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Exploring the roles of academic self-concept and perseverance of effort in self-assessment practices

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ABSTRACT

Based on the self-system processes model of motivation, we explored the mediating role of academic self-concept in the relationship between perseverance of effort and self-assessment. The results showed that perseverance of effort has a positive but not statistically significant association with self-assessment when controlling academic self-concept. The results supported our hypotheses that academic self-concept, whether at the domain-specific or component-specific level, significantly mediated the effect of the perseverance of effort on self-assessment, lending empirical support to the closer conceptual link between self-perceptions and self-assessment practices in learning. The results contribute to the literature of the three research lines (grit, academic self-concept and self-assessment) and suggest that academic self-concept enhancement interventions are beneficial not only to academic achievement based on the reciprocal relationship that has been well documented in the self-concept literature but also to self-assessment in the light of the self-system processes model of motivation.

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Perseverance; grit; academic self-concept; self-assessment practice; Chinese secondary students

Introduction

Self-assessment defined as the judgement of students about their own learning (Boud & Falchikov, 1989) has been regarded as ‘a central component of current conceptions of formative and classroom assessment’ (Brown et al., 2015, p. 444) and is positively associated with learning and achievement (Brown & Harris, 2013; Yan et al., 2021). Learning enhancement through self-assessment (hereafter abbreviated as SA) has long been widely examined in educational studies (Boud, 1995; Falchikov & Boud, 1989; McDonald & Boud, 2003; Yan & Brown, 2017). However, psychological factors that influence students’ self-assessing practices have not yet

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been adequately examined. In a relevant study, Yan et al. (2020) examined the associations of four factors (i.e. attitude, subjective norms, perceived behaviour control and psychological safety) with intentions and practices regarding self-assessment in over 1000 primary and secondary students. The results showed that students with more positive attitudes, higher subjective norms, higher perceived behaviour control and higher psychological safety tended to have higher intentions to self-assess; higher intention, perceived behaviour control and psychological safety were associated with more frequent SA practices.

In reviewing psychological influences on SA performance in the previous research (e.g. Yan et al., 2020), we found that grit and academic self-concept as two psychological factors with controllable and modifiable features have not yet been examined (Alan et al., 2019; Marsh & Craven, 2006; Park et al., 2020). There is also accumulated evidence supporting them to be influential psychological factors associated with high performance and achievement (A. L. Duckworth et al., 2007; H. Wu et al., 2021; Lam & Zhou, 2022). A recent meta-analysis conducted by Lam and Zhou (2022) on grit showed a statistically significant correlation between grit and achievement and subsequently called for 'promoting grit in school contexts is likely to achieve the goal of strengthening students' positive qualities and enhancing their learning outcomes' (p. 614). There are also an increasing number of studies that examine the malleable feature of grit. However, research on the consistency of interest facet in grit is not uniformly positive (e.g. Credé et al., 2017; Datu et al., 2016). Our study focuses on the facet of perseverance of effort. There are also an increasing number of studies showing consistent findings of the effectiveness of perseverance in grit. For instance, Alan et al. (2019) found children's grit can be enhanced by fostering their optimistic beliefs about the productivity of perseverance of efforts and encouraging them to persevere when facing challenging but rewarding tasks. Teacher training was involved before grit intervention to students with a focus on three key elements: growth mindset, goal setting and perseverance in adversities for achieving goals (Alan et al., 2019). Park et al. (2020) found that students who believed that intellectual ability can be modified (i.e. growth mindset) worked steadfastly in order to achieve challenging goals. As for academic self-concept (ASC), a psychological factor on students' competence and affect self-perceptions in learning school subjects, numerous studies have examined its relationship with academic achievement (Marsh & Craven, 2006; Marsh & Martin, 2011; Marsh, 2022). An updated meta-analysis by H. Wu et al. (2021) based on 68 longitudinal studies published from 1981 to 2020 consistently provides accumulated and consistent evidence on the reciprocally reinforcing relationship between ASC and academic achievement.

The major limitations in research on SA, ASC and grit are summarised as follows: all three variables are highly associated with achievement, but their relationships with achievement have been examined in separate studies. ASC and grit have been found to be modifiable psychological factors, but their roles in SA have not yet been researched. Therefore, this paper aims to explore the relationship between the three variables based on the self-system processes model of motivation as our conceptual framework. The sections below explain why we

wished to study the three variables and the appropriateness of the conceptual framework to explore the three hypotheses in this study.

Literature review

Self-assessment

Self-assessment is conceptualised as a learning process by which students attribute strengths and weaknesses to the qualities of their individual learning for informing further improvements (e.g. Boud, 1995; Sargeant et al., 2010). However, types of self-assessment processes differ across studies (Panadero et al., 2016). As the fundamental purposes of self-assessment are ‘to identify areas of strength and weakness in one’s work to make improvements and promote learning’ (Andrade & Valtcheva, 2009, p. 12), scholars have increasingly recognised that the process is complex and involves multiple steps, such as seeking and using feedback, evaluating one’s own work against criteria and identifying learning strengths and weaknesses (Yan, 2022). To unpack this complex process, Yan and Brown’s (2017) study suggested a series of self-assessment practices: determining self-assessment criteria, seeking feedback from external and internal sources and self-reflection. The two scholars suggested students may need to formulate self-assessment criteria to identify on what basis to make a judgement. If there might not be insufficient feedback information available, students would use inquiry or monitoring approaches to seek data related to their own performance from a variety of sources. Seeking external feedback through inquiry (SEFI) happens when students seek information from other people (e.g. teachers and peers), while seeking external feedback through monitoring (SEFM) occurs when students seek information from learning materials (e.g. prior assignments, extra work and learning guides). Seeking internal feedback information (SIF) through internal reactions to their own performance (e.g. emotions, feelings, physical sensations and internal states) is proposed as another part of the self-assessment process. Self-reflection (SR) occurs when students can reflect on the quality of their own work by analysing their strengths and weaknesses generated from both external and internal sources. Students can continuously calibrate their judgements as needed based on such a process involving SEFI, SEFM, SIF and SR. However, the personal characteristics of students that may influence their self-assessments remain understudied.

As for the link between self-assessment and learning outcomes, review studies have consistently reported that self-assessment not only can improve the quality of students’ learning and their academic performance across subjects and grade levels (e.g. Brown & Harris, 2013; Yan et al., 2021) but also have a positive impact on their self-regulated learning strategies and motivational variables such as self-efficacy (Panadero et al., 2017; Topping, 2003). Some scholars indicate that self-assessment may contribute to student learning by involving students in monitoring the learning process, facilitating reflection on the learning outcome and experiencing successful performance (e.g. Brown & Harris, 2013; Panadero & Alonso-Tapia, 2013; Paris & Paris, 2001; Yan, 2020b). Consistent with previous research, Mendoza and Yan (2021) analysed Filipino secondary students’ self-assessment practices and identified the role of self-assessment practices in students’

cognitive and metacognitive engagement. Specifically, self-reflection (SR) was a positive and statistically significant predictor of all three engagement aspects (agentic, cognitive and metacognitive). Seeking external feedback through inquiry (SEFI) was a positive and statistically significant predictor of agentic engagement. Seeking internal feedback (SIF) was a positive and statistically significant predictor of metacognitive engagement. Given increasing evidence showing positive associations between self-assessment and learning outcomes (e.g. achievement, engagement and self-regulated learning), there are compelling reasons to explore personal psychological factors affecting self-assessment (Yan et al., 2020).

