likert scale was used where 1 denotes "Not at all true of me", while 7 denotes "Very true of me". A 7-point Likert scale was selected because its wider scale affords a higher level granularity which allows respondents to make a finer discrimination as they select their response (Tourangeau, Rips, & Rasinski, 2000). Having described the development of the instrument, the next segment details validation of the instrument which includes procedures for the modified Delphi technique, survey administration, and validation data analysis.

Instrument validation: Self-regulated Learning Behaviour Scale (SRLBS)

Establishment of validity using the modified Delphi technique

Face validity refers to the extent to which the items appear to measure the intended construct, whereas content validity refers to the extent to which the instrument addresses the intended construct (Creswell, 2012). The face validity and content validity of the instrument were established using the modified Delphi technique. This refers to an iterative process that seeks consensus from an expert panel after rounds of evaluating the survey items by giving qualitative feedback as well as a rating based on the given criteria (Hasson, Keeney, & McKenna, 2000; Yousuf, 2007).

In this study, the members of the expert panel comprised four academic staff members each with at least 10 years of teaching experience. The expert panel examined the original 22-item questionnaire critically, and discussion amongst the members ensued to suggest the addition and/or removal of items, as well as to identify areas for improvement. In this modified Delphi technique, the expert panel provided only qualitative opinions. Feedback from the first round of examination informed the subsequent rounds of questionnaire enhancement. This process was repeated for two more rounds until consensus was obtained for the finalised questionnaire design. The original 22-item pool was reduced to 18 items after eliminating three items that seemed ambiguous and another one that was double-barrelled. The double-barrelled item touched upon two issues but only allowed one response. Closer scrutiny of the survey items revealed that few items explored beyond the self-regulated learning behaviours (eg. "I found the rubrics useful to help me judge the quality of my work independently"). After further removal of irrelevant items, the survey items was eventually trimmed to a final pool of 14 items.

Administration of the instrument

To reiterate, a total of 306 polytechnic students from the design, business, and applied science courses participated in this study. To examine the impact of self-assessment administered across different disciplines, four subject sites involving laboratory techniques (*n*=121), problem solving (*n*=72), design thinking (*n*=35), and project work (*n*= 78) were selected. A key consideration for the site selection was to cater to a diversity of contexts in which student self-assessment was deployed. The other consideration was to have a sample size of at least 300 students, typically deemed to be the minimum number for the validation of a survey instrument (Tabachnick & Fidell, 2007 cited in Cohen, Manion, & Morrison, 2011, p. 675).

Prior to the commencement of this study, approval from the respective heads of departments was sought to ensure that the study design was sound, and students' personal data would not be compromised. The researchers also explained the purpose of the study before they administered the questionnaires. The instrument was distributed during the lessons at the polytechnic. Students were given assurance that participation was purely voluntary and that they could choose to withdraw from completing the questionnaire at any time. Students were invited to seek clarification, if needed. In the questionnaire, respondents were asked to describe themselves by indicating on a 7-point Likert scale the extent to which the item was descriptive of their own characteristics. The instrument comprised a total of 14 items scored on a 7-point Likert scale, ranging from 1 ("Not at all true of me"), 4 ("True of me half the time"), and finally to 7 ("Very true of me"). They were encouraged to provide honest input and the researchers also clarified that there are no right or wrong answers.

Data analysis

Self-regulated learning behavior is multi-faceted and complex. As such, the instrument incorporated a pool of survey items where specific groups, when analysed collectively, will reflect each facet more accurately. In statistics, a facet is referred to as a factor. Exploratory factor analysis was employed as the key statistical technique to uncover the number of factors measured by the pool of survey items in this instrument (Ziegler & Hagemann, 2015).

The researchers conducted an exploratory factor analysis, using principal axis factoring with varimax and oblimin rotations, on the 14 items to explore the convergent validity and the factor structure of the instrument. The instrument's convergent validity, also known as internal consistency, was determined by analysing the Cronbach's coefficient alpha.

