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The Diagnostic Assessment and Achievement of College Skills (DAACS) online system assesses newly enrolled college students' skills in reading, writing, mathematics, and self-regulated learning, and provides individualized feedback and links to resources. The purpose of this study is to examine validity evidence regarding the internal structure of the DAACS Self-Regulated Learning (SRL) self-report survey. Factor structure was initially examined using maximum-likelihood exploratory factor analysis with varimax rotation on a pilot sample (n = 682). Based on the results, as well as the intended uses of the survey and expert opinion, two confirmatory factor analysis models were tested: the measurement model, and the instructional model. Validity evidence regarding the survey's internal structure were gathered using a new sample of 6,644 adult learners at an online university. The confirmatory factor analysis results, correlations, and internal consistency reliability estimates suggested acceptable model fit for both the measurement and instructional models. Both models were retained to serve different purposes.

Keywords: Self-regulated learning, survey, higher education, adult learners, validity and reliability

Institutions of higher education often base assessments of student readiness for college on placement exams in reading, writing, and mathematics (Bailey & Cho, 2010; Belfield & Crosta, 2012). These assessments are used to identify students who might be academically at-risk and to place them in remedial or basic coursework, often for no credit. However, typical placement-based assessments do not provide students with any feedback regarding their academic strengths and weaknesses, nor do they recommend useful resources. They also fail to provide information about other academic competencies needed to succeed in college, including and especially self-regulated learning (SRL), which refers to the processes by which students tailor their cognitions, emotions, and behaviors to the achievement of their academic goals (Zimmerman & Schunk, 2011). Self-regulated learning skills have been linked to student success, and can be taught (Zimmerman, Moylan, Hudseman, White, & Flugman, 2011; Zimmerman & Schunk, 2011).

The Diagnostic Assessment and Achievement of College Skills (DAACS; https://daacs.net) is an assessment and feedback system that was developed to address these shortcomings of traditional college readiness assessments. DAACS assesses students' skills in reading, writing, mathematics, and SRL, and gives them access to individualized feedback and resources. DAACS is unique in that it is diagnostic (no stakes) and open source.

The impetus for creating the DAACS SRL survey was the need for a practical, freely accessible, and actionable assessment of SRL. Like other SRL measures (e.g., Cleary, 2006; Dugan & Andrade, 2011; Pintrich, Smith, Garcia, & McKeachie, 1993), the survey is designed to measure metacognition, motivation, and learning strategies. Unlike others, the DAACS survey is short enough to encourage its use, having been designed to ensure that the three areas of self-regulated learning are adequately represented with a small but psychometrically sound number of items. In addition, this survey is designed to serve instructional purposes; each scale, subscale, and item is explicitly linked to actionable feedback that can assist students to help themselves become more academically successful.

The DAACS is currently being used by two major online universities, which have made it a part of their orientation process in lieu of traditional placement exams. It is implemented to measure students' college readiness and provide feedback to students at the onset of their academic studies. Academic advisors are trained to use the information provided by the DAACS

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assessments to give students individualized support. The objective of this paper is to examine the evidence for the validity and reliability of the inferences made based on the SRL survey.

Validation requires specifying the interpretations and uses of test scores, and supporting them with theory and evidence (American Educational Research Association [AERA], American Psychological Association [APA], & National Council on Measurement in Education [NCME], 2014; Kane, 1992, 2011, 2013). According to Kane's (2013) argument-based approach, validity, at its most basic level, is a two-step process in which test developers provide: (a) a rationale for the interpretations (or uses) of the test scores, and (b) evidence of the plausibility of the proposed interpretations. A proposed interpretation or use can be considered valid to the extent that the interpretation/use argument is "coherent and complete… and its assumptions are either highly plausible a priori or are adequately supported by evidence" (pp. 2-3). Given the intended purposes of the DAACS SRL survey, three assumptions inform the interpretive argument for validation: (a) Self-regulated learning refers to the processes by which students tailor their cognitions, emotions, and behaviors towards the achievement of their academic goals; (b) the interpretation of scores should serve practical, instructional purposes, thereby providing actionable feedback to students; and (c) self-regulated learning is a malleable skill that has been linked to academic success.

Assumption #1: Self-regulated learning refers to the processes by which students tailor their cognitions, emotions, and behaviors toward the achievement of their academic goals

The DAACS SRL survey was designed to measure cognitive, emotional, and behavioral processes related to self-regulated learning, specifically in the areas of metacognition, motivation, and strategies for learning. The survey treats SRL as a domain-general trait, rather than a domain-specific state. Although there is support in the research literature for both perspectives (e.g., Pintrich & De Groot, 1990; Robbins, Allen, Casillas, Hamme-Peterson, & Le, 2006), treating SRL as a domain-specific state would necessitate dozens or even hundreds of surveys. The domain-general DAACS SRL survey is practical as well as theoretically defensible.

Metacognition is the awareness and management of one's thoughts, and involves planning one's learning, monitoring how learning progresses, and assessing if and how well learning has occurred (McKeown & Beck, 2008; Serra & Metcalfe, 2008). Most or all models of SRL include planning, monitoring, and evaluation in one form or another (Butler, 2002; Paris & Paris, 2001; Pintrich, 2004; Winne & Perry, 2000; Zimmerman, 2000; Zimmerman & Schunk, 2011). Accordingly, the metacognition scale in the DAACS SRL survey includes planning, monitoring, and evaluation subscales.

Motivation is the process that activates and sustains cognitions, emotions, and actions in the interest of one's goals (Schunk & Zimmerman, 2008). Academic motivation is a multi-dimensional construct that includes task interest, task value, test anxiety, goal orientation, mindset, and self-efficacy. Because most motivational processes are related to adaptive behaviors and academic success, researchers have explored the effects of interventions that target multiple motivational constructs (Rosenzweig & Wigfield, 2016). The strong empirical evidence for the associations between academic achievement and test anxiety, mastery orientation, mindset, and self-efficacy led us to select those constructs as subscales in the DAACS SRL survey (Bembenutty & Zimmerman, 2003; Mega, Ronconi, & DeBeni, 2014).

Strategies for learning includes the cognitions and behaviors that learners engage in when processing new information or completing academic tasks (Mayer, 1988; Zimmerman, 1989). While previous research mostly focused on cognitive learning strategies such as elaboration, organization, rehearsal, and comprehension (Paris & Paris, 2001), strategies that aid with organizing one's environment and time and seeking help are also important (Cleary, Dembitzer, & Kettler, 2015). Items in the strategies for learning scale of the DAACS SRL survey are therefore related to managing environment, managing time, help-seeking, and enhancing understanding.

