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THE DEVELOPMENT AND INITIAL VALIDATION OF THE SELF-REGULATED LEARNING STRATEGIES SURVEY FOR ELEMENTARY SCHOOL STUDENTS

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Разработка и первоначальная апробация опросника стратегий саморегулируемого обучения для учащихся начальной школы

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Abstract

Self-regulated learning (SRL) refers to the processes of setting goals, monitoring progress, selecting learning strategies, and revising learning goals. Research evidence shows positive associations between SRL and academic achievement, motivation, well-being, and other constructs. The purpose of this paper is to establish the initial evidence of the construct validity of the SRL Strategies survey for elementary school students. The SRL Strategies survey includes 12 items, focusing on the strategies of environment, time, and learning management ranging from 1

Резюме

Саморегулируемое обучение относится к процессам постановки целей, отслеживания прогресса, выбора стратегий и пересмотра целей обучения. Многочисленные данные исследований показывают положительную связь между саморегуляцией обучения и академической успеваемостью, мотивацией, благополучием и другими конструктами. В статье представлены первоначальные результаты апробации опросника стратегий саморегуляции обучения (опросник СРО). Опросник стратегий саморегуляции обучения включает 12 пунктов, посвященных стратегиям организации среды, времени и обучения по шкале Ликерта в диапазоне от 1 (почти никогда) до 4 (почти всегда). В исследовании

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(almost never) to 4 (almost always) on a Likert-type scale. The unified validity framework (Messick, 1995) was used to conduct the validation study by collecting content, internal structure, convergent, discriminant, and response processes evidence. The application of classical test theory (CTT) using exploratory and confirmatory factor analyses, reliability estimates, and Pearson's correlations on a sample of 1,877 fourth graders provided initial evidence of construct validity by suggesting a one-factor model, which was confirmed on another sample of elementary school students (n = 317). The additional item response theory (IRT) analyses provided evidence of differential item functioning for Items 2, 5, and 6 based on student gender, but not on location. Combined evidence from CTT and IRT analyses resulted in acceptable properties of the combined one-factor SRL Strategies survey (α = 0.83; ωh = 0.71, ωt= 0.85). As a result, the SRL Strategies survey can be recommended for the use by researchers and practitioners.

Keywords: self-regulated learning, SRL, validity, reliability, exploratory factor analysis, confirmatory factor analysis, item-response theory.

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использовалась единая система оценки валидности (Messick, 1995), которая позволила провести анализ валидности, основываясь на содержательных, конвергентных и дискриминантных доказательствах, включая внутреннюю согласованность опросника. Применение методов классической теории тестирования (КТТ) с использованием эксплораторного и конфирматорного анализа, а также оценка надежности и корреляции Пирсона на выборке 1877 четвероклассников предоставили первоначальные доказательства валидности опросника СРО, предложив однофакторную модель. Однофакторная модель опросника стратегий саморегулируемого обучения была подтверждена на другой выборке учеников начальной школы (n = 317). Дополнительный анализ с применением современной теории тестирования выявил дифференцированное функционирование утверждений 2, 5 и 6 в зависимости от пола учащихся. Схожий анализ не выявил дифференцированное функционирование утверждений в зависимости от места проживания. Совокупные данные показали приемлемые свойства однофакторного опросника стратегий саморегулируемого обучения (α = 0.83; ωh = 0.71, ωt = 0.85). Таким образом, опросник может быть рекомендован для использования в исследованиях и педагогической практике.

Ключевые слова: саморегуляция обучения, валидность, надежность, эксплораторный факторный анализ, конфирматорный факторный анализ, современная теория тестирования.

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The federal state educational standards for primary and secondary education in Russia emphasize the development of meta-subject skills. The meta-subject skills outlined in the standards include students' abilities to set and achieve learning goals, and select and use available resources and strategies to attain those goals, to interact and cooperate with other participants of the learning process, and hone their reflective skills to understand the reasons for their learning successes and failures. The meta-subject skills resonate with self-regulated learning.

Self-regulated learning (SRL) is a construct well-researched both in Russian and foreign scholarly literature (Morosanova & Bondarenko, 2015; Leontiev, 2012; Panadero, 2017; Zimmerman & Schunk, 2011; Zinchenko & Morosanova, 2020). Russian and international scholars agree that SRL includes the processes of goal setting, monitoring, and reflection while working on learning tasks (Fomina, 2022; Morosanova & Bondarenko, 2015; Vilkova, 2020; Zimmerman & Schunk, 2011). Numerous research studies have indicated positive effects of SRL on the academic achievement of students across age groups, abilities, and educational settings (Dignath & Büttner, 2008; Dent & Koenka, 2016). SRL skills are measured using various research tools and methods, including surveys (Morosanova & Bondarenko, 2015; Wolters & Won, 2017), think-aloud protocols (Greene et al., 2017), microanalytic techniques (Cleary & Callan, 2017), and trace data (Bernacki, 2017).