RESULTS

This section reports the findings of the instrument validation, achieved using exploratory factor analysis. The establishment of the ability of the items in the instrument to measure the same construct was reported by means of item unidimensionality testing. Derivation of the number of factors measured by the instrument was revealed through principal axis factoring. Cronbach's coefficient alpha values were reported to reflect the overall internal consistency of the instrument as well as for each factor. Finally, associations between the different factors were reported using the computed Pearson correlation coefficients.

Item unidimensionality

A unidimensional scale is one where systematic differences within the item variance are attributed to only one variance source, commonly termed as latent variable (Ziegler & Hagemann, 2015). As such, the items in a unidimensional scale should measure the same underlying construct (Fisher, King, & Tague, 2001). To test for item unidimensionality, item-total correlation coefficients were determined with the results reported in Table 1. Following the recommendations by Fisher, King, and Tague (2001), items with correlation coefficient of less than 0.3 were dropped from the scale. With this, all 14 items were retained in the scale, although one of the items had a correlation coefficient of only 0.372.

Table 1

Item-total correlation statistics

	Mean	Std. Deviation	Corrected Item-Total Correlation
Item1	5.29	1.306	.460
Item2	5.74	1.167	.555
Item3	5.12	1.282	.560
Item4	5.13	1.194	.666
Item5	5.13	1.195	.680
Item6	5.22	1.118	.708
Item7	5.28	1.120	.675
Item8	5.28	1.162	.752
Item9	4.89	1.141	.708
Item10	4.94	1.214	.711
Item11	5.26	1.208	.601
Item12	5.31	1.239	.658
Item13	5.13	1.427	.372
Item14	5.07	1.194	.584

Exploratory factor analysis using principal axis factoring

An exploratory factor analysis was conducted to examine the factorial structure of the original 14-item scale. To assess the suitability of the data for factor analysis, Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was computed. The overall KMO measure of sampling adequacy was 0.903, and since the value was greater than 0.7 (deVaus, 1991), the correlation among items was deemed sufficiently high to make factor analysis suitable.

Since the aim is to identify latent construct, principal axis factoring is preferred to principal component analysis (Fabrigar, Wegener, MacCallum, & Strahan, 1999). The number of factors retained were determined using the "Eigenvalues greater than 1" rule (Henson & Roberts, 2006). The factor analysis revealed three factors and this was illustrated by the Scree Plot. Only items with loading greater than 0.3 on that factor will be retained (Abd-El-Fattah, 2010). The three factors accounting for 47.7% of the variance were subjected to varimax and oblimin rotations. The % variance explained was comparable to the Self-directed Learning Aptitude Scale (SDLAS) and the Self-directed Learning Readiness Scale (SDLRS), where their % variance were 22% and 36.4% respectively (Abd-El-Fattah, 2010; Fisher, King, & Tague, 2001). As shown in Table 2, the two rotational methods (varimax and oblimin) yielded similar loading results for the 14 items.

The analysis retained three factors: help-seeking (HS; three items), self-monitoring (SM; six items), and strategic adaptation (SA; five items). Schunk (2014) viewed help-seeking as a self-regulatory behaviour as it involves regulating the social environment to promote learning. Self-monitoring enables the learners to gain awareness of their learning progress and take control of their learning (Pintrich, 2004). Strategic adaptation involves making key adjustments of learning strategies to improve or complete their work (Schunk, 2014).

Internal consistency reliability

Internal consistency reliability measures the extent to which the items on a subscale or test address the same construct. In this study, Cronbach's coefficient alpha was computed to assess the instrument's overall internal consistency as well as for each factor. According to the guideline from deVaus (1991), Cronbach's coefficient alpha greater than 0.7 signifies acceptable internal consistency. As such, the overall reliability of the scale with Cronbach's coefficient alpha of 0.909 was considered acceptably high. As reported in Table 2, the internal consistency of the three subscales was also within the acceptable range.