In summary, in order to reflect current models of SRL, the DAACS survey has three scales, each with subscales: motivation has four subscales (i.e., anxiety, mastery orientation, mindset, and self-efficacy); metacognition has three subscales (i.e., planning, monitoring, and evaluation); and strategies for learning has four subscales (i.e., help-seeking, managing environment, managing time, and strategies for understanding), for a total of 11 subscales. This assumption about the structure of SRL was tested using factor analyses and correlations.

Assumption #2: The interpretation of scores should serve practical, instructional purposes, thereby providing actionable feedback to students

Theory and research on feedback consistently indicate that learning is enhanced when students have information about the gap between their current and desired levels of achievement, and information about how to close the gap (Hattie & Timperley, 2007; Shute, 2008; Wiliam & Thompson, 2007). The items in the 11 subscales were carefully selected or written by SRL experts to be instructionally tractable and specific enough to generate meaningful, actionable feedback about how students could improve as learners. Feedback, therefore, is a key element of the interpretation and subsequent use of the DAACS SRL survey results.

Upon completing the survey, students are given one of three possible scores—developing, emerging, or mastering—which correspond with low, medium, and high scores for each of the scales and sub-scales. The category labels were chosen in order to suggest a growth opportunity and to avoid discouraging students. Receiving a score of mastering indicates a likely area of strength; emerging indicates that the student reports partial but inconsistent commitment to the skill or belief assessed by the scale. A score of developing suggests a potential barrier to successful learning—an area in need of improvement.

Scale scores are reported in terms of the three categorical rankings, along with descriptions of the scale and results, and short, animated videos that describe the scale and its importance. Students can get more information about subscales by clicking on links to detailed, item-level feedback about their results, as well as a scenario illustrating the sub-scale's importance. From there, students can dive even deeper by clicking on links to detailed

information about the sub-scale, profiles of fictional students who have overcome difficulties with that particular skill, strategies students can use to improve, and links to additional open educational resources.

Assumption #3: Self-regulated learning is a malleable skill that has been linked to academic success

Research on SRL demonstrates that students of all ages and across disciplines improve their academic performance when they use strategies to manage their learning, motivation, metacognition, and environment (DeCorte, Mason, Depaepe, & Verschaffel, 2011; Graham & Perin, 2007; Kitsantas & Kavussanu, 2011; Pintrich, 2004; Tonks & Taboada, 2011; Winne & Hadwin, 1998; Zimmerman, 2000, 2011; Zimmerman, et al., 2011). Accordingly, the DAACS SRL survey and the corresponding results and feedback are all designed with the expectation that, when used effectively, they will help to improve self-regulated learning behaviors, and subsequently lead to academic success.

The DAACS SRL survey is designed to encourage students to change their behaviors and perceptions as learners. The survey and feedback are free, open-source, and easily accessible online, and the feedback is immediate. If students are unfamiliar with a particular domain or subdomain, there are content-related materials within the feedback that introduce students to the construct and its importance to learning and achievement. The availability of information and resources is intended to encourage autonomy in learning.

However, some students might find it challenging to interpret their scores and feedback. To facilitate their understanding and usage of the SRL resources, academic advisors at the participating institutions help students interpret their results by identifying their strengths and areas in need of improvement. In addition, academic advisors assist students with selecting strategies to improve their SRL skills and, subsequently, learning and performance.

Purpose of the Study

This paper describes the development of the DAACS SRL survey and examines the evidence for the plausibility of Assumption 1, regarding the structure of SRL as comprising metacognition, motivation, and strategies for learning. Evidence for the plausibility of Assumptions 2 and 3 is currently being analyzed. Validity evidence regarding the internal structure of the survey is reported here. Two confirmatory factor analysis models were tested. One model was based on exploratory factor analysis (EFA) results, and another model took into consideration the instructional and practical purposes of DAACS and the SRL survey. Since both models are based on strong theoretical foundations as well as empirical evidence, we hypothesize that both models will be useful but for different purposes.

Method

Sample

Two samples were used for this study. The first sample included 682 incoming students from two online institutions, most of whom were non-traditional/adult learners. The students were randomly selected, and participation was voluntary and anonymous. This first sample was used for exploratory factor analysis.

The second sample included 6,644 incoming students in one private, non-profit, fully-online university in the Western region of the United States who enrolled between April and July 2017. Of the 6,644 students, a little more than half were female (54%), and just under half were first-generation college students (45%). The majority were 18 to 37 years old (63%), and White (70%) or Black (11%). The remaining 19% of students were Hispanic (3%), Asian (3%), American Indian, Alaskan Native, or Native Hawaiian (1%), or mixed or unknown race (5%). Since these were adult learners, the majority were earning a salary of at least $35,000 (58%); only 7% were reported to have an income of less than $16,000.

The sample of 6,644 students was part of a randomized control trial of the DAACS intervention. All newly enrolled students at the participating university were required to attend an online orientation. Treatment students were required to complete the DAACS SRL survey as part of their orientation, while control students were not. Most completed the survey in 15 minutes or less.

The DAACS SRL Survey

The DAACS SRL survey is a 47-item self-report survey that assesses *motivation* (20 items; 4 subscales; anxiety, mastery orientation, mindset, and self-efficacy), *metacognition* (13 items; 3 subscales; planning, monitoring, and evaluation), and *strategies for learning* (14 items; 4 subscales; help-seeking, managing environment, managing time, and strategies for understanding). The items use two 5-point Likert-type scales: either 0 = *almost never* to 4 = *almost always*, or 0 = *strongly disagree* to 4 = *strongly agree*.

Items on the scale are actionable and instructionally meaningful, and can be used to provide feedback to students and their advisors. For example, two items in the strategies for understanding subscale are, "I think about the types of questions that might be on a test" and "I make pictures or diagrams to help me learn concepts." Depending on how students respond to these items, students and advisors could be advised by DAACS to incorporate these self-regulated learning behaviors into their repertoire of study strategies.

Procedures for the Development of the DAACS SRL Survey

According to the *Standards for Educational and Psychological Testing* (AERA, APA, & NCME, 2014), validity evidence based on internal structure includes the relationships among the test items and the degree to which those relationships conform to the construct. Best practices for instrument development, particularly for diagnostic assessments (DeVellis, 2011; Downing, 2006; Gorin, 2007; Johnson & Morgan, 2016), were followed to develop the DAACS SRL survey and to gather reliability and validity evidence to support the assumptions. The instrument development procedures, which consisted of three phases, are summarized in the next section with a focus on the survey's internal structure.