Perseverance of effort as a separable facet of grit (Grit-PE)

Grit with two facets – perseverance and passion (also operationalised as consistency of interest) for achieving long-term goals – is an important psychological construct that Duckworth and her associates have popularised since 2007 (A. L. Duckworth et al., 2007). The construct of grit with two facets (i.e. perseverance of effort and consistency of interest) has been examined and found to be an influential factor in helping individuals persist in the face of adversity and do well in life (see Hou et al., 2021 for a meta-analysis). Recently, a limited number of longitudinal studies also provided preliminary evidence on the reciprocal relationship between grit and growth mindset (e.g. Park et al., 2020; T. Zhang et al., 2022). In terms of the dimensionality of grit, the perseverance dimension has been consistently found to be a positive predictor of both objective and subjective success (A. L. Duckworth et al., 2012) and a wide range of positive learning outcomes (e.g. behavioural engagement in learning, positive emotions and well-being) (Datu et al., 2016). In a meta-analysis of 88 independent samples, Credé et al. (2017) also found ‘the perseverance of effort facet has significantly stronger criterion validities than the consistency of interest facet, and that perseverance of effort explains variance in academic performance even after controlling for conscientiousness’ (p. 492). In an updated meta-analysis with 156 samples, Lam and Zhou (2022) found that the correlation of the perseverance of effort facet of grit to achievement was stronger than the facet of consistency of interest, and this correlational pattern persists even after accounting for cultural psychological variables such as individualism and collectivism.

In Asian cultural settings, Datu et al. have consistently found that perseverance of effort is positively associated with a variety of educational and well-being outcomes; however, these positive associations were not found with the facet of consistency of interest (e.g. Datu et al., 2016, 2018, 2021), leading an evidence-based argument by Datu et al. (2016) ‘perseverance counts but consistency does not’ (p. 121). Credé (2018), in a critical review of grit, also argued that ‘at present there is no empirical support for the idea that grit is the combination of perseverance and passion’ (p. 610). As noted earlier, passion serves as a synonym of the consistency of interest facet of grit (A. L. Duckworth et al., 2007). To sum up, the two facets as documented in the previous research have clearly separable features regardless of conceptually and methodologically (e.g. Credé, 2018; Datu et al., 2016; J. Guo et al., 2019). Based on these consistently updated findings of the effects of the perseverance of effort (e.g. Lam & Zhou, 2022) and its importance in

achieving academic success (see Ho & Hau, 2008; J. Li, 2002), in this study, we focused on assessing the perseverance of effort facet of grit. We assumed this facet would be a positive predictor of self-assessment practice in the light of the self-system processes model of motivation (Connell & Wellborn, 1991; Rickert & Skinner, 2022).

Academic self-concept

Self-concept is broadly defined as an individual's self-perceptions generated from one's experience and interpretations of his/her environment. According to Shavelson et al. (1976), the construct of self-concept is organised with multiple self-perceptions of personal behaviour in academic domains and non-academic broader domains (e.g. social and physical) with a global self-concept (also known as self-esteem) located at the apex. Academic domains of self-concept (also known as academic self-concept) cover a series of school subjects (e.g. mathematics, English, and science). Academic self-concept (hereafter abbreviated as ASC) refers to students' self-perceptions of competence and affect in learning school subjects (Marsh & Martin, 2011; Marsh, 1990).

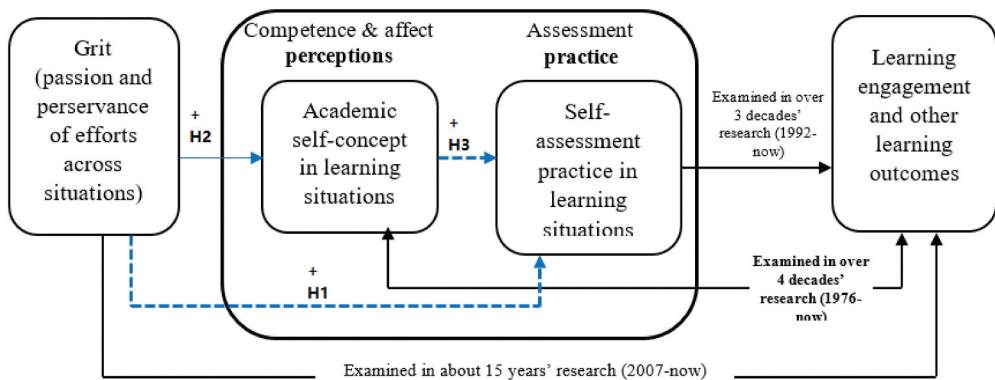
The multidimensionality of ASC has been widely tested and supported (e.g. Arens et al., 2021). Recently, researchers found its twofold multidimensionality, meaning that each academic domain (e.g. verbal and mathematical domains), can be further separated into two component-specific dimensions: the competence dimension of students' self-perceptions (in alignment with self-efficacy) and the affective dimension of students' self-perceptions (enjoyment and interests) in learning school subjects (Arens & Hasselhorn, 2015; Arens et al., 2021; Yang et al., 2016; Yang, 2018). The reciprocally causal relationship between academic self-concept and achievement has also been widely tested and supported in the past three decades of research in academic self-concept (e.g. Guay et al., 2003; H. Wu et al., 2021; Marsh & Martin, 2011).

Grit-PE, academic self-concept and self-assessment

Although in the three research lines reviewed above, the roles of grit, academic self-concept and self-assessment in student learning have been essentially summarised, we found few studies linking all of them in one study. In Table 1, we present their key descriptions, conceptual links and similarities (e.g. all three constructs involve self as an agent), providing a rationale for us to explore them in this single study. Empirically, we found several studies in examining the role of grit and academic self-concept in learning and achievement (Coker, 2021; Wong & Vallacher, 2018; Y. Li et al., 2019), well-being (Chen & Gong, 2021) and life satisfaction (J. Li et al., 2018). Some studies examined the reciprocal relations between achievement and the two constructs (grit and academic self-concept), but separately (see Jiang et al., 2019; Marsh, 2022 for updated evidence). Studies on explicitly examining the relationship between the two constructs are scarce. Dixon (2021) compared the predictive effect of grit on achievement with other psychological factors, including academic self-concept, and found the latter performed better than grit. Chen and Gong's (2021) study would be the first study explicitly linking grit to academic self-concept. The two scholars tested the predictive effects of grit and academic self-concept on university students' mathematics performance and well-being. The results showed the perseverance of effort facet of grit was positively correlated with academic

Table 1. Summary of key features of the three variables and conceptual links.