Self-report surveys is the most prevalent way to measure SRL skills (Wolters & Won, 2017). There are several validated SRL questionnaires, such as the *Motivated Strategies for Learning Questionnaire* (MSLQ; Pintrich et al., 1993), the *Learning and Study Strategies Inventory* (LASSI; Weinstein et al., 2016), and the SRL survey within the suite of *Diagnostic Assessment and Achievement of College Skills* (DAACS; Lui et al., 2018). In the Russian context, Morosanova and colleagues (Morosanova & Bondarenko, 2015, 2017) have developed and validated the *Self-Regulation Profile Questionnaire* (SRPQM).

While a plethora of SRL tools exist, many of them are not developed to measure SRL skills in elementary school settings (Lui et al., 2018; Pintrich et al., 1993; Vilkova, 2020). The SRQPM was used to measure SRL skills in samples of elementary school students with varying degrees of success (Morosanova & Bondarenko, 2015, 2017). The SRQPM consists of 67 items and measures ten SRL subdomains, including goal setting, flexibility, autonomy, and social desirability, to name a few. While the subdomains cover many SRL domains, it might be difficult for young children to reflect on these domains and provide objective responses. As a result, we have developed a short SRL survey (12 items) targeting concrete strategies of

managing time, environment, and learning, which are represented in other surveys and practitioner-oriented literature (Pintrich, 2004; Seli & Dembo, 2020). We believe that the strategies reflected in the SRL survey might be translated into actionable and easy-to-implement practices for younger students.

Irrespective of the methods, data collected using any instrument to measure SRL skills should demonstrate evidence of validity and reliability (American Educational Research Association et al., 2014; Kane, 2006; Messick, 1995). Therefore, the main purpose of this study is to provide initial evidence of validity and reliability of the inferences made based on the SRL Strategies survey for elementary school students. Before delving into the examination of the validity evidence, it is important to understand the current state of the SRL research.

Literature Review

Self-regulated learning includes such processes as (a) setting goals for learning; (b) monitoring progress; (c) adjusting learning strategies; and (d) revising goals (Andrade et al., 2021; Morosanova & Bondarenko, 2015; Pintrich, 2004; Winne, 1995; Zimmerman & Schunk, 2011). SRL includes multiple psychological, motivational, affective, and cognitive processes working together to facilitate the achievement of learning goals (Andrade et al., 2021).

SRL and its components have been extensively researched over the last three decades, generating numerous definitions, models, and theories (Fomina, 2022; Panadero, 2017; Pintrich, 2004; Zimmerman & Schunk, 2011). Research studies provide compelling evidence that learners tend to regulate their learning, and effective SRL is related to the academic achievement of students across ages, domains, abilities, and educational settings (Dent & Koenka, 2016; Dignath & Büttner, 2008; Xu et al., 2023; Zinchenko & Morosanova, 2020). Numerous intervention studies show that SRL has the properties of a skill, and it is teachable (Xu et al., 2023). However, learners need enough scaffolding to become proficient in SRL. SRL interventions have been developed and applied across domains, including math, science, reading, writing, and history (Dignath & Büttner, 2008; Dent & Koenka, 2016). Recently, the focus has shifted to promoting SRL skills in online learning environments (Azevedo et al., 2017; Greene et al., 2015; Vilkova, 2022; Wong et al., 2019; Xu et al., 2023). Research studies on the effectiveness of SRL interventions based on the cumulative meta-analytic evidence with traditional and online learning environments suggest that SRL interventions result in improved academic performance of elementary school students (Dignath & Büttner, 2008; Xu et al., 2023).

To measure and understand the manifestations of SRL skills, a few theoretical models have been developed and proposed (Panadero, 2017). This study is informed by the *Model of Self- and Socially Regulated Learning* (Akhmedjanova, 2024b), which is grounded in the social cognitive theory (Bandura, 1985) and the sociocultural theory of cognitive development (Vygotsky, 1983).