Phase one: Operationalizing SRL. We began by defining the scales and selecting items to pilot. Several experts in self-regulated learning, assessment, and measurement examined existing measures, including the Self-Regulation Strategy Inventory – Self-Report (SRSI-SR; Cleary, 2006), the Survey of Academic Self-Regulation (SASR; Dugan & Andrade, 2011), the Online Learning

Value and Self-Efficacy Scale (OLVSES; Artino & McCoach, 2008), the Metacognitive Awareness Inventory (Schraw & Dennison, 1994), Mindset (Dweck, 2006), and the Westside Test Anxiety Scale (Driscoll, 2007). Details regarding reliability and validity as well as norming samples of these original scales are provided in Appendix A. One-hundred and ten items were selected for pilot testing based on content, clarity, and usefulness for feedback.

Phase two: Pilot testing and scale development. Phase two involved generating scales and refining items based on empirical data and expert judgments. The 110-item version of the survey was administered to 682 adult learners at two online, adult-serving institutions. Data from the pilot testing were used to conduct maximum-likelihood exploratory factor analysis using the `factanal` function in *R*. Since the purpose of this step is to reduce the number of items and identify factors of the survey, varimax rotation was used. In addition, academic advisors, who are experts in student advisement, were asked to rate all 110 items based on their usefulness for providing actionable feedback to students.

Phase three: Survey model confirmation. Two models were tested using confirmatory factor analysis (CFA): (a) the most parsimonious model derived from the EFA, which we call the *measurement model*, and (b) a model we call the *instructional model*, which was based on the theoretical framework, the results from the EFA, and the survey's intended purposes. Internal consistency estimates were evaluated to determine the appropriateness of the scales and subscales. Finally, correlations between and within scales were examined to confirm that the scales were distinct yet related, and subscales within a scale were more related to each other than to other scales.

Results

Exploratory Factor Analysis of the SRL Survey

The scree plot and parallel analysis suggested an eight-factor structure; however, the factor loadings from the EFA of an eight factor structure, along with conceptual justifications by expert judgments, led us to a six-factor structure with 47-items (Table 1). Empirically, 63 of the 110 items were omitted because they failed to have a factor loading of .30 or above (Brown, 2006), they were repetitive with other retained items, or both. The ratings of items by the academic advisors, as well as the evaluations of items and scales by the SRL experts, were also considered when determining the scales and items for the shorter version of the survey. After the 63 items were removed, two factors were left with two or less items. These two factors were ultimately dropped, but the items were retained and moved to a conceptually relevant factor, resulting in a six-factor structure.

The first factor was characterized by items describing individuals' motivational dispositions, including their mastery orientation and self-efficacy; this factor was therefore named *mastery motivation*. As expected, the second factor, named *mindset,* revealed that Dweck's (2006) mindset items held together. The third factor, named *metacognition*, was defined by items that described metacognitive processes, including planning, monitoring, and evaluation. The fourth factor was composed of items describing anxious behaviors; this factor was thus named *anxiety*. The fifth factor, strategies for *managing time and environment*, was characterized by items describing learning strategies related to management of time and environment. Finally, the sixth factor was defined by items describing help-seeking behaviors and strategies used to understand new information or to clarify what was confusing; therefore, this factor was named *strategies for understanding and help-seeking*.

Only one or two items loaded on the seventh and eighth factors. These items represented teachable skills and were deemed important by the experts, so two relevant items from the seventh factor were moved to the strategies for managing time and environment factor, and the one item from the eighth factor was moved to the strategies for managing understanding and help-seeking factor. Given its meaning and relevance, one item, "I avoid asking questions about things I don't understand," was moved from the strategies for time and environmental management factor to the strategies for understanding and help-seeking. The resulting model is illustrated in Figure 1.

The second model was developed to reflect the practical purposes of the DAACS SRL survey (Figure 2) and the structure of the feedback provided to students. This model was based on the factor structure from the EFA, but the items and factors were regrouped into first and second latent factors based on their instructional utility. Specifically, mastery motivation items were separated into self-efficacy and mastery orientation, and these two subscales, along with mindset and anxiety, were grouped under the second-order factor of motivation. Metacognition was another second-order factor, but its items were separated into three first-order factors to represent three distinct metacognitive processes: planning, monitoring, and evaluation. Finally, both strategies scales were grouped together as the third second order factor of *strategies*, and separated into four first-order factors: managing environment, managing time, help-seeking, and understanding.

Confirmatory Factor Analyses of the Measurement and Instructional Models

Maximum-likelihood CFA was conducted using the `lavaan` R package (Rosseel, 2017) to cross-validate the factor loadings of the EFA on the revised survey with a new sample of non-traditional online adult learners (n=6,644). CFA was also used to evaluate the fit of the instructional model, which was based on theoretical assumptions and the intended diagnostic and instructional uses of the survey.

The standardized loadings and measures of model fit for both models are presented in Table 2. According to Hu and Bentler's (1999) criteria that consider jointly a combination of indices, both the measurement and instructional models have model fits that establish the smallest Type 1 and Type 2 errors (SRMR $\leq$ .09; RMSEA $\leq$ .06). In comparison to the measurement model, the Akaike Information Criterion (AIC) index of the