Constructs	Key description	Conceptual elaboration	Essential elements
Grit-PE	Perseverance of effort for achieving long-term goals.	Grit-PE involves long-term striving processes, including affective and behavioural efforts to achieve personal goals across situations, including life and learning events. (e.g. A. Duckworth, 2016; A. L. Duckworth et al., 2007; Lam & Zhou, 2022; Silvia et al., 2013)	Personal striving processes
ASC	Self-concept is broadly defined as an individual's self-perceptions generated from one's experience and interpretations of his/her environment. It has hierarchical and multidimensional features covering academic domains (academic self-concepts) and non-academic domains (non-academic self-concepts).	Self-perceptions in academic domains include the cognitive aspects of students' evaluation of their knowledge and competence in learning school subjects. Self-perceptions also have the descriptive and affective aspects of students' self-perceived enjoyment and interests in learning school subjects; (e.g. Arens et al., 2011; Marsh et al., 1999; Shavelson et al., 1976; Yang et al., 2016; Yang, 2018)	Self-perceptions of one's own abilities and affect in learning
SA	Self-assessment comprises three major actions/practices: 1) determining assessment criteria, 2) self-directed feedback-seeking from external and internal sources and 3) self-reflection.	SA is conceptualised as a process for learning involving students' evaluative judgement of their knowledge, skills and performance through the three major actions/practices (as described in the left column). (e.g. Boud, 1995; Yan & Brown, 2017; Yan, 2016, 2020a)	Self-practices of assessment in learning

**Figure 1.** The self-system processes model of motivation prepared by the authors based on Connell and Wellborn (1991) and existing literature of the variables included in this study.

Note. In drawing the arrows from the three research lines (self-assessment, academic self-concept and grit) to learning outcomes, we referred to previous findings in signature research work documented in the three research lines: a) the monograph on the link between self-assessment and learning enhancement (Boud, 1992, 1995); b) the classic review on the multidimensional and hierarchical construct of self-concept (Shavelson et al., 1976) and c) the first paper on grit as individuals' passion and perseverance of effort for pursuing long-term goals (A. L. Duckworth et al., 2007), respectively. These paths examined in the previous research are expressed in solid lines, whereas those tested in this study are indicated via dashed lines. **H1** denotes the perseverance of effort facet of grit will positively predict students' self-assessment practice in learning situations; **H2** denotes the perseverance of effort facet of grit will positively predict students' perceptions of competence and affect self-concepts in learning situations and **H3** denotes students' perceptions will mediate the relationship between the perseverance of effort facet of grit and SA practice.

self-concept ($r = .46, p < .01$). While academic self-concept was a stronger positive predictor of mathematics achievement ($\beta = .32, p < .01$) than the perseverance of effort ($\beta = .15, p < .01$), the two constructs predicted subjective well-being similarly ($\beta = .35$ and $\beta = .34, ps < .01$). Despite its contribution to understanding the relationship between grit and academic self-concept, Chen and Gong's (2021) study did not include self-assessment as an outcome variable. The conceptual rationale (see also Table 1) and accumulated evidence demonstrate that grit and academic self-concept have been widely tested as two influential individual correlates with educational outcomes. The self-system processes model (Connell & Wellborn, 1991) aims to examine their roles in students' SA practice (Figure 1).

The conceptual framework of the present study

The self-system processes model (Connell & Wellborn, 1991) is a motivational model focusing on revealing the relations between students' self-action-product in learning situations. This model has been widely used to explore students' academic self-concept and self-determining roles in learning and achievement (e.g. Guay et al., 2004, 2010; Schnitzler et al., 2021; Xia et al., 2021 and Yang, 2018). Its conceptual commonalities with these variables we examined in this study (e.g. self-process, perception and action, see also Table 1) and its feasibility allowed us to posit these variables as Figure 1 shows. Given the accumulated evidence on the power of the perseverance of effort facet of grit and the insignificant effects of the (in)consistency of interest facet of grit with learning outcomes (e.g. Chen & Gong, 2021; Datu et al., 2016; J. Guo et al., 2019), we focused on assessing this facet of perseverance of effort. Also, given research shows the long-term process of students' striving feature in pursuing goals that this facet has (e.g. Calo et al., 2019; Datu et al., 2017a; Teuber et al., 2021), we proposed its predictive effects on students' ASC as self-perceptions (H2) and SA as assessment practice (H1). In line with Yan et al. (2020) on examining personal and contextual factors on SA practices, in this study, we also examined the predictive effect of ASC (including both the competence and the affective dimensions of self-perceptions in learning school subjects) on SA practice (as the key-dependent variable of study) (H3).

Two key research questions guided this study:

To what extent students' perseverance of effort can be directly and indirectly associated with academic self-concept and self-assessment practices?

Will academic self-concept play a significant mediating role in the relationship between students' perseverance of efforts and self-assessment practices?

Method

Participants

Participants ($n = 180$) were selected from tutoring centres. More demographic information of these students was that they came from 58 secondary schools in China's Guangxi Province. These students were aged 12–18 years old. The 58 schools represented 36% of local schools. They were students from grade 7 to grade 12, and the respective

percentages were 36.7% (grade 7), 35.0% (grade 8), 7.2% (grade 9), 20.6% (grade 10) and 0.6% (grade 12), without grade 11 students; and 48.3% were males. There were about three to four students from each school because these students were recruited through tutoring centres that supported the team's research projects involving private tutoring and mainstream education. Given the voluntary nature of attending tutoring education, the sample size of students cannot be compared with directly collecting data from 58 schools that may have required much more resources to achieve. One advantage of the current sample may have been that participants were not limited to attending one or two junior or senior secondary schools.

Another point to highlight was that these schools were comparable although we invited three private tutoring centres to assist in the data collection. Those local schools were not unique in terms of students' enrolment. They recruit students with mixed-abilities. Students attending private tutoring are neither high nor low achievers. Like those in mainstream education, students in private tutoring are those with mixed abilities given that private tutoring in China is a major activity in after-school education (also known as shadow education, W. Zhang & Bray, 2016). In China, 60% of primary and junior high students experienced private tutoring (Xue & Ding, 2009). Marginson's (2011) review further commented: 'While public tuition subsidies vary, a feature in all Confucian systems is the willingness of middle class families – and in some systems, most families – to invest privately in secondary and tertiary education and tutoring to position their children for the one-off contest for university entry which determines their life chances . . . Private tutoring, which is often provided by public sector teachers operating a second job in the marketplace, is focused on preparing students for successive examination and selection hurdles at the beginning of each stage of secondary and tertiary education' (pp. 596–597). In China, 'The total number of nationwide student enrolments in K-12 after-school tutoring has increased from 202.6 million in 2015 to 325.3 million in 2019' (Wai, 2021). Given the prevalence of private tutoring in China, the results from students attending it are applicable to the general population of students.