Table 2

Factor loadings and Cronbach's coefficient alpha of the SRLBS

Factor	Item No.	Item	Factor loading (Varimax rotation)	Factor loading (Oblimin rotation)	Cronbach's coefficient alpha
Help-seeking (HS)	1	During self-assessment, I seek help from my peers if I am unsure of what to do.	.722	.745	.751
	3	During self-assessment, I find peers who will give critical feedback on my work	.671	.740	
	2	During self-assessment, I use cues provided by tutor to improve on my work.	.526	.621	
Self-monitoring (SM)	6	I perform self-assessment to evaluate my own learning / judge my own work.	.815	.875	.900
	8	I perform self-assessment to keep track of my own learning.	.738	.846	
	7	I perform self-assessment to reflect on my strengths and weaknesses.	.786	.840	
	9	As part of self-assessment, I record my performance and review it to monitor my progress.	.554	.712	
	5	During the self-assessment process, I check if I have achieved my personal goals for the task assigned.	.566	.697	
	4	As part of the self-assessment process, I set specific goals for myself for the task assigned.	.506	.652	
Strategic adaptation (SA)	10	I perform self-assessment to come up with action plan to improve my work.	.733	.832	.801
	12	As part of self-assessment, I make a plan to complete my work.	.696	.774	
	11	After self-assessment, I modify my approach if I find the one I am using is not working well.	.634	.708	
	14	I feel more motivated to improve my work further after doing self-assessment.	.437	.567	
	13	I look for resources (e.g. textbook / internet) to improve my work after doing self-assessment.	.441	.466	

Inter-factor correlations

Associations were established between different factors by examining the Pearson correlation coefficients. The sign of the correlation coefficient signifies the direction of the relationship. A positive correlation coefficient indicates a direct correlation between 2 variables where the value of one variable increases as the other variable increases. The correlations between the different factors are shown in Table 3. The positive values of the results showed that the factors were positively correlated to each other.

Table 3

Correlations between help-seeking (HS), self-monitoring (SM), and strategic adaptation (SA)

	HS	SM	SA
HS	-		
SM	0.52	-	
SA	0.51	0.63	-

Since Table 3 suggested that the three factors are associated, the outcomes of oblimin rotations are presented in Figure 1 to show the respective factor loading plots. The results show that HS and SA items align more closely to Factors 2 and 3 respectively. Although closely clustered, SM items appear to be straddling between different factors.