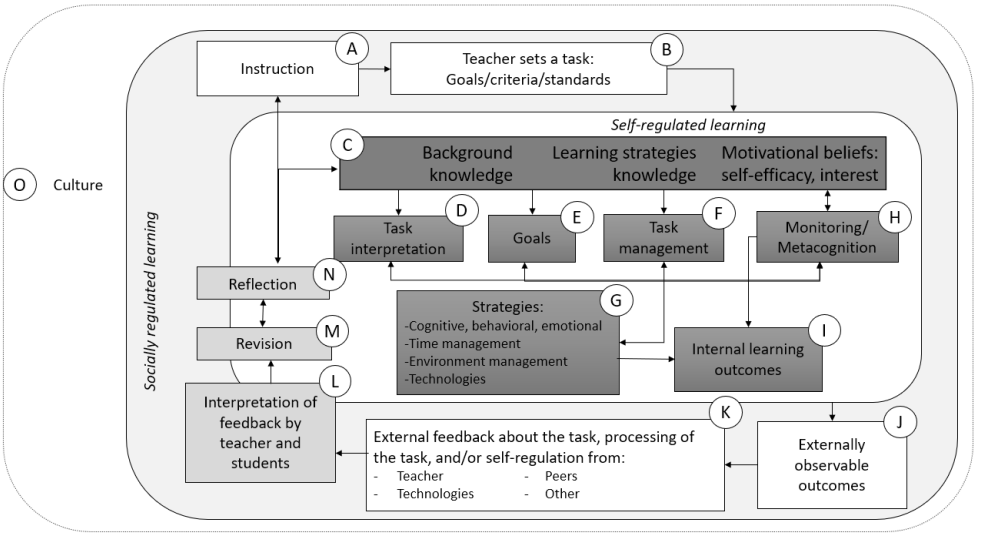
Theoretical framework

The *Model of Self- and Socially Regulated Learning* (Akhmedjanova, 2024b; Figure 1) is divided into three main sections: self-regulated learning (C–I, L–N), socially regulated learning (A–B, J–L), and culture (O). Instructional techniques (A–B) and formative assessment procedures (J–L), primarily feedback, are examples of socially regulated learning. Socially regulated learning (SoRL) refers to the processes of the goal setting, progress monitoring, and reflection, but in cooperation with other people, technologies, or resources (Andrade et al., 2021). Self-regulated learning includes students' background knowledge and motivational beliefs that lead to their decisions of which strategies to use to complete the task (C–I, M–N). Finally, culture (O) places both SRL and SoRL in a sociocultural setting.

The model in Figure 1 combines socially and self-regulated learning processes. However, this study focuses only on the environmental and time management, learning strategies, and self-efficacy beliefs in the domains of mathematics and reading. As a result, the survey includes the cognitive and behavioral strategies (G) and a motivational sub-process of self-efficacy (C) of SRL shown in Figure 1. The choice of the strategies outlined above stems from targeting a sample of elementary school students whose abstract thinking is still developing at this age (Uytun, 2018). It is easier for elementary school students to reflect on their confidence in solving a math problem while doing homework in a quiet room rather than reflecting on how much they have learned in a single lesson. Before describing the development and content of the SRL survey used in this study, it is worth examining SRL surveys developed in Russia and abroad.

Figure 1

Model of Self- and Socially Regulated Learning



Existing SRL surveys

Several surveys have been developed to measure SRL skills. For example, the *Motivated Strategies for Learning Questionnaire* (MSLQ; Pintrich et al., 1993) is one of the most widely used surveys to measure SRL skills. MSLQ is a Likert-type scale ranging from 1 (not at all true of me) to 7 (very true of me), which includes 81 questions. The MSLQ consists of two subscales: (1) motivation orientation and (2) learning strategies. The motivation orientation subscale evaluates students' values, expectancies, and affective beliefs; the learning strategies subscale measures cognitive, metacognitive, and resource management strategies. The validity study using EFA and CFA demonstrated the evidence of internal structure and acceptable reliability estimates across all subscales ($\alpha > 0.7$).

Another instrument for measuring SRL is the *Learning and Study Strategies Inventory* (LASSI; Weinstein et al., 2016). The third edition of LASSI contains 60 Likert-type items ranging from 1 (not at all typical of me) to 5 (very much typical of me). LASSI includes ten subscales: attitude, motivation, task management, anxiety, concentration, information processing, selecting main ideas, study aids, self-testing, and test strategies. The validity study demonstrated Cronbach's alphas from 0.76 to 0.87 for each subscale (Ibid.).

Yet another instrument that was developed to measure the college preparedness of first-year students is the SRL survey embedded in DAACS (Lui et al., 2018). DAACS SRL survey is a self-report measure that includes 47 Likert-type items ranging from 1 (strongly disagree) to 5 (strongly agree). The survey assesses motivation (anxiety, mastery orientation, mindset, and self-efficacy), metacognition (planning, monitoring, and evaluation), and strategies for learning (help-seeking, managing environment, managing time, and strategies for understanding). The results of EFA and CFA provided evidence of the internal structure of the survey, and reliability analyses provided good internal consistency of subscales ($\alpha = 0.79$ to 0.91).