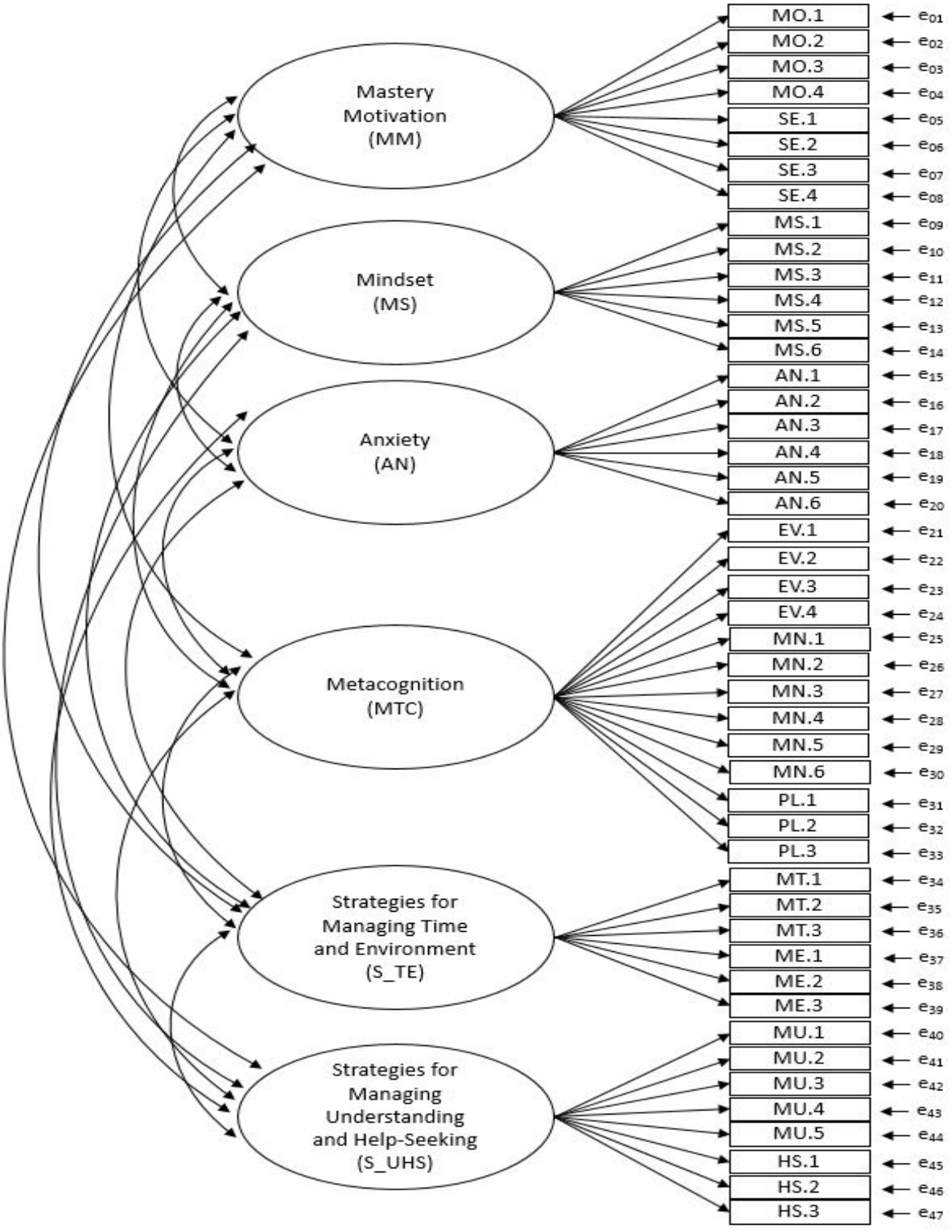

Figure 1. The measurement model that was informed by EFA, and tested and retained using CFA

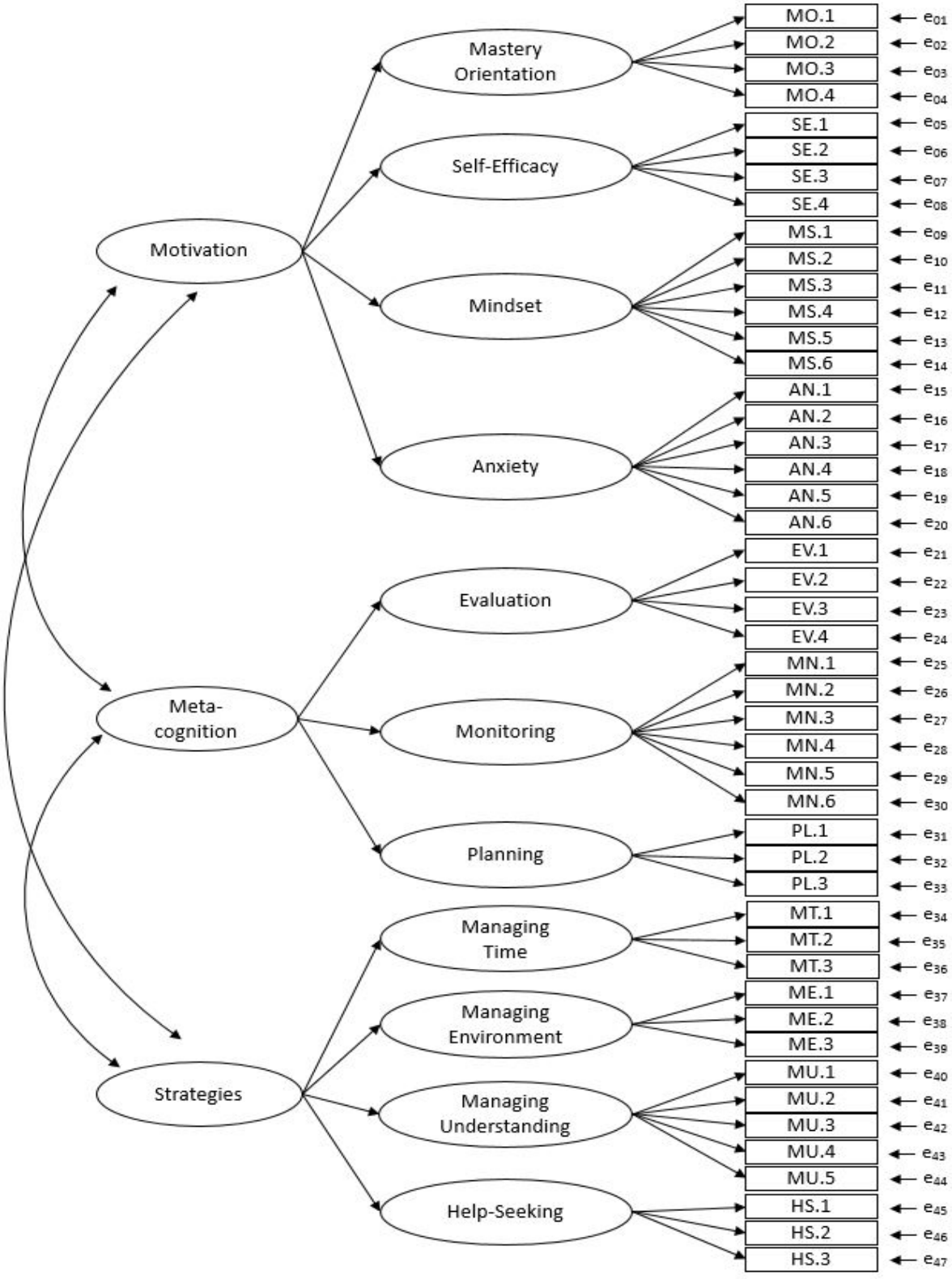

Figure 2. The instructional model that was based on the measurement model, adapted in light of the purposes of the DAACS, and tested and retained using CFA

TABLES AND FIGURES

Table 1

Varimax EFA Standardized Factor Loadings (n=682) and Internal Consistency Estimates