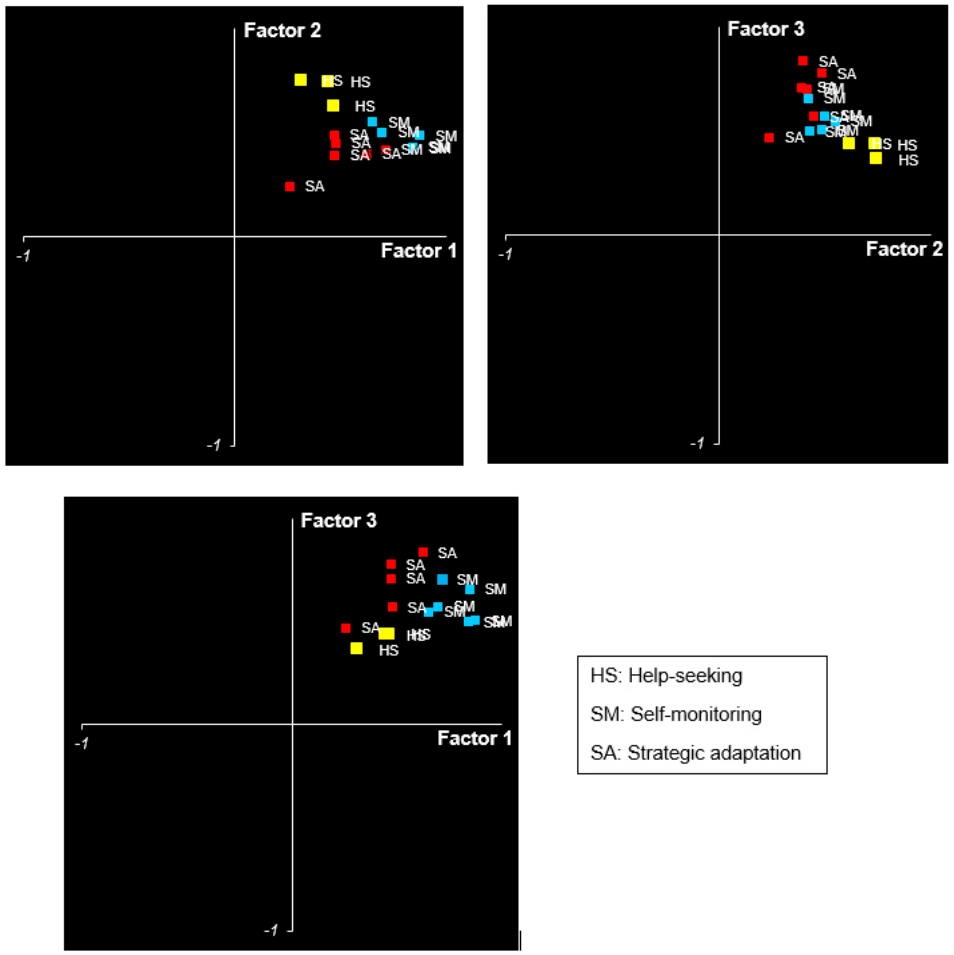

Figure 1. Factor loading plots following oblimin rotations

DISCUSSION

This study aims to develop a concise instrument to assess the extent to which self-assessment influences self-regulated learning behaviour in local polytechnic students. This section discusses the following: emergence of three factors that present as three subscales within the instrument, determination of the instrument's internal consistency, and finally the relationship between the factors.

The developed scale (SRLBS) consisted of a total of 14 items. The content validity of the scale was established by firstly developing scale items based on the literature, secondly assessment by the expert panel using the Delphi technique, and finally testing using exploratory factor analysis. Exploratory factor analysis revealed three factors, which were presented as subscales of the instrument. This suggests that the instrument is capable of measuring the different facets of self-regulated learning behaviour.

The acceptably high overall Cronbach coefficient alpha suggests that the instrument is homogeneous, in that the individual items in the instrument are measuring the same overarching construct. The internal consistencies of the subscales were also above acceptable levels, which suggests that the items within each subscale were measuring their respective construct. It is noteworthy that the overall Cronbach coefficient alpha was higher for each subscale. This could be attributed to inter-correlation amongst items across different subscales fostering the overall strength of internal consistency.

Figure 2 shows the proposed structural model for the 14-item SRLBS. The three subscales, namely help-seeking (HS), self-monitoring (SM), and strategic adaptation (SA), are aligned with the self-regulated learning behaviours reported in the literature. Through gaining awareness of learning progress by self-assessment, students could regulate their learning by seeking help and feedback from peers and teachers when necessary, so as to bridge identified learning gaps (Brown & Harris, 2012). Students could also self-monitor their learning by setting personal learning goals, making judgements of and reflecting upon their own performance when they are engaged in self-assessment. With the input from self-assessment, strategic adaptation enables students to devise action plans, modify their approaches to improve or complete their work.

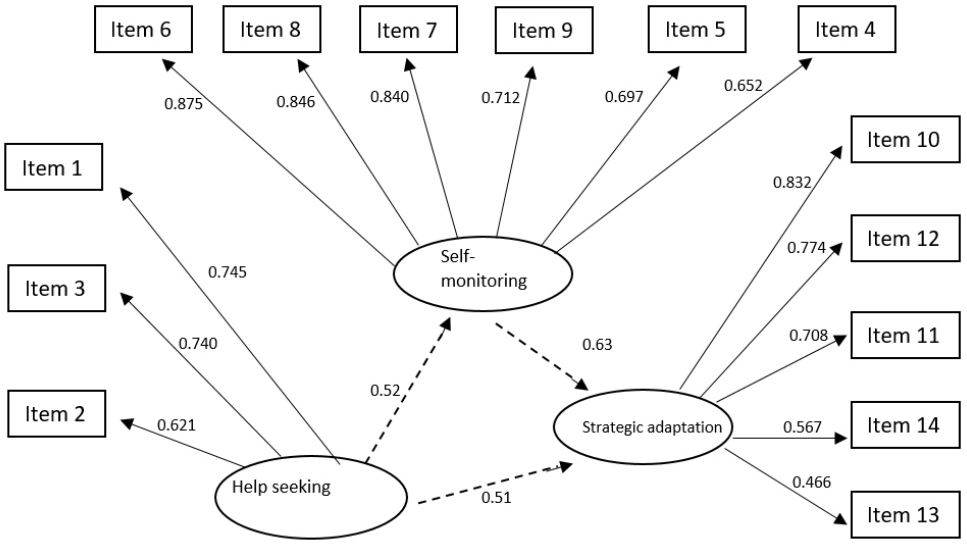

Figure 2. Structural model of the SRLBS.