Finally, Morosanova and colleagues have developed *Morosanova's Self-Regulation Profile Questionnaire* (SRPQM; Morosanova & Bondarenko, 2017; Zinchenko & Morosanova, 2020). The original scale includes 67 items across ten subscales, and the recent edition has introduced a 28-item version of SRPQM, which includes seven subscales: (1) regulatory-personal characteristics such as goal planning, modelling of significant conditions, programming of actions, and results evaluation, and (2) regulatory-personal characteristics such as flexibility, reliability, and insistency, which also collapse into a general factor of self-regulation (Morosanova & Bondarenko, 2015). SRL is measured on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The internal consistency analyses indicated good estimates ($\alpha = 0.60$ to 0.83).

The MSLQ, LASSI, DAACS, and SRPQM SRL surveys were mostly developed for estimating college students' abilities and were researched based on a sample of older children and students. Even though Morosanova and colleagues (2015) tried measuring SRL of younger children, they concluded that surveys do not work as expected with children younger than 9 years old. As a result, there is a research gap

in assessing SRL in primary schools. To close this research gap, the SRL scale for elementary school children was developed.

To understand the quality of measurement instruments, it is necessary to establish evidence of validity and reliability. The SRL survey for elementary school students should have appropriate psychometric properties to draw valid and reliable inferences based on the data collected using the instrument (American Educational Research Association et al., 2014). In the following section, we provide an overview of the validity and reliability theoretical framework that informed this study. Next, we report on the development of the SRL survey, followed by the results of the validation study.

Validity and reliability

The SRL survey was validated within the unified validity framework (Messick, 1995; Kane, 2006). The standards for educational and psychological testing also state that construct validity requires evidence from multiple sources to support the claims and intended uses of measurement instruments (American Educational Research Association et al., 2014). Claims about evidence of validity are a joint function of the quality of the instrument, and how the data collected are interpreted and used for specific purposes. The AERA, APA, and NCME joint standards (Ibid.) outline five sources of validity evidence, such as content, response processes, internal structure, relations with other variables, and consequences of testing. Validity evidence cannot be fulfilled without examining reliability or the internal consistency of the scale (American Educational Research Association et al., 2014; Messick, 1995).

In this study, we assume that the SRL survey includes the processes of environment and time management, use of strategies for learning, and help-seeking by elementary school students. To examine this assumption, we pose the following research questions:

1. What is the evidence of validity based on content of the SRL survey?
2. What is the evidence of validity based on the internal structure of the SRL survey?
3. What is the evidence of validity based on the relations of the SRL survey with other variables?
4. What is the evidence of reliability of the SRL survey?
5. What is the evidence of the response processes of the SRL survey?

That is, this paper attempts to provide evidence of construct validity of the SRL survey by examining: (1) content representation by describing the development of the scale; (2) evidence of the internal structure based on factor analyses; (3) relationships with other variables by collecting convergent and discriminant evidence; (4) reliability by examining the internal consistency of the scale; and (5) response processes by examining differential item functioning by student gender and location.

Evidence Based on Survey Content

According to the best practices of instrument development, it should take place in three phases: (1) operationalization of the construct; (2) pilot testing and scale development; and (3) survey model confirmation (Johnson & Morgan, 2016).

Operationalization of SRL. A group of experts in self-regulated learning, assessment, child, and instrument development examined available SRL scales, such as MSLQ (Pintrich et al., 1993), LASSI (Weinstein et al., 2016), DAACS SRL survey (Lui et al., 2018), and SRPQM (Morosanova & Bondarenko, 2017; Zinchenko & Morosanova, 2020), to identify subscales and possible items. Given the young age of the study participants and compelling evidence from neuropsychological studies showing that abstract thinking and analyzing skills are still developing in elementary school children (Uytun, 2018), we decided to select specific behavioral and cognitive strategies that are typical for children of this age. In addition, we consulted the federal state educational standards to make sure that SRL subscales and items align with the meta-subject skills outlined in the standards.

The examination of existing SRL scales, federal educational standards, and children's age resulted in the generation of the environment (4 items) and time management (4), learning strategies (7), and help-seeking (4) strategies of the SRL survey, which correspond with strategies (G) in Figure 1. To identify learning strategies to include in the corresponding subscale, we used the study of Dunlosky and colleagues (2013), who made a list of the ten most effective learning strategies in educational settings. We selected only seven strategies out of ten such as practice testing, distributed practice, self-explanation, rereading, summarization, highlighting, and imagery for text, because they are age-appropriate and more likely to be taught and modeled by teachers, parents, and peers.