	Factor Loadings								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**α**
Factor 1: Mastery Motivation									**.29**
I find coursework enjoyable.	.59								
What I am learning is relevant to my life.	.57								
Learning is fun for me.	.55								
I want to master the things I am learning.	.52								
I am confident I can do an outstanding job on the activities in an online course.	.55								
I am confident I can learn without the physical presence of an instructor to assist me.	.54								
I am certain I can understand even the most difficult material presented in an online course.	.50								
Even with distractions, I am confident I can learn material presented online.	.45								
Factor 2: Mindset									**.90**
You can always greatly change how intelligent you are.		.75							
No matter how much intelligence you have, you can always change it quite a bit.		.72							
No matter who you are, you can significantly change your intelligence level.		.71							
(You have a certain amount of intelligence, and you can't really do much about it.)		-.74							
(You can learn new things, but you can't really change your basic intelligence.)		-.79							
(Your intelligence is something about you that you can't change very much.)		-.81							
Factor 3: Anxiety									**.89**
During important exams, I cannot remember material that I knew before the exam.			.79						
I feel out of sorts or not really myself when I take important exams.			.78						
I worry so much before a major exam that I am too worn out to do my best on the exam.			.77						
During important exams, I think that I am doing awful or that I may fail.			.73						
The closer I am to a major exam, the harder it is for me to concentrate on the material.			.71						
When I study for my exams, I worry that I will not remember the material on the exam.			.67						
Factor 4: Metacognition									**.90**
I ask myself if I learned as much as I could have once I finish a task.				.67					
I ask myself how well I accomplished my goals once I'm finished.				.66					
I ask myself if I have considered all options after I solve a problem.				.66					
I summarize what I've learned after I finish.				.65					
I ask myself questions about how well I am doing while I am learning something new.				.63					
I ask myself questions about the material before I begin.				.62					
I consider several alternatives to a problem before I answer.				.62					
I find myself analyzing the usefulness of strategies while I study.				.58					

	Factor Loadings								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**α**
I find myself pausing regularly to check my comprehension.				.53					
I ask myself periodically if I am meeting my goals.				.51					
I ask myself if what I'm reading is related to what I already know.				.49					
I think about what I really need to learn before I begin a task.				.49					
I think of several ways to solve a problem and choose the best one.				.46					
Factor 5: Strategies for Managing Time and Environment									**.80**
I finish all of my schoolwork before I do anything else.					.59				
I pace myself while learning in order to have enough time.					.53				
(I wait to the last minute to start studying for upcoming tests.)					-.65				
(I let people interrupt me when I am studying.)					-.49				
I try to study in a place that has no distractions (e.g., noise, people talking).							.86[a]		
I make sure no one disturbs me when I study.							.64 [a]		
Factor 6: Strategies for Managing Understanding									**.74**
I stop and reread when I get confused.						.63			
I stop and go back over new information that is not clear.						.60			
I consciously focus my attention on important information.						.49			
I think about the types of questions that might be on a test.						.35			
I make pictures or diagrams to help me learn concepts.								.86 [a]	
I ask others for help when I don't understand something.									
I ask my instructor questions when I do not understand something.						.34			
(I avoid asking questions about things I don't understand.)					-.48	-.27 [a]			
Eigenvalues	22.66	7.74		4.46	3.23	2.77	2.70	2.39	
Cumulative variance explained	9%	17%	23%	29%	33%	36%	39%	41%	

*Note*s: Items in parentheses are reverse-coded items

[a]These items were moved from their original factors to one of the six factors with which they were theoretically similar

Table 2

Comparison of CFA Standardized Loadings and Goodness-of-Fit Indices for Measurement (6 Factors) and Instructional (3 Second Order, 11 First Order Factors) Models (n=6644)

	Measurement Model			Instructional Model		
Items	**Factor. Indicator#**	**Loadings**	**α**	**(2nd order → 1st order) Factor. Indicator#**	**Loadings**	**α**
Factor 1: Mastery Motivation (MM)	**F1: MM**		.83	**F1: Motivation (MOT)**		.61
				MOT → MO	.86	.71
I find coursework enjoyable.	MM.1	.37		MO.1	.46	
I want to master the things I am learning.	MM.2	.29		MO.2	.32	
What I am learning is relevant to my life.	MM.3	.29		MO.3	.32	
Learning is fun for me.	MM.4	.40		MO.4	.50	
				MOT → SE	.80	.82
I am confident I can learn without the physical presence of an instructor to assist me.	MM.5	.43		SE.1	.44	
I am certain I can understand even the most difficult material presented in an online course.	MM.6	.51		SE.2	.52	
I am confident I can do an outstanding job on the activities in an online course.	MM.7	.46		SE.3	.48	
Even with distractions, I am confident I can learn material presented online.	MM.8	.47		SE.4	.49	
Factor 2: Mindset (MS)	**F2: MS**		.86	MOT → MS	.43	.86
You have a certain amount of intelligence, and you can't really do much about it.	MS.1	.45		MS.1	.45	
No matter who you are, you can significantly change your intelligence level.	MS.2	.60		MS.2	.60	
You can always greatly change how intelligent you are.	MS.3	.66		MS.3	.65	
Your intelligence is something about you that you can't change very much.	MS.4	.57		MS.4	.58	
You can learn new things, but you can't really change your basic intelligence.	MS.5	.62		MS.5	.62	
No matter how much intelligence you have, you can always change it quite a bit.	MS.6	.59		MS.6	.59	
Factor 3: Anxiety (AN)	**F3: AN**		.91	MOT → AN	.47	.91
During important exams, I think that I am doing awful or that I may fail.	AN.1	.77		AN.1	.77	
I feel out of sorts or not really myself when I take important exams.	AN.2	.79		AN.2	.79	
During important exams, I cannot remember material that I knew before the exam.	AN.3	.70		AN.3	.70	
The closer I am to a major exam, the harder it is for me to concentrate on the material.	AN.4	.70		AN.4	.70	
When I study for my exams, I worry that I will not remember the material on the exam.	AN.5	.81		AN.5	.81	
I worry so much before a major exam that I am too worn out to do my best on the exam.	AN.6	.66		AN.6	.65	
Factor 4: Metacognition (MTC)	**F4: MTC**		.90	**F2: Metacognition (MTC)**		.89
				MTC→EV	.98	.73
I ask myself if I learned as much as I could have once I finish a task.	MTC.1	.55		EV.1	.56	
I ask myself how well I accomplished my goals once I'm finished.	MTC.2	.63		EV.2	.64	
I summarize what I've learned after I finish.	MTC.3	.65		EV.3	.65	
I ask myself if I have considered all options after I solve a problem.	MTC.4	.60		EV.4	.60	
				MTC→MN	1.03	.79
I ask myself periodically if I am meeting my goals.	MTC.5	.65		MN.1	.65	
I find myself analyzing the usefulness of strategies while I study.	MTC.6	.63		MN.2	.62	
I ask myself questions about how well I am doing while I am learning something new.	MTC.7	.58		MN.3	.57	