Correlation is expressed on a range from +1 to -1, where the sign of value indicates the direction of the relationship and the higher value (i.e. closer to 1, as opposed to 0) indicates a stronger correlation. As revealed by the positive correlation coefficients shown in Table 3, there were positive correlations between HS and SM, as well as between SM and SA. The high correlation coefficient for the three factors could also imply the presence of a higher order construct. That is, HS, SM and SA were loaded to a higher factor, a self-regulated learning second-order factor.

The positive correlations between these constructs may be explained by using Bandura's (1986) notion of triadic reciprocality. Figure 3 illustrates the triadic interaction between HS, SA and SM that could influence self-regulation. Personal factors, such as metacognitive awareness of own learning goal, facilitate SM by charting one's progress in relation to the personal goals. As explained by Schunk (2005), when the students gain behavioural control during self-regulation, they would refrain from seeking help indiscriminately. Indeed, a self-regulated learner who monitors his or her own learning progress would gain cognisance of specific learning gaps and hence would be able to perform adaptive help-seeking where assistance is sought to address the specific learning gaps. Informed by one's self-monitoring findings, greater effort in strategic adaptation may also be expended to adjust behaviours and action plans so as to improve future performance. Social cognitive theorists assert the influence of social environment on self-regulation. Indeed, garnering peer feedback could illuminate blind pots and hence support the regulation of behaviours to improve subsequent performance (Schunk, 2014).

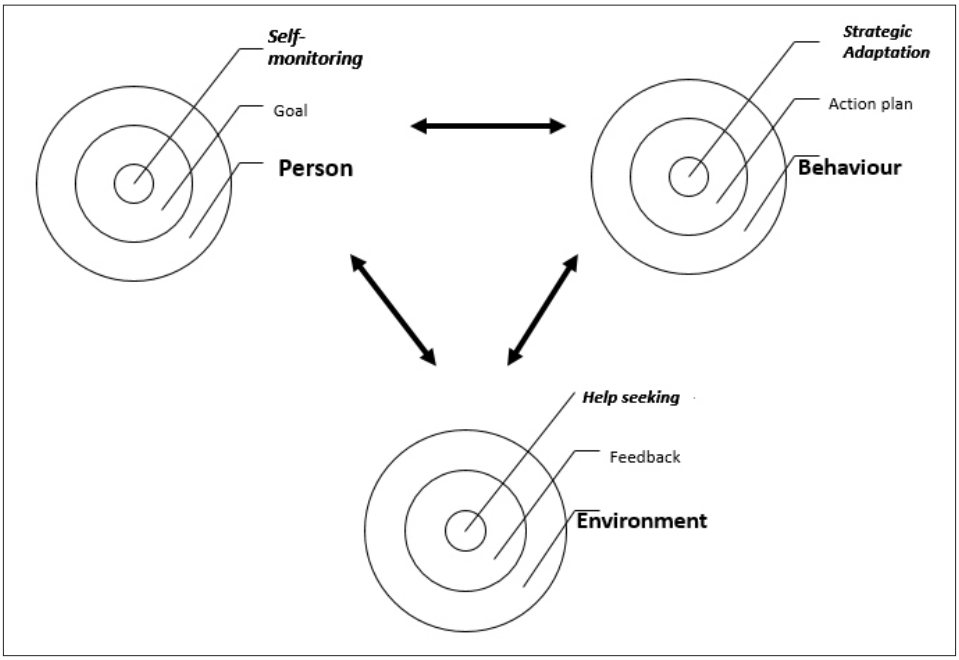

Figure 3. Triadic relationship between self-monitoring (SM), strategic adaptation (SA), and help-seeking (HS).