Pilot testing and scale development. Before the data collection started, the initial cognitive laboratory was conducted with two fourth grade students resembling the demographic characteristics of the target population to check for the readability and understanding of items on the SRL scale. Feedback from these students allowed us to wordsmith some of the items to make them more age-appropriate and clear. Further, the SRL survey was embedded in the project examining the factors related to school failure. The results of the scale development and pilot testing are reported in the following sections by combining the methods of classical test theory (CTT) and item response theory (IRT), followed by the survey model confirmation on a sample of elementary students from another setting.

Methods

Study design. This study is a longitudinal project using a mixed-methods design to examine factors related to the academic failure of schoolchildren in the region of Nizhny Novgorod in Russia (https://ioe.hse.ru/failure-factors/). The first wave of data was collected in urban and rural public schools in the fall 2022. Data were collected from Grade 1 and 4 students, their parents, and teachers. For the purposes of this study, we used the survey data from the fourth-grade students.

Sample. The initial sample included 2,661 responses from fourth graders (50% girls). After excluding responses with missing data, the final sample included 1,877

students (50.4% girls, $n = 947$)[1]. Many students come from a large city ($n = 1,209$), followed by small towns ($n = 523$) and rural areas ($n = 145$).

An additional sample used for the survey model confirmation included 317 elementary students from one of the schools in Moscow (45.74% girls, $n = 145$) from third ($n = 89$), fourth ($n = 74$), fifth ($n = 45$), and sixth grades ($n = 109$) between the ages of 9 and 13 ($M = 10.89$, SD=1.33).

Instruments. The proposed SRL scale includes the subscales of environment management (4 items), time management (4), learning strategies (7), and help-seeking (4), using a Likert-type scale (4 – almost always, 1 – almost never). An example item: *"I plan when I am going to do my homework"*.

The self-efficacy surveys for mathematics (4 items) and reading (4 items) use a Likert-type scale (4 – I can do it well, 1 – I cannot do it at all). According to Albert Bandura (2006), self-efficacy is domain-specific, which is why separate self-efficacy scales were developed for mathematics and reading (Akhmedjanova, 2024a). An example item: *"Can you solve a math problem?"*. The internal consistency for both scales was good: $\alpha_{math} = 0.8$; $\omega_{math} = 0.81$ and $\alpha_{read} = 0.78$; $\omega_{read} = 0.8$.

The survey of subjective well-being in school (SSWBS) was used to measure the well-being of fourth graders (Kanonire et al., 2020). The SSWBS includes the subscales of satisfaction with school (7 items), affect toward school (3), well-being related to communication with peers (12), and subjective physical well-being (2) on a Likert-type scale ranging from 1 (no) to 4 (yes). The reliability indices revealed appropriate estimates ($\alpha = 0.87$; $\omega = 0.89$).

Procedures. After receiving approval from the HSE University's Ethics Committee (#19), the data collection took place online in 40 public schools. Parents were informed about the purpose of the study and signed online consent forms, and children provided their assent to participate in this study.

Data analyses. The data analyses were conducted in R. The missing data analyses were done using the *mice* package (van Buuren et al., 2023). The EFA analysis was performed in the *psychometric* package (Fletcher, 2023), and the CFA analysis in *lavaan* (Rosseel et al., 2023). The *psych* package (Revelle, 2023) was used to run Pearson *r* correlation analyses and identify Cronbach's alpha and McDonald's omega reliability estimates. The IRT analyses were conducted in the *eRm* (Mair et al., 2023), *ltm* (Rizopoulos, 2022) and *lordif* (Choi, 2022) packages.

Missing data. The missing data analyses revealed various degrees of missing data depending on the variable ranging from 0% for students' location to 21% for the variable of subjective well-being. The Pearson's chi-squared test generated large p-values, which suggested that there was no association between missingness on the items for the SRL survey, self-efficacy for math and reading, subjective well-being, and the observed values of the student's gender and location. Additionally, the results indicated that the missingness mechanism was not systematic, and missing values were possibly missing completely at random (MCAR). Therefore, it was

[1] We do not report the age of students in this sample because we did not ask our participants to report on their age due to a rather long survey. We had to make hard choices on what questions to include. All students attended Grade 4 and must have been between 9 and 10 years old.

decided to use listwise deletion, which resulted in deleting 784 cases with missing values and reducing the sample size to 1,877 observations that were used and sufficed for further analyses.

Results

Evidence Based on Internal Structure

To address the second research question, EFA and CFA were conducted.