Measures

Self-assessment. Self-assessment was assessed by seeking external feedback through monitoring seeking (SEFM, three items, e.g. 'I check whether I have mastered the course content by doing extra exercises.'). seeking external feedback through inquiry (SEFI, three items, e.g. 'I ask my friends to tell me how to improve my learning.'). and self-reflection (SR, three items, e.g. 'When I do exercise, I look at what I got wrong or did poorly on to guide me as to what I should learn next.'). The three subscales were taken from the short form of the Self-assessment Practice Scale (SaPS) developed by Yan et al. (2020). The items were rated on a four-point Likert scale (1 = 'strongly disagree' to 4 = 'strongly agree'). The reliabilities for the composite scale and each subscale were satisfactory (SA $\alpha = .89$; SEFM $\alpha = .78$; SEFI $\alpha = .84$; SR $\alpha = .79$). We excluded the dimension of seeking internal feedback (SIF) and included only those self-assessment practices that could be controllable and adjustable, namely SEFM, SEFI and SR. Doing so was in line with the focus of this study on examining SA practices that have controllable and modifiable features (e.g. self-reflection and seeking external feedback). Two sample items of seeking internal feedback were 'My gut feelings tell me whether my work is good or bad', 'My

intuition tells me if I am doing a good job or not. Although gut feelings and intuition are important inner states where students may seek internal feedback, it might be difficult to design instructional practices/intervention programmes to change them. As such, we focused on examining the other three dimensions of the SaPS.

Academic self-concept (ASC). The items of this scale were selected from the Chinese version of the Self-Description Questionnaire-I (Yang, 2012) based on the English version of Marsh (1990). It was assessed by the competence facet of academic self-concept (two items) and the affect facet of academic self-concept (two items). A sample item of the competence facet was *'I learn things quickly in all school subjects'*. One sample item for the affect facet was *'I enjoy doing work in all school subjects'*. A shorter version of academic self-concept (three items) without differentiating the competence and affect facets was once used in Xu et al. (2013) study in Hong Kong secondary students and found good reliabilities for three core school subjects (Cronbach's α coefficients for mathematics, Chinese and English were .83, .83 and .80, respectively). In this study, we kept two items for each sub-facet (competence vs. affect). All items were rated on a four-point scale (1 = 'strongly disagree' to 4 = 'strongly agree'). The Cronbach's α coefficients for academic self-concept, its competence and affect facets were .88, .79 and .92, respectively.

Grit-Perseverance of effort (Grit-PE). *Grit-PE* was assessed by using the sub-scale of Datu and Zhang's (2021) Chinese version of Grit (9 items). This scale contains three items. Students rated on a 4-point rating scale (1 = 'strongly disagree' to 4 = 'strongly agree'). A sample item was *'I finish whatever I begin.'* The reliability (Cronbach's α coefficient = .87) was satisfactory for research purposes.

Statistical analysis

Statistical analyses were performed through two major steps: Confirmatory factor analysis to re-examine these scales with this new sample and Path analysis to explore the relationship between Grit-PE (perseverance) and SA practice with ASC as a mediator. No missing data were among the studied variables. Descriptive statistics and Pearson interrelation among the studied constructs and Cronbach's alpha reliability were calculated using SPSS 26.0. Structural equation modelling (SEM) approach was adopted to examine the two path models (see Figures 2 and 3) with Mplus version 8.3 (Muthén & Muthén, 1998–2019). The following model fit indices were used for the model fit assessment: χ^2 ,

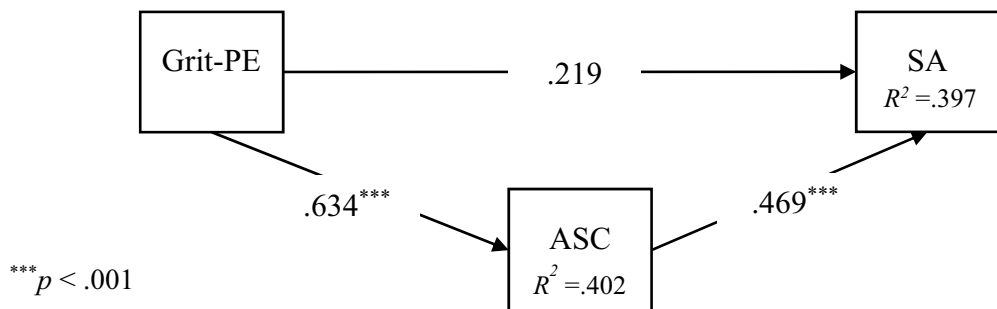


Figure 2. Path model 1 to test the predictive effects of Grit-PE and ASC on SA.

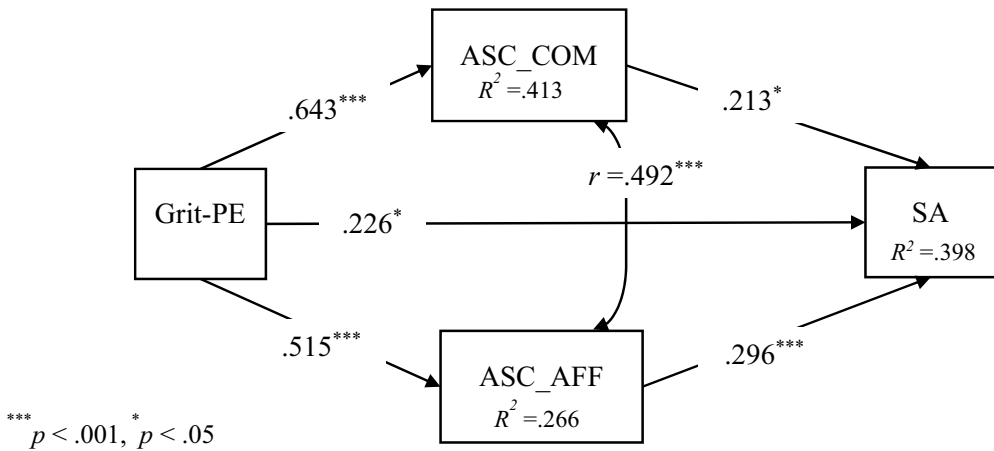


Figure 3. Path model 2 to test the predictive effects of Grit-PE and the two aspects of ASC on SA.

Table 2. Descriptive statistics, reliabilities and correlations among the variables.

	1	2	3	4	5	6	7	8
1. SA	-							
2. SEFM	.881***	-						
3. SEFI	.863***	.615***	-					
4. SR	.850***	.719***	.542***	-				
5. Grit-PE	.516***	.383***	.493***	.446***	-			
6. ASC	.607***	.474***	.596***	.483***	.634***	-		
7. ASC_COM	.552***	.438***	.527***	.452***	.643***	.902***	-	
8. ASC_AFF	.552***	.424***	.555***	.427***	.515***	.916***	.654***	-
No. of items	9	3	3	3	3	4	2	2
Mean	3.01	3.14	2.74	3.16	2.67	2.60	2.50	2.71
SD	.50	.52	.69	.53	.77	.75	.79	.85
Alpha	.89	.78	.84	.79	.87	.88	.79	.92

*** $p < .001$.

Note. SA = self-assessment, SA is the mean score of SEFM, SEFI and SR; SEFM = seeking external feedback through monitoring; SEFI = seeking external feedback through inquiry; SR = self-reflection Grit-PE = the perseverance of effort facet of grit; ASC = academic self-concept; ASC_COM = the competence component of ASC; ASC_AFF = the affective component of ASC.

the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA) and the standardised root mean square residual (SRMR). To further examine the significance of the mediation effects, bootstrapping analysis was conducted, resampling and replacing the data 5,000 times.