I consider several alternatives to a problem before I answer.	MTC.8	.59		MN.4	.58	
I find myself pausing regularly to check my comprehension.	MTC.9	.44		MN.5	.43	
I ask myself if what I'm reading is related to what I already know.	MTC.10	.53		MN.6	.52	
				MTC→PL	.99	.71
I think of several ways to solve a problem and choose the best one.	MTC.11	.54		PL.1	.54	
I think about what I really need to learn before I begin a task.	MTC.12	.61		PL.2	.62	
I ask myself questions about the material before I begin.	MTC.13	.70		PL.3	.70	
Factor 5: Strategies for Managing Time and Environment (S_TE)	**F5: S_TE**		.79	**F3: Strategies for Learning (STR)**		.74
				STR→MT	.80	.70
I wait to the last minute to start studying for upcoming tests.	S_TE.1	.42		MT.1	.45	
I pace myself while learning in order to have enough time.	S_TE.2	.52		MT.2	.63	
I finish all of my schoolwork before I do anything else.	S_TE.3	.48		MT.3	.54	
				STR→ME	.56	.80
I make sure no one disturbs me when I study.	S_TE.4	.68		ME.1	.79	
I try to study in a place that has no distractions (e.g., noise, people talking).	S_TE.5	.63		ME.2	.69	
I let people interrupt me when I am studying.	S_TE.6	.50		ME.3	.53	
Factor 6: Strategies for Managing Understanding and Help-Seeking (S_UHS)	**F6: S_UHS**		.79			
				STR → MU	.94	.69
I consciously focus my attention on important information.	S_UHS.1	.50		MU.1	.53	
I stop and go back over new information that is not clear.	S_UHS.2	.47		MU.2	.48	
I think about the types of questions that might be on a test.	S_UHS.3	.43		MU.3	.46	
I stop and reread when I get confused.	S_UHS.4	.42		MU.4	.42	
I make pictures or diagrams to help me learn concepts.	S_UHS.5	.44		MU.5	.45	
				STR → HS	.68	.78
I ask others for help when I don't understand something.	S_UHS.6	.54		HS.1	.65	
I avoid asking questions about things I don't understand.	S_UHS.7	.34		HS.2	.43	
I ask my instructor questions when I do not understand something.	S_UHS.8	.54		HS.3	.69	

Goodness-of-Fit Indices	Measurement Model	Instructional Model
χ^2 (p-value)	26019.806 ($p < .001$)	19988.706 ($p < .001$)
df	1019	1020
χ^2/df	25.534	19.597
AIC	648410.705	642377.605
CFI	.826	.868
RMSEA [90% CI]	.061 [.060, .061]	.053 [.052, .054]
SRMR	.059	.051

Note: In the measurement model, factors were Mastery Motivation (MM), Mindset (MS), Anxiety (AN), Metacognition (MTC), Strategies for Managing Time and Environment (S_TE), and Strategies for Managing Understanding and Help-Seeking (S_UHS). In the instructional model, first-order factors were Mastery Orientation (MO), Self-efficacy (SE), Mindset (MS), Evaluation (EV), Monitoring (MN), Planning (PL), Anxiety (AN), Managing Time (MT), Managing Environment (ME), Understanding (MU) and Help-seeking (HS). Second-order factors were Motivation (MOT), Metacognition (MTC) and Strategies (STR).
* p-values were significant.

instructional model is smaller, and therefore slightly better. Furthermore, a $\chi 2$ difference test was conducted to compare the model fits between the measurement model and the instructional model. Using the nonnest2 R package (Merkle & You, 2018), findings from the non-nested likelihood ratio test suggests that the instructional model has a better fit than the measurement model, $z = -21.330$, $p < .001$.

Internal Consistency Reliability

Cronbach's coefficient alpha was used to examine internal consistency reliability for the scales and subscales of the measurement and instructional models. As shown in Table 2, the six scales in the measurement model had sufficient internal consistency reliability estimates ($\alpha = .79$ to .91). Likewise, the 11 first order factors in the instructional model had acceptable to moderately high internal consistency reliability estimates ($\alpha = .69$ to .91). The second order internal consistencies were also acceptable (.61 to .89). These estimates indicate that the items cluster well as subscales and scales.

Relationships Within and Between Scales

Inter-correlations within and between subscales and scales were examined to determine if the scales were distinct yet related. Correlations, means, and standard deviations are provided in Tables 3 (measurement model) and 4 (instructional model).

As shown in Table 3, the correlations between the six factors in the measurement model ranged from low to moderate ($r = .15$ to .64). This suggests that these scales are distinct, but somewhat related. As shown in Table 4, correlations between the instructional model's subscales (*e.g., self-efficacy, mindset, mastery orientation, and anxiety)* within a given scale (*e.g., motivation*) were generally greater than the correlations with subscales from different scales. For example, evaluation, monitoring, and planning were highly correlated with each other ($r = .68$ to .79), and highly correlated with their respective *metacognition scale* ($r = .86$ to .95), as expected. In contrast, the three *metacognition subscales* were less strongly correlated with the *motivation scale* ($r = .36$ to .44) and the *strategies scale* ($r = .56$ to .62), also as expected.

Strategies for managing environment, managing time, help-seeking, and strategies for understanding were moderately correlated with each other ($r = .32$ to .50), and highly correlated with their respective *strategies scale* ($r = .72$ to .82). As expected, the four *strategies subscales* were less correlated to the *metacognition scale* ($r = .34$ to .67) and the *motivation scale* ($r = .33$ to .45).

Interestingly, some of the correlations between the subscales within the *motivation scale* were relatively low ($r = .15$ to .54). This reflects the original EFA findings, which showed that the four *motivation subscales* loaded as distinct factors, and the two subscales that did load together (*self-efficacy and mastery orientation*) resulted in low internal consistency ($\alpha = .28$). For practical and instructional reasons, they were grouped into one scale—*motivation*—for which the CFA produced good model fit. The correlations between these subscales and their respective *motivation scale* ($r = .62$ to .76) were higher than those with the *metacognition scale* ($r = .22$ to .46) and the *strategies scale* ($r = .32$ to .49).

Discussion

The DAACS SRL survey was designed as a part of the DAACS system to identify students' self-regulatory strengths and weaknesses, and offer feedback and resources for improvement in weak areas. The purpose of this study was to provide validity evidence regarding the internal structure of the survey. Two models that serve different purposes each resulted in acceptable model fit. The measurement model comprised six factors with six to thirteen items in each factor. The instructional model comprised 11 first-order factors and 3 second-order factors, with three to six items in each first-order factor. The factors in both models are conceptually aligned with our theoretical framework for self-regulated learning, which encompasses metacognition, motivation, and strategies for learning. The internal consistency estimates for the scales and subscales of the models also provide evidence of the reliability of the inferences made by both structures. The CFA results and the internal consistency estimates provide promising empirical evidence for validity regarding internal structure.