Exploratory Factor Analysis (EFA)

Since the self-regulated learning survey was developed specifically for the purposes of this study, both EFA and CFA were used to identify the factor structure. The sample (n = 1,877) was randomly split into equal parts, and we conducted EFA using 938 observations followed by CFA (n = 939). The EFA was conducted on the original 19 items of the SRL survey, and the CFA allowed for verification of the factor structure proposed by the EFA. As a result, the factor analyses contributed to validity evidence by suggesting a parsimonious model to identify the internal structure of the survey (Boateng et al., 2018).

As the first step of EFA, the correlations and assumptions of factorability and sphericity were checked. The inter-item correlations indicated small to medium positive and negative correlations among items ranging from −0.21 to 0.54. As expected, items within the same domains were more highly correlated with each other than with items from other domains. The negative correlations were mostly detected between the items in the domains of environment management and help-seeking. The Kaiser Meyer Olkin (KMO) factor adequacy overall estimate was 0.89, and the estimates for each item ranged from 0.67 to 0.93. The KMO estimates suggested that factor analysis could be performed since KMO estimates equal to or larger than 0.60 are adequate for conducting factor analysis (Dziuban & Shirkey, 1974). The estimates of the Bartlett test of sphericity also suggested that a factor analysis was appropriate for this dataset, χ^2 (171) = 3560.48, $p < 0.001$.

The factor structure, based on eigenvalues and scree plots of the principal axis factor analysis, suggested a three-factor model. A separate parallel analysis suggested four factors. The three- and four-factor models were analyzed using oblique rotation. While both models resulted in good model fit indices (Table 1), the graphs showed cross-loadings of items from environment and time management subscales on the subscale of learning strategies. Therefore, it was decided to check two- and one-factor solutions. While the model fit estimates of the one-factor model indicated an acceptable fit, the model explained 86% of the proportion of variance. In comparison, the four-factor model explained only 48% of variance. Given the evidence of cross-loadings, conceptual understanding that items focus on strategies (time, environment, and learning), and low item loadings, the resulting SRL scale includes only one factor that combines the strategies of learning, time, and environment management (Table 2).

Table 1

Model Fit Indices based on EFA Models (*n* = 938)

Model	χ^2	df	p	TLI	RMSEA	RMSR
4 factors	167.78	101	< .001	0.97	0.03	0.02
3 factors	245.96	117	<.001	0.94	0.03	0.03
2 factors	414.95	134	<.001	0.89	0.05	0.04
1 factor	808.33	152	<.001	0.78	0.07	0.07

Note. TLI – Tucker–Lewis Index, RMSEA – root mean square error of approximation, RMSR – root mean square of the residuals.

Table 2

Reliabilities and Item Level Estimates for the SRL survey (*n* = 939)

	Self-regulated survey: Strategies	Item loadings	Mean (SD)	Item–total correlation	ITC if item is dropped
1.	I do homework in a quiet room.	0.41	3.2 (0.97)	0.45	0.33
2.	I am distracted by my phone, toys, videos, and internet when I do my homework at home.	0.37	3.0 (0.98)	0.43	0.31
3.	I plan my tasks for the whole week.	0.58	2.5 (1.0)	0.59	0.49
4.	I follow my schedule.	0.61	2.7 (1.0)	0.62	0.52
5.	I can plan when to do my homework.	0.67	2.9 (1.0)	0.67	0.57
6.	I study even if I do not have homework for tomorrow.	0.62	2.2 (0.99)	0.61	0.51
7.	I study before tests.	0.62	2.7 (1.05)	0.62	0.52
8.	I look through my previous notes to understand new topics.	0.72	2.8 (0.96)	0.68	0.60
9.	I try to explain in my own words what I read or learned in class.	0.65	2.9 (0.95)	0.62	0.52
10.	I summarize what I read.	0.64	2.8 (0.98)	0.62	0.53
11.	I reread the text several times to understand it better.	0.61	3.1 (0.94)	0.60	0.50
12.	I draw schemes or graphs when I learn something new.	0.53	2.4 (1.08)	0.55	0.43

Note. McDonald's omega_h = 0.71, McDonald's omega_t = 0.85, Cronbach's alpha = 0.83.

Confirmatory Factor Analysis (CFA)

The CFA analysis was conducted on the second half of the sample (n = 939) to examine the one-factor structure. The diagonally weighted least squares (DWLS) estimator was used to estimate the model parameters due to the ordinal nature of the SRL survey. The CFA indicated an excellent model fit, χ^2 (54) = 141.37, $p < 0.000$,

CFI = 0.99, TLI = 0.99, RMSEA = 0.04, SRMR = 0.04. The χ^2/df coefficient resulted in an estimate of 2.62. Table 2 reports on the item-level statistics.