Results

Preliminary analyses

Table 2 shows the means, standard deviations, inter-correlations and reliabilities of all variables. The results showed a significant positive correlation between all the variables in this study. The reliability (Cronbach's alpha) of each scale was within an acceptable range. A series of confirmatory factor analyses were conducted to confirm the internal structure of these scales, and the results are consistent with previous

research (see [Table A1](#) in the Appendices for details). In addition, the results of the measurement models for [Figure 2](#) (Model 1) and [Figure 3](#) (Model 2) showed good model fit indices (Model 1: $\chi^2 = 141.846$, $df = 96$; $p < .001$; CFI = .958; TLI = .948; RMSEA = .052; SRMR = .075; Model 2: $\chi^2 = 139.430$, $df = 95$; $p < .001$; CFI = .960; TLI = .949; RMSEA = .051; SRMR = .072).

Path analysis

[Figure 2](#) and [Figure 3](#) show the results of the path analysis for the two hypothesised models. The path coefficients displayed in the figures were standardised to facilitate explanations of the effects. The two models are just-identified/saturated models. Given this, chi-square and degree of freedom were equal to zero. The goodness-of-fit indices for the two saturated models were good (CFI = 1.000; TLI = 1.000; RMSEA = .000; SRMR = .000). Specifically, the results of Model 1 ([Figure 2](#)) revealed that students' perseverance of effort significantly and positively predicted ASC ($\beta = .634$, $p < .001$), indicating that students' higher perseverance of effort would be associated with higher ASC they may perceive. ASC also significantly and positively predicted SA ($\beta = .469$, $p < .001$), suggesting the higher ASC students have, the more SA practices they would perform. However, in Model 1, the relationship between Grit-PE and SA appears insignificant at p less than the .05 level, but might be regarded as marginally significant ($\beta = .219$, $p = .052$). The results of Model 2 showed that Grit-PE was a significant positive predictor of the competence and affect components of ASC and SA ($\beta = .643$, $p < .001$; $\beta = .515$, $p < .001$; $\beta = .226$, $p < .05$, respectively), indicating that the grittier in terms of their perseverance of effort would be associated with the higher competence and affect self-concepts they may perceive and the more SA practices they may perform. The competence and affect self-concepts also significantly and positively predicted SA ($\beta = .213$, $p < .05$; $\beta = .296$, $p < .001$), suggesting the higher the self-concepts of competence and affect, the higher the SA. The model fit indices were good. R^2 for SA was .397, indicating about 40% variance of SA of this sample could be explained by both academic self-concept and their perseverance of effort; R^2 for ASC was .402, indicating 40% variance of academic self-concept could be explained by their perseverance of effort. Considering the multidimensional features of the SaPS, we also conducted a series of supplementary analyses. The results (see [Table A3](#) in the Appendices) are consistent with those in our main analyses for Models 1 and 2 (see also [Figures 2 and 3](#)).

[Table 3](#) presents the mediating effects of ASC and its two components of it. The results of the mediation analysis for Model 1 ([Figure 2](#)) showed that the indirect path (Grit-PE \rightarrow ASC \rightarrow SA) was significant. ASC has a statistically significant indirect effect on SA, confirming the full mediation effect ($\beta = .297$, $p < .001$) of ASC. The model explained 39.7% of the variance in

Table 3. Bootstrap analysis on mediation effects.

Paths	Standardised β	SE	Bias-corrected percentile 95% CI	
			Lower	Upper
Model 1				
Grit-PE \rightarrow ASC \rightarrow SA	.297***	.062	.184	.427
Model 2				
Grit-PE \rightarrow ASC_COM \rightarrow SA	.137*	.056	.033	.252
Grit-PE \rightarrow ASC_AFF \rightarrow SA	.153**	.051	.065	.270

*** $p < .001$; ** $p < .01$; * $p < .05$.

Notes. SA = self-assessment; Grit-PE = the perseverance of effort facet of grit; ASC = academic self-concept; ASC_COM = the competence component of ASC; ASC_AFF = the affective component of ASC. Bootstrapping analysis was conducted to examine the mediation effects by resampling and replacing the data 5,000 times.

SA. Similarly, the results of the mediation analysis for Model 2 (Figure 3) showed that the two indirect paths from perseverance of effort to self-assessment practices through the competence and affect self-concepts ($\beta = .137, p < .05$; $\beta = .153, p < .01$, respectively). Perseverance of effort could explain 41.3% variance of the competence component of ASC than that of the affective component of ASC (26.6%), suggesting a stronger link between perseverance of effort and the competence component of ASC. Consistent with Model 1, 39.8% variance of SA could be explained by Grit-PE and the two components of ASC.

Supplementary analysis and results

Given the multidimensionality of SaPS, we adopted a multidimensional Rasch-based model (Adams et al., 1997) using ConQuest 2.0 (M. L. Wu et al., 2007). We used response category functioning and item fit statistics (i.e. Infit MNSQ and Outfit MNSQ) as important indicators to check the scale quality. The MNSQ values ranged from 0.6 to 1.4, representing a good fit between data from the rating scales and models (e.g. Wright et al., 1994). Aside from reliability estimates via Cronbach's alpha values to indicate internal consistency, we also computed Rasch reliabilities (i.e. EAP/PV reliabilities generated by ConQuest) for the three subscales of the SaPS and the two sub-dimensions of ASC. The Rasch reliabilities for the three subscales of the SaPS in the

Table 4. Psychometric indicators for the three subscales of SaPS based on CFA and Rasch analyses.

Item Descriptions	Standardised factor loading		Item measures*				Outfit			
	A	B	A	B	A	B	A	B	A	B
<i>Seeking External Feedback Monitoring (SEFM)</i>	A. This study n = 180	B. Yan's (2020a) n = 1,416								
1. I check whether I have fully understood the course content by doing past exam papers.	0.83	0.82	-0.35	-0.13	0.12	0.02	0.91	0.83	0.78	0.82
2. I check whether I have mastered the course content by doing extra exercises.	0.93	0.82	-0.38	-0.05	0.12	0.02	0.67	0.90	0.60	0.89
3. I keep track of my progress by recording my performance.	0.53	0.70	0.72	0.18	0.17	0.03	1.17	1.01	1.14	1.01
Average values	0.76	0.78					0.92	0.91	0.84	0.91
<i>Seeking External Feedback Inquiry (SEFI)</i>	A	B	A	B	A	B	A	B	A	B
4. I ask my fellow group members to evaluate my contributions to group work tasks.	0.85	0.79	-0.16	-0.03	0.11	0.03	0.85	0.97	0.80	0.96
5. I ask my friends to tell me how to improve my learning.	0.86	0.75	-0.19	-0.11	0.11	0.02	0.92	1.15	0.95	1.13
6. I ask my teachers to give me feedback about my performance.	0.71	0.72	0.35	0.14	0.15	0.02	1.18	1.11	1.26	1.12
Average values	0.80	0.75					0.98	1.08	1.00	1.07
<i>Self-Reflection (SR)</i>	A	B	A	B	A	B	A	B	A	B
7. When I do exercise, I look at what I got wrong or did poorly on to guide me as to what I should learn next.	0.74	0.83	0.08	0.15	0.12	0.02	0.87	0.80	0.80	0.83
8. As I study, I think about whether the way I am studying is really helping me learn.	0.67	0.81	0.08	0.22	0.12	0.02	1.18	0.90	1.07	0.92
9. I pay attention to my assessment results in order to identify what I can do better next time.	0.85	0.70	-0.16	-0.37	0.17	0.03	0.81	1.12	0.74	1.07
Average values	0.75	0.78					0.95	0.94	0.87	0.94