While there was also positive correlation between help-seeking and strategic adaptation, the association was the weakest among the three inter-factor correlations as evident by its correlation coefficient value being least proximal to the value 1. Indeed, while feedback gained from help-seeking can enable adaptation of strategies to advance one's learning, self-assessment may be mistaken as a socially isolated process. As such, help-seeking may not come across naturally as an inherent part of the self-assessment process for some students, nor was it emphasised by some teachers.

Currently, there are limited instruments related to self-regulation and the number of survey items in each of these instruments tend to exceed 50. Comparatively, the SRLBS is a concise instrument with only 14 items. As shown by its high Cronbach coefficient alpha, this instrument's succinctness has not compromised its internal consistencies.

LIMITATIONS AND FUTURE RESEARCH

Like all self-reported questionnaires, it is acknowledged that this instrument could be subjected to social desirability bias where the respondents failed to answer truthfully so as to conform to social norms. To further improve the validity of the findings, it would be advisable to explore triangulating the data

by designing another instrument that measures the self-regulated learning behaviour through observations from the teachers. Further studies may also be extended to correlate the SRLBS with the relevant subscales of the established questionnaires such as MSLQ or LASSI.

Closer examination of the SA subscale revealed that one of the items, "I feel more motivated to improve my work further after doing self-assessment", assesses the impact of self-assessment on the perceived change in motivation level instead of overt self-regulated learning behaviour. However, the motivational adjustment may be deemed as a means of strategic adaptation. This is especially so since students who become more motivated after self-assessment may actively bridge their learning gaps, which in turn promote their self-regulated behaviour. Nevertheless, this suggests the need for examining other constructs of self-regulated learning, such as motivation. While it is undeniably challenging to measure motivation, it is still an important driver for student learning and hence worth exploring.

It is envisaged that this developed instrument could inform educators the extent to which self-assessment influences self-regulated behaviour in polytechnic students. Such diagnostic data may support educators in making adjustment to their instructional design when using student self-assessment to foster self-regulated learning.

CONCLUSION

The validation data of the SRLBS that was developed in this study suggests that the instrument is valid and homogeneous. Its overall internal consistency was high and its face and content validity have been established using the Delphi technique. This 14-item instrument will assist teachers in examining students' perceptions of self-assessment in terms of its effectiveness in honing their self-regulated behaviour in the polytechnic curriculum. It is hoped that the use of this instrument will inform the teachers' process of adjusting their design and implementation of self-assessment to build students' capacity in self-regulated learning.

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APPENDIX. SELF-REGULATED LEARNING BEHAVIOUR SCALE (SRLBS)

This questionnaire seeks to find out your learning experience and perceptions of self-assessment. There is no right or wrong answer; do provide your honest input. Using the scale of 1-7, answer all the following questions. If the statement is very true of you, circle 7. If the statement is not at all true of you, circle 1.

	Not at all true of me			True of me half the time			Very true of me
1. During self-assessment, I seek help from my peers if I am unsure of what to do	1	2	3	4	5	6	7
2. During self-assessment, I use cues provided by tutor to improve on my work	1	2	3	4	5	6	7
3. During self-assessment, I find peers who will give critical feedback on my work	1	2	3	4	5	6	7
4. As part of the self-assessment process, I set specific goals for myself for the task assigned	1	2	3	4	5	6	7
5. During self-assessment, I check if I have achieved my personal goals for the task assigned	1	2	3	4	5	6	7
6. I perform self-assessment to evaluate my own learning / judge my own work	1	2	3	4	5	6	7
7. I perform self-assessment to reflect on my strength and weakness	1	2	3	4	5	6	7
8. I perform self-assessment to keep track of my own learning	1	2	3	4	5	6	7
9. As part of self-assessment, I record my own performance and review it to monitor my progress ...	1	2	3	4	5	6	7
10. I perform self-assessment to come up with an action plan to improve my work	1	2	3	4	5	6	7
11. After self-assessment, I modify my approach if I find the one I am using is not working well	1	2	3	4	5	6	7
12. As part of the self-assessment, I make a plan to complete my work	1	2	3	4	5	6	7
13. I look for resources (e.g. Textbook / internet) to improve my work after doing self-assessment	1	2	3	4	5	6	7
14. I feel more motivated to improve my work further after doing self-assessment.....	1	2	3	4	5	6	7