For the purposes of survey model confirmation (Johnson & Morgan, 2016), the survey was checked on a different sample of elementary school students. The CFA indicated an acceptable model fit, χ^2 (54) = 116.32, $p < 0.000$, CFI = 0.97, TLI = 0.96, RMSEA = 0.06, SRMR = 0.07. The χ^2/df coefficient resulted in an estimate of 2.15.

Evidence Based on Relations to Other Variables

Establishing convergent evidence requires measuring the same construct using a different instrument (American Educational Research Association et al., 2014). In this project, we did not measure SRL using other scales. Instead, convergent and discriminant evidence was examined using the raw scores collected with the help of the surveys of subjective well-being in school, self-efficacy for mathematics and for reading because research evidence suggests close links among these constructs (Céspedes et al., 2021; Chu et al., 2020; Schunk & DiBenedetto, 2016).

The correlations of subscales of well-being, self-efficacy for mathematics, and self-efficacy for reading had statistically significant positive correlations with the SRL scale ranging from 0.19 to 0.49 (Table 3), which provides some convergent and discriminant evidence of validity. The correlation estimates between self-efficacy for mathematics and reading and SRL were significant and positive yet weak, suggesting that they are related but measure different constructs. The only correlation approaching a moderate estimate (0.49) was observed for the subscale of satisfaction with school, showing a stronger relationship and providing preliminary convergent evidence. Other subscales of well-being such as affect toward school, relations with peers, and physical well-being showed positive, significant, yet weak correlations with SRL and serve as discriminant evidence of validity. These results

Table 3

Correlations among Subscales of SRL Survey, Self-Efficacy, and Subjective Well-Being (n = 1,877).

	1	2	3	4	5	6	7
1. SRL	1						
2. SE math	0.19***	1					
3. SE reading	0.31***	0.57***	1				
4. Satisfaction	0.49***	0.23***	0.24***	1			
5. Affect	0.45***	0.17***	0.23***	0.61***	1		
6. Peers	0.41***	0.23***	0.26***	0.51***	0.44***	1	
7. Physical WB	0.39***	0.19***	0.20***	0.42***	0.40***	0.33***	1
Mean (SD)	2.75 (0.59)	3.02 (0.66)	2.76 (0.63)	3.34 (0.51)	2.78 (0.62)	2.88 (0.41)	3.62 (0.91)

*** $p < 0.0001$.

suggest that all constructs relate to each other positively with varying degrees of strength, meaning that as SRL increases so does self-efficacy and well-being; however, we can observe the prevalence of discriminant evidence of validity.

Evidence Based on Reliability

The reliability analysis was performed by estimating both Cronbach's alpha and McDonald's omega, which provide complimentary and robust evidence of the internal consistency of the scales (Deng & Chan, 2017). The reliability indices of the whole SRL scale are good, $\alpha = 0.83$; $\omega_h = 0.71$, $\omega_t = 0.85$. The estimates used for the model confirmation on another sample of elementary students ($n = 317$) also provided acceptable coefficients, $\alpha = 0.78$; $\omega_h = 0.56$, $\omega_t = 0.81$.

Evidence Based on Response Processes

The IRT analysis was conducted on 12 items of the SRL Strategies scale to examine the quality of each item and check evidence of rating scale category functioning.

The Graded Response Model was used to estimate the parameters since the Likert-type response scale was ordinal in nature (Samejima, 1969). Both constrained (the discrimination parameter remains the same across all items) and unconstrained (each item has its own discrimination parameter) models were evaluated, which resulted in a significant difference between two models ($p < 0.001$). The unconstrained model indicated a better fit to the data, and therefore was used for further analyses.

The assessment of the model indicated an adequate model fit, ($M_2 = 345.18$, $df = 54$, $p < 0.0001$, RMSEA = 0.05, TLI = 0.96, CFI = 0.97). The initial examination of the discrimination parameter (Table 4) indicated that most items fell within the

Table 4

Item Fit Statistics

Item number	S-χ2	df	*p*	a	b1	b2	b3
I1	110.65	81	0.02	0.80	−3.35	−1.73	−0.15
I2	125.19	82	0.002	0.73	−3.18	−1.62	0.72
I3	80.23	71	0.21	1.25	−1.38	0.11	1.42
I4	91.39	73	0.07	1.23	−1.88	−0.45	0.98
I5	82.56	70	0.14	1.43	−1.78	−0.63	0.47
I6	65.35	65	0.46	1.49	−0.86	0.54	1.66
I7	88.33	67	0.04	1.57	−1.31	−0.17	0.94
I8	54.19	60	0.69	2.11	−1.57	−0.32	0.78
I9	109.71	66	0.001	1.61	−2.02	−0.68	0.64
I10	83.50	68	0.09	1.51	−1.71	−0.36	0.96
I11	91.50	70	0.04	1.38	−2.22	−0.94	0.48
I12	65.64	71	0.66	1.17	−1.09	0.36	1.45