present study were 0.89 (SEFM), 0.89 (SEFI), 0.87 (SR). The Rasch reliabilities for the two subscales of ASC were 0.86 (competency component) and 0.89 (affect component). The results suggested all these scales have good reliabilities for research purposes. Comparatively, the Rasch reliabilities of the three subscales of the SaPS in Yan's (2020a) study with a sample of 1,416 primary and secondary Chinese students were 0.85 (SEFM), 0.86 (SEFI) and 0.84 (SR). This reflects the stability of Rasch reliabilities of the three subscales in the current study with 180 secondary students.

Table 4 presents the item difficulty, standard error and item fit statistics (i.e. Infit and Outfit MNSQ) for the three dimensions of the SaPS used in the present study. For knowing better the psychometric properties of the three scales with the 180 students, we also included Yan's (2020a) results of using the same scales with a relatively large sample of Chinese students ($n = 1,416$). All the nine items showed satisfactory indicators (all infit and outfit values were within the suggested range 0.60 to 1.4) fitting the three-dimensional Rasch model. The average infit and outfit scores were similar with those found in Yan's (2020a) study. These results indicate that items for each subscale assessed the corresponding dimension of SaPS in the current sample of students as theorised in the previous research (Yan, 2018, 2020a).

Discussion

While we know more about the role of self-assessment in enhancing learning, we know relatively less about psychological factors influencing students' self-assessment practice. The study examined two crucial psychological factors of students: Grit and ASC. Specifically, this study took the initiative to integrate three research lines: grit (A. L. Duckworth et al., 2007), academic self-concept (Marsh, 1990; Shavelson et al., 1976; Yang, 2018) and self-assessment (Boud, 1992; Yan, 2016) through the self-system processes model of motivation (Connell & Wellborn, 1991) to explore their relationships.

The results supported Hypothesis 1 on the positive correlations among SA, Grit-PE and ASC. Correlation coefficients of all three key variables were statistically significant, ranging from .52 to .63 ($ps < .001$). Consistently, the three facets of SA (i.e. self-reflection, seeking external feedback through monitoring and seeking external feedback through inquiry) were positively and significantly correlated with the competence and affect components of academic self-concept and the Grit-PE. Students' self-concept had stronger correlations with SA at both the academic domain level and the component-specific level. These findings supported the conceptual closeness and links between the three variables (see also Table 1): Grit as a psychological factor involving long-term striving processes for achieving personal goals across situations (e.g. A. Duckworth, 2016) → self-perceptions in learning school subjects (e.g. Marsh, 1990, 2022) → self-assessment practices in learning school subjects (e.g. Boud, 1992; Yan, 2016). In other words, students' striving processes through the Grit-PE may influence their self-perceptions in learning (domain-specific perceptions) and self-practices in terms of self-assessment in learning (domain-specific practices) as consequences. However, we need to note the results of the current study, given its cross-sectional design, do not infer any causation of the three variables but links. The results also support the appropriateness and explanatory power of the self-system processes model (Connell & Wellborn, 1991) to link the three variables conceptually. Both Grit-PE and ASC are positive predictors of SA. This

result supports Hypothesis 2. However, the path coefficient of Grit-PE to SA was not statistically significant after we consider ASC.

This study found academic self-concept mediated the relationship between Grit-PE and SA. This result is consistent with our Hypothesis 3 (see also [Figures 2 and 3](#)), and it supports the conceptual model ([Figure 1](#)) too. Considering the twofold multidimensionality of academic self-concept with two separable components (competence and affect) as suggested by previous research (Arens et al., 2021; Marsh et al., 1999), we did the other path analysis by separating the two components of ASC; we consistently found that both the competence and affect self-concepts mediated the relationship between Grit-PE and SA. The results provide support to the cognitive and behavioural-oriented features (e.g. inquiry, monitoring and self-reflection) of SA practices as defined by self-assessment researchers (e.g. Yan & Brown, 2017; Yan, 2016) and measured by the SaPS scale that focuses on assessing students' self-assessment actions (Yan, 2016, 2020a, 2020b). The over four decades of self-efficacy literature pertaining to the significance of one's perceived competence in completing tasks in given situations (Bandura, 1977; Schunk & DiBenedetto, 2021) also lend some empirical support to the salient role of students' competence self-concept in action-taking (see also Bong & Skaalvik, 2003). The affect component of self-concept is also associated with SA and plays a significant mediating role. The results support the conceptual positioning of affective factors as motivational influencers, as shown in [Figure 1](#) that assumed internal affective states also influence SA. Findings of the bootstrap analysis ([Figure 3](#)) also support the necessity to consider the component-specific (competence vs. affect) dimensionality of ASC when examining its role in other psychological constructs and learning outcomes (e.g. Arens et al., 2011; Yang, 2018). Our supplementary analyses by considering the component-specific dimensionality of ASC and the discrete SA practices (self-reflection, inquiry and monitoring) also provide consistent support to the positive mediating roles of the two components of ASC in the relationship between Grit-PE and these SA practices. Replication studies using the scales in this study or similar scales across educational levels and cultures could contribute valuable insights for providing comprehensive explanations to enrich the understanding of the relations of the three variables in diverse learners. Future large-scale sample studies that allow researchers use SEM to perform more complicated and rigorous analyses than the current study would also produce more valuable evidence to explore the relationships among these variables.

Theoretical and empirical implications

The results enrich the current scope of self-assessment research (e.g. Panadero & Romero, 2014; Panadero et al., 2012; Yan et al., 2022) by revealing the roles of both Grit-PE and ASC as two influencers from the perspective of educational psychology. The statistically significant role of ASC as a general domain and its sub-component/dimension of competence self-concept in mediating the relationship between Grit-PE and self-assessment practice have implications for self-assessment researchers to consider and integrate Grit-PE and ASC as important psychological factors to include or expand the internal and personal sources to adequately explore antecedents of self-assessment aside from studying consequences of self-assessment. This study consistently supported the multidimensionality of the ASC construct based on the distinguishable effects of Grit-PE

on the two sub-components of ASC and their positive association with self-assessment practice. This differentiation has implications for researchers and practitioners to design self-enhancement interventions based on the need of students (Yeung et al., 2013) and with proper training to administer self-concept interventions (Gasa et al., 2019; O'mara et al., 2006). For example, it might be more important to intervene in students' self-perception of competence in learning school subjects than their affective component of ASC (e.g. interests and enjoyment). Students may have a greater interest in learning school subjects than they perceive themselves as capable learners of school subjects; the latter usually requires a certain amount of practice and accumulated academic achievements (Yeung et al., 2010; Yeung, 2011). The stronger correlations between the self-perception of competence and self-assessment practices than those for the affective component of ASC (see Table 2) may indicate that targeted self-enhancement of this component of ASC is likely to produce beneficial effects on SA.