In accordance with Kane's (2013) interpretation/use argument validity framework, we began by articulating the assumptions on which the survey was based. The first assumption highlighted the need for validity evidence regarding the internal structure of the survey. Based on a large sample, the findings supported the hypothesized structure of SRL as having three main components – metacognition, motivation, and learning strategies – for both the measurement and instructional models. Furthermore, items that loaded on the metacognition factor were related to planning, monitoring, and evaluation, all of which were key metacognitive processes (Lai, 2011), generally consistent with the Regulation of Cognition scale of the *Metacognitive Awareness Inventory* (Schraw & Dennison, 1994). The motivation scale encompassed items related to self-efficacy, mindset, goal orientation, and anxiety. Although they are distinct constructs, they are beliefs and emotions known to influence motivation (Pintrich, 2004). Items that loaded under the strategies category were behavioral in nature, and included strategies for managing time, environment, understanding, and learning, including help-seeking. These items and subscales are consistent with the Seeking and Learning Information and the Behavior and Environment Management factors from the SRSI (Cleary, 2006; Cleary, Kettler, & Dembitzer, 2015). In sum, in addition to empirical evidence for its internal structure, there is also strong conceptual alignment between the DAACS SRL survey and the research literature.

Implications

Statistical comparisons indicated the model fit of the instructional model was better than the measurement model; however they both had acceptable fit statistics according to Hu and Bentler's (1999) criteria, and both models are appropriate depending on the intended uses of the survey. For research and analytical purposes (e.g., predictive modeling, cluster analyses), the measurement model would be more appropriate to use, as it is the simpler model, without second order latent variables. If, on the other hand, users are interested in the SRL survey for self-improvement, advisement, or instructional purposes, then the

Table 3
Means, Standard Deviations, and Correlations between Scales of the Measurement Model

Scales (# of items)	MM	MS	AN	MTC	S_TE	S_UHS	M (SD)
MM (8 items)	1.00	--	--	--	--	--	3.3 (0.44)
MS (6 items)	0.30	1.00	--	--	--	--	3.1 (0.64)
AN (6 items)	0.39	0.15	1.00	--	--	--	2.8 (0.77)
MTC (13 items)	0.50	0.26	0.22	1.00	--	--	2.7 (0.63)
S_TE (6 items)	0.41	0.25	0.32	0.47	1.00	--	2.8 (0.60)
S_UHS (8 items)	0.49	0.31	0.27	0.64	0.54	1.00	3.2 (0.52)

Note: Mastery Motivation (MM), Mindset (MS), Anxiety (AN), Metacognition (MTC), Strategies for Managing Time and Environment (S_TE), and Strategies for Managing Understanding and Help-Seeking (S_UHS)

Table 4
Means, Standard Deviations, and Correlations within and between Scales of the Instructional Model

Scales and Subscales (# of items)	MOT	MO	SE	MS	AN	MTC	PL	MN	EV	STR	MT	ME	MU	HS	M (SD)
MOT (4 subscales)	1.00	--	--	--	--	--	--	--	--	--	--	--	--	--	3.1 (0.42)
MO (4 items)	0.62	1.00	--	--	--	--	--	--	--	--	--	--	--	--	3.3 (0.47)
SE (4 items)	0.69	0.54	1.00	--	--	--	--	--	--	--	--	--	--	--	3.3 (0.53)
MS (6 items)	0.65	0.26	0.27	1.00	--	--	--	--	--	--	--	--	--	--	3.1 (0.64)
AN (6 items)	0.76	0.30	0.38	0.15	1.00	--	--	--	--	--	--	--	--	--	2.8 (0.77)
MTC (3 subscales)	0.44	0.46	0.42	0.26	0.22	1.00	--	--	--	--	--	--	--	--	2.7 (0.63)
PL (3 items)	0.44	0.42	0.41	0.23	0.27	0.86	1.00	--	--	--	--	--	--	--	2.8 (0.73)
MN (6 items)	0.41	0.43	0.40	0.24	0.20	0.95	0.75	1.00	--	--	--	--	--	--	2.7 (0.64)
EV (4 items)	0.36	0.40	0.34	0.24	0.15	0.91	0.68	0.79	1.00	--	--	--	--	--	2.5 (0.72)
STR (4 subscales)	0.53	0.49	0.42	0.32	0.33	0.64	0.62	0.59	0.56	1.00	--	--	--	--	3.0 (0.49)
MT (3 items)	0.45	0.41	0.35	0.24	0.30	0.49	0.47	0.44	0.44	0.77	1.00	--	--	--	2.7 (0.65)
ME (3 items)	0.33	0.28	0.23	0.18	0.24	0.34	0.34	0.29	0.30	0.72	0.48	1.00	--	--	2.9 (0.75)
MU (5 items)	0.44	0.46	0.41	0.28	0.22	0.67	0.64	0.64	0.57	0.82	0.48	0.39	1.00	--	3.1 (0.55)
HS (3 items)	0.40	0.32	0.28	0.25	0.27	0.40	0.39	0.37	0.35	0.72	0.43	0.32	0.50	1.00	3.3 (0.66)

Note: highlighted in gray are subscales within the same scale; the darker shade indicates the scales (metacognition, motivation, strategies), and the overall SRL score.
Scales = Motivation (MOT), Metacognition (MTC) and Strategies (STR)
Subscales = Mastery Orientation (MO), Self-efficacy (SE), Mindset (MS), Evaluation (EV), Monitoring (MN), Planning (PL), Anxiety (AN), Managing Time (MT), Managing Environment (ME), Understanding (MU) and Help-seeking (HS)

instructional model is more appropriate, given that the first and second order factors provide conceptual clarity. For example, if a student scored low on the metacognitive scale, the student and advisor could focus on making improvements to planning, monitoring, and evaluation, each of which hang together conceptually and can be taught and learned.

This dual model approach appears to be unique. Although the proposed uses of many SRL measures include both research and practical assessment (e.g., SASR [Dugan & Andrade, 2011]; MSLQ [Pintrich, et al., 1993], MAI [Schraw & Dennison, 1994]; LASSI [Weinstein, Palmer, & Shulte, 2002]), only one structure is generally used for both purposes. One model might be preferable for prediction purposes, but could be less informative to students and advisors who use it for instructional purposes. By acknowledging both the prediction aspect and the diagnostic quality of the DAACS SRL survey, one survey can serve multiple purposes.