Moving a step further, Pekrun et al. (2022) suggested, 'Informational feedback that uses mastery standards may be better suited to support all students in developing favourable competence beliefs' (p. 12). The positive effect of feedback intervention on changing academic self-concept has also been evident in several previous studies (Craven et al., 1991; Simonsmeier et al., 2020; Yang & Watkins, 2013). Given the positive links between ASC and SA, also given the reciprocally causal relationship between ASC and academic achievement consistently identified in longitudinal studies (e.g. Marsh & Craven, 2006; Marsh & Martin, 2011; Marsh et al., 2018), ASC may play a much more salient role in both SA and academic achievement as compared to Grit (see also Dixon, 2021). The findings of the high correlation between Grit-PE and the competence component of ASC ($r = .64$) and the affective component of ASC ($r = .52$) may suggest that positive changes in grit are also likely to be associated with positive ASC. There are also several studies on the changeable features of grit through classroom-based intervention by integrating goal setting, growth mindset and perseverance in adversities (e.g. Alan et al., 2019) and accumulated experience in learning situations (e.g. Hwang & Nam, 2021). However, this hypothesis needs further experimental studies to verify.

Limitations and future directions of research

Based on the promising evidence of the aspect of grit involving perseverance of effort, this study focused on examining it. The study is, thus, limited in terms of providing a broader picture of the role of multifaceted grit (e.g. perseverance of effort, [in]consistence of interest and adaptability) in academic self-concept and self-assessment practices. We found that the impact of the perseverance of effort facet has been consistently more influential than the facet of (in)consistence of interest. By extending the two facets that have been typically examined in Western cultures (A. L. Duckworth & Quinn, 2009) to Asian cultural settings, recent studies have provided accumulated stronger evidence of the perseverance of effort (see Datu & Zhang, 2021; Datu et al., 2016, 2017b; Ting & Datu, 2020). We also noticed the adaptability (AD) dimension as an additional dimension to the Grit construct to explore its association with one's life long goals (Datu et al., 2016). As Datu et al. (2021, p. 984) argued: 'Instead of constantly persevering in accomplishing difficult activities or plans to achieve long-term goals, individuals with high levels of adaptability may give up such plans for other equally appealing pathways to achieve

distant goals in life'. Given the scope of the current study to explore the role of perseverance of effort in affecting self-perceptions and practices of assessment in learning situations instead of distant goals in life, we did not consider this dimension. Future studies may consider the adaptative dimension to with research designs of exploring students' long-term life goals aside from learning goals in schools. Another limitation of this study is that students' self-report data assessed self-assessment practice via the SaPS scale (Yan, 2016, 2020a) rather than any direct measures of self-assessment performance. In addition, as noted in the measure section, given the multidimensional features of SA practice, we explicitly excluded the dimension of seeking internal feedback through gut feelings and intuition in the SaPS scale. We did this because we treated SA as a dependent variable in this study and our focus was on SA practice that would be teachable and modifiable (e.g. self-reflection and seeking external feedback). We did not mean seeking internal feedback through the inner state may not be important. Instead, we may suspect the effects of external interventions through ASC/Grit-PE on less teachable/modifiable features of intuition/gut feelings. Researchers who are interested in examining the relationship between feedback seeking through inner states (e.g. gut feelings and intuition) and other outcome variables (e.g. academic achievement and achievement emotions) may add this dimension. It would also be promising for future research to expand the scope of research design to include the process data of assessing students' behaviours to select self-assessment criteria in addition to seeking feedback from others and performing self-reflection. Doing so will generate a richer picture of understanding the relationships between perseverance of effort, ASC and SA than what was done by this study. Measures of self-assessment that are not merely based on self-report but other informants will also contribute resourceful information to informing real educational implications.

Furthermore, given the well-established multidimensionality of academic self-concept identified in the past four decades (Marsh et al., 2022; Shavelson et al., 1976), future studies should produce more influential impact by considering and including subject-specific ASC (e.g. mathematics, native and non-native languages) in exploring the relations between ASC and SA. The current study focused on assessing students' overall ASC of learning school subjects. In future studies, including more learning outcome variables (e.g. achievement indicators [e.g. school-based grades and standardised test scores] and self-regulated learning measures) will produce more useful information for the readers' understanding of the self-system processes model of motivation in explaining the sequence of contextual self-action outcomes. It is also interesting to explore how domain-specific form of perseverance (e.g. perseverance in English or mathematics) may contribute to academic self-concept and self-assessment practices in specific academic subjects. We also want to point out that although the sample of students in our study came from over 58 schools (representing 36% of local schools), it was not randomly sampled. The sampling method itself has its limitation. It would also be meaningful to extend the current design to students in higher education, given that self-assessment is also one of the core components of formative assessment practices in higher education (Falchikov & Boud, 1989; Mok et al., 2006; Yan et al., 2021). Longitudinal and experimental designs will provide more valuable evidence in examining the reciprocal relationships of the variables and, to what extent, Grit and ASC can influence SA and

its consequences directly and indirectly. In addition, the number of sub-items to assess the competency and affect components of academic self-concept need to be increased from the current two items to more (e.g. four) in relation to previous self-concept research (e.g. Marsh et al., 1999; Yang et al., 2016). Although this study would be one of the first to explore the links between grit, academic self-concept and SA practices, constrained by the sample size, we used manifested mean scores of the three variables in the two regression analyses instead of using latent estimates through structural equation modelling (SEM, Bollen & Long, 1992). Using manifest scores, measurement errors (Fuller, 1987) were omitted in regression analyses. Considering the same size, we separately analysed measurement models through a series of confirmatory factor analyses and provided detailed results in Table A1. The results supported all measures have good model fit indices. To address the limitations affected by sample size, future research with large-scale designs and latent variable analyses will be promising to verify the current findings. Another point to note is that although we considered the twofold multidimensionality of academic self-concept (i.e. domain-specific and component-specific) that has been identified in the previous research across students in Western and Eastern countries (e.g. Arens et al., 2021; Marsh et al., 1999; Yang et al., 2016), we used the two items' component-specific academic self-concept to explore more information about the mediating role of academic self-concept. The reliabilities of the two subscales (competence and affect) of academic self-concept were satisfactory. We also did Rasch analysis and found that the Rasch reliabilities (EAP/PV reliabilities) of the two subscales were consistently satisfactory: competence (.856) and affect (.888). Consistent with Kenny et al. (1998) comment that two items as indicators for a construct is 'at least', we would say our exploration provided some preliminary findings of understanding the associations of the competence and affect components of academic self-concept with self-assessment practices. Future studies should consider adding more items than two for each component (competence/affect) to verify the relationships examined with limited items. These improvements in the future research design in cross-cultural studies will also extend the existing scope to include more motivational variables and direct measures of self-assessment performance in Figure 1 to enrich self-assessment research. As Panadero et al. (2016, p. 824) insightful review commented 'cross-cultural research and greater awareness of socio-cultural values as important contextual influences' and more research 'into the psychological aspects of the SSA process' including motivational and emotional aspects are greatly needed.

Conclusion

There is accumulating evidence from a variety of research designs (for meta-analytical studies, see Falchikov & Boud, 1989; Panadero et al., 2017; Yan et al., 2021) that self-assessment matters for students' learning and achievement. However, studies revealing effective influencers of self-assessment practices remain inadequate. This study was one of the first to integrate both grit and academic self-concept literature to examine the role of the two influential psychological factors in SA. The results supported our hypotheses that academic self-concept mediated the relationship between the perseverance of effort facet of grit and self-assessment

practices. The power of both perseverance of effort and academic self-concept in maximising the productive effects of self-assessment practices on student learning outcomes appears to be a facilitating topic to be explored by future research across educational levels.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendices

Table A1. Fit indices for the measurement of the scales.

	Scales used	Description	χ^2 (<i>df</i>)	RMSEA	CFI	TLI	SRMR
CFA Model A1	SA	General factor	119.206 (27)	.138	.791	.722	.081
CFA Model A2	SEFM, SEFI, & SR	Three correlated factors	51.752 (24)	.080	.937	.906	.063
CFA Model A3	SEFM, SEFI, & SR	Second-order	51.752 (24)	.080	.937	.906	.063
CFA Model A4	SEFM and SR items (as SA F1), SEFI as SA F2	Two correlated factors	64.625 (26)	.091	.913	.879	.059
CFA Model A5	Grit-PE	General factor	.000 (0)	.000	1.000	1.000	.000
CFA Model A6	ASC	General factor	2.471 (1)	.090	.992	.955	.011
CFA Model A7	ASC_COM & ASC_AFF	Two correlated factors	2.471 (1)	.090	.992	.955	.011

Note. CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root-mean-square error of approximation; SRMR = standardised root mean square residual; SA = self-assessment; SEFM = seeking external feedback through monitoring; SEFI = seeking external feedback through inquiry; SR = self-reflection; Grit-PE = the perseverance of effort facet of grit; ASC = academic self-concept; ASC_COM = the competence component of ASC; ASC_AFF = the affective component of ASC. In CFA Model A4, two highly correlated items of the affective component of ASC were correlated ($r = .733$, $p < .001$). CFA Model A3 was a saturated model.

Table A2. Items of these scales used in the current study with means, SDs and factor loadings.

Item Description	M	SD	Factor loadings	
			General factor	Correlated factors
Self-assessment				
<i>SEFM</i>				
1. I check whether I have fully understood the course content by doing past exam papers.	3.21	.62	.714	.831
2. I check whether I have mastered the course content by doing extra exercises.	3.22	.61	.808	.934
3. I keep track of my progress by recording my performance.	3.00	.66	.600	.531
<i>SEFI</i>				
4. I ask my fellow group members to evaluate my contributions to group work tasks.	2.78	.77	.585	.848
5. I ask my friends to tell me how to improve my learning.	2.78	.79	.626	.859
6. I ask my teachers to give me feedback about my performance.	2.66	.83	.342	.705
<i>SR</i>				
7. When I do exercise, I look at what I got wrong or did poorly on to guide me as to what I should learn next.	3.14	.60	.745	.740
8. As I study, I think about whether the way I am studying is really helping me learn.	3.14	.67	.600	.667
9. I pay attention to my assessment results in order to identify what I can do better next time.	3.19	.63	.796	.849
<i>ASC</i>				
<i>ASC_COM</i>				
10. I learn things quickly in all school subjects.	2.56	.85	.814	.814
11. I get good marks in all school subjects.	2.44	.89	.809	.809
<i>ASC_AFF</i>				
12. I enjoy doing work in all school subjects.	2.74	.89	.663	.869
13. I am interested in all school subjects	2.67	.88	.755	.990
<i>Grit-PE</i>				
13. I am a hard worker.	2.67	.86	.833	-
14. I finish whatever I begin.	2.68	.85	.725	-
15. I am diligent.	2.64	.87	.937	-

Note. Students rated on a 4-point scale ranging from 1 (strongly disagree) to 4 (strongly agree). SEFM = seeking external feedback through monitoring; SEFI = seeking external feedback through inquiry; SR = self-reflection; Grit-PE = the perseverance of effort facet of grit; ASC = academic self-concept; ASC_COM = the competence component of ASC; ASC_AFF = the affective component of ASC.

Table A3. Bootstrap analysis on mediation effects.

Models	Paths	Standardised β	SE	Bias-corrected percentile 95% CI	
				Lower	Upper
A3.1	Grit-PE \rightarrow ASC \rightarrow SR	.212**	.077	.062	.366
A3.2	Grit-PE \rightarrow ASC \rightarrow SEFM	.245***	.069	.115	.386
A3.3	Grit-PE \rightarrow ASC \rightarrow SEFI	.300***	.057	.195	.420
A3.4.1	Grit-PE \rightarrow ASC \rightarrow SA (as a latent variable defined by SR, SEFM, SEFI)	.306***	.072	.164	.445
A3.4.2	Grit-PE \rightarrow ASC_COM \rightarrow SA (as a latent variable defined by SR, SEFM, SEFI)	.150*	.062	.030	.274
	Grit-PE \rightarrow ASC_AFF \rightarrow SA (as a latent variable defined by SR, SEFM, SEFI)	.151**	.057	.045	.273

*** $p < .001$; ** $p < .01$; * $p < .05$.

Note. In examining the significance of the mediation effects, bootstrapping analysis was conducted, resampling and replacing the data 5,000 times.

Table A4. Fit indices for these models (see Table A3) in the supplementary analyses.

Models	Description	χ^2 (df)	RMSEA	CFI	TLI	SRMR
A3.1	Grit-PE \rightarrow ASC \rightarrow SR	.000 (0)	.000	1.000	1.000	.000
A3.2	Grit-PE \rightarrow ASC \rightarrow SEFM	.000 (0)	.000	1.000	1.000	.000
A3.3	Grit-PE \rightarrow ASC \rightarrow SEFI	.000 (0)	.000	1.000	1.000	.000
A3.4.1	Grit-PE \rightarrow ASC \rightarrow SA (as a latent variable defined by SR, SEFM, SEFI)	24.774 (4)	.170	.949	.872	.047
A3.4.2	Grit-PE \rightarrow ASC_COM \rightarrow SA defined by SR, SEFM, SEFI	25.927 (6)	.136	.961	.902	.047
	Grit-PE \rightarrow ASC_AFF \rightarrow SA (as a latent variable defined by SR, SEFM, SEFI)					

Note. Models A3.1 to A3.3 were saturated models as shown in Appendices. Given this, chi-square and degree of freedom were equal to zero and model fit indices were satisfactory for research purposes.