Limitations and Future Directions

The findings and proposed uses of the DAACS SRL survey should be considered in light of several limitations of the study. One of the main limitations is its generalizability. Although the sample was large, it included only students from two online universities, most of whom were non-traditional, adult learners. This could limit the degree to which the findings can be generalized to traditionally-aged college students.

The second limitation is the small number of items per subscale. In order to align with our definition of self-regulated learning, the survey was designed to measure a broad range of constructs, including motivation, metacognition, strategies, and the skills, processes, and beliefs within each of these. To minimize the threats to validity that could arise from survey fatigue, we limited the number of items that represent each of the constructs being measured. The small number of items per subscale might be an underrepresentation of each of the subscales; at the same time, adding more items could prevent students who are not required to take the survey from using the DAACS unless they are highly motivated. For this reason, we have followed guidelines and ensured that each subscale has at least three items (Carpenter, 2018; Costello & Osborne, 2005).

In spite of these limitations, the model fit indices of the two confirmatory factor analyses indicated that the hypothesized factor structure with scales and subscales fits the data well, allowing us to retain two models that represented the theoretical framework used to develop the survey. In spite of the small number of items per subscale, the generally moderately high reliability estimates revealed internal consistencies of the scales and subscales of both models; the correlations between subscales within and among scales were generally as hypothesized. The survey's scales and subscales function well, and are important for it to serve its diagnostic and instructional purposes (Davison, Davenport, Chang, Vu, & Su, 2015). The CFA results, internal consistency reliability estimates, and correlations provide promising evidence in support of the internal structure of the DAACS SRL survey. Future studies will involve the collection of other types of validity evidence to support the three assumptions about the DAACS SRL survey. Data from a sample of students in traditional colleges is also needed to determine if the internal structure of the survey is generalizable.

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APPENDICES

Appendix A

Established Reliability and Validity of Scales used to Construct the DAACS SRL Survey

Reliability

Reliability coefficients from previous research on each of the scales.

Scale	Cronbach's alpha	Norming Sample
SASR Self-Regulation	.86	*n*=205 for pilot study *n*=491 students from a public university and a private 4-year college.
Mindset	.94 to .98 for 3 *'d items (Dweck et al., 1995) .78-.77 with 6-items (Blackwell, et al. 2007)	6 validation studies with various samples, including college students.
Self-Efficacy for Learning with Self-Paced Online Training	.87	Study 1(*n*=204) U.S. Navy personnel Study 2 (*n*=646) Study 3 (*n*=481) – undergraduates from the U.S. Naval Academy
Westside Anxiety	Not reported	Sample 1 (*n*=25) anxious college students Sample 2 *(n*=34) anxious 5th grade students.
*MAI "Regulation of Cognition" (*planning, monitoring, evaluation, debugging, and information management)	Regulation of cognition: alpha=.91; .88 Overall: alpha=.95; .93	Experiment 1 (*n*=197) undergraduate students Experiment 2 (*n*=110) undergraduate students
SRSI—maladaptive regulatory behaviors	.72	142 9th and 10th grade students.
SRSI—managing behavior and environment	.88	
SRSI–seeking and learning information	.84	

Validity

Existing validity evidence

Scale	Validity Evidence
SASR Self-Regulation	***Convergent and discriminant validity:*** SASR compared with LASSI (Weinstein et al., 2002) and MSLQ (Pintrich et al., 1991) provided moderate support for SASR validity. The best validity evidence was found in the EXTR, INTR, PRC, and SE (META and SRL could be explained theoretically and in context with the LASSI and MSLQ aims for measuring these constructs). Further validity evidence provided by examination of SASR and course grades and GPA; anticipated "predictive" results (except EXTR).
Mindset	(for the 3 *'d items, Dweck, et al., 1995) ***Convergent validity:*** implicit person theory was significantly predicted by intelligence theory (*B*=.32, *p*=.0001) ***Discriminant validity:*** not significantly related to measures of cognitive ability, confidence in intellectual ability, self-esteem, optimism or confidence in other people and the world, social-political attitudes, and political conservatism or liberalism (with 6 items, Blackwell, et al., 2007) ***Predictive validity:*** growth mindset predicted upward trajectory in grades over 2 years; fixed mindset predicted flat trajectory intervention involving teaching incremental mindset to students improved classroom motivation
Self-Efficacy for Learning with Self-Paced Online Training	***Criterion-related validity:*** -OLVSES comparison to Pekrun, Goetz, and Perry (2005) negative achievement emotions boredom and frustration subscales; -OLVSES comparison to MSLQ (Pintrich et al., 1993) elaboration and metacognitive self-regulation subscales. -Self-Efficacy scale was significantly related to negative achievement emotions for boredom (r=-0.31, p<0.001) and frustration (r=-0.30, p<0.001) and to elaboration (r=0.27, p<0.001) and metacognitive strategies (r=0.20, p<0.001) as would be expected.
Westside Anxiety	***Face validity:*** similar items to other anxiety scales (e.g., Cassady-Johnson's Cognitive Test Anxiety Scale; Alpert-Haber's Debilitative Anxiety Scale). This scale represents the cognitive impairment, and not the physiological over-arousal component of anxiety. ***Predictive validity:*** Correlation between anxiety-reduction on Westside scale and test gains was r = .49 (df = 23, p < .01) in one study (n=25, college students), and r = .40 (df = 32, p < .01) in another (n=34, fifth graders), suggest average weighted scale validity of r=.44. This indicates strong correspondence between anxiety-reduction and objective test gains.
MAI "Regulation of Cognition"	the two MAI categories are somewhat related: knowledge and regulation of cognition (r=.54; .45);

Scale	Validity Evidence
	Predictive validity: MAI and metacognitive knowledge about one's monitoring skills: non-significant (MANOVA with 2 categories as DV; $F(6,210)=1.89$, $MS=.476$) MAI and test performance: knowledge of cognition was statistically related to higher test performance; regulation of cognition was not (in reading comprehension). MAI and monitoring accuracy: no significant differences in MAI across groups with different monitoring accuracy AKA MAI has little predictive power.
SRSI-maladaptive regulatory behaviors *SRSI-managing behavior and environment* *SRSI – seeking and learning information*	***Convergent and discriminant validity:*** principal component analysis with 3 subscales, and two self-motivational belief measures (TII and PII). All three subscales of the SRSI-SR loaded onto one higher order factor of self-regulation strategy use (loadings = .83 to .71; convergent validity), while TII and PII loaded onto another, which is consistent theoretically (evidence of discriminant validity). ***Predictive validity:*** Examination of achievement groups was consistent with previous research (lower-achieving students scored lower on SRSI-SR subscales, except the Maladaptive subscale, as anticipated).