acceptable range between 0.5 and 2 (De Ayala, 2013). As a next step, the item response category characteristics curves (ICCC) were examined for each of the 12 items to assess the discrimination parameter. All items indicated acceptable discrimination and likelihood of selecting one of the four available category responses (4 — almost always, 1 — almost never). Further analyses of the Test Information Function revealed that the survey estimates the attribute of SRL strategies in the range between −2.88 and 2, which also corresponds with the accepted range for the attribute parameter between −3.00 and 3.00.

The item functioning was also measured by using the generalization of Orlando and Thissen's (2003) S-χ^2 item-fit statistic for polytomous data, which shows the similarity of estimates between the predicted and observed response frequencies for each item. Statistically significant estimates ($p < 0.01$) suggest that the model does not fit the data (Toland, 2014). Table 4 shows that Items 2 and 9 show statistically significant S-χ^2 values $p < 0.01$. The threshold parameters (b1 – b3 in Table 4) cover a wide range of latent trait across all items but Item 1, which covers the range of responses at the lower end of the latent trait.

The final research question examined whether the items function differently depending on student's gender and location. A separate differential item functioning was performed by gender, followed by location using the ordinal logistic regression combined with IRT in *lordif* R package (Choi, 2022). The analysis by gender using Chi squared criterion (Ibid.) revealed that Items 2, 5, and 6 function differently depending on students' gender. However, the R^2 estimates for each of the items were low, for instance, for Item 5: $R_{12}^2 = 0.0027$. Examination of the graphs by gender indicated slight differences both for attribute distribution by male and female (Figure 2) and comparison of test characteristics curves across all items and only for differentially functioning items (Figure 3). Figure 4 shows responses of females and males adjusting for the differential functioning on three items. The graph suggests that some female students with aptitude ranging from −1 to 2 are more likely to select lower response categories than higher ones. The opposite is

Figure 2

Differential Trait Distribution between Male and Female Students (*n* = 1877)

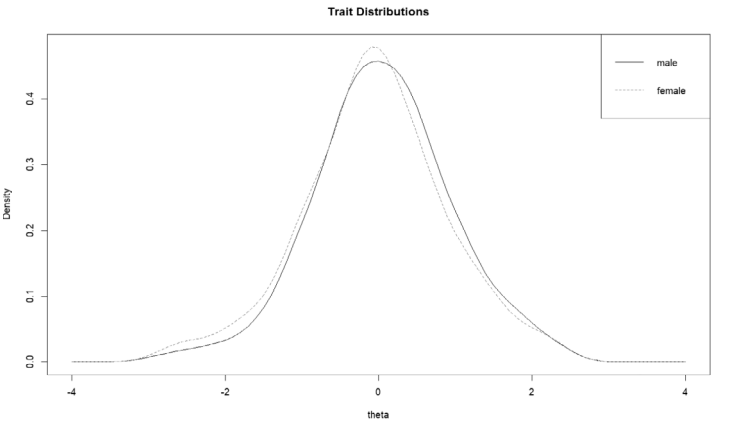
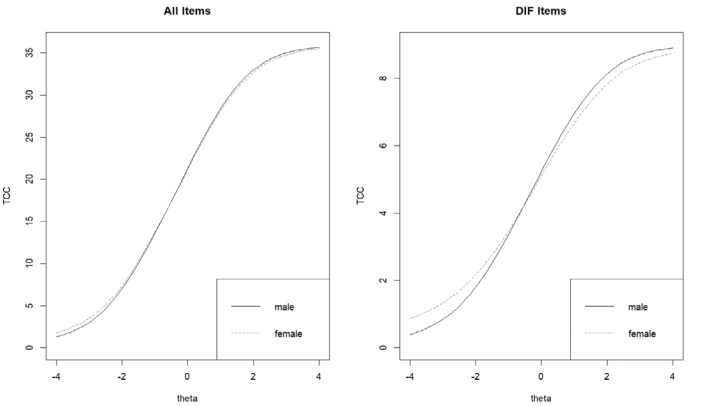


Figure 3

Test Characteristics Curves by Gender for all Items and for Differentially Functioning Items



Note. TCC – test characteristics curves; DIF – differentially functioning items.

true for male students – the higher their aptitude levels, the more likely they are to select higher response categories.

A similar analysis by student location did not identify any differentially functioning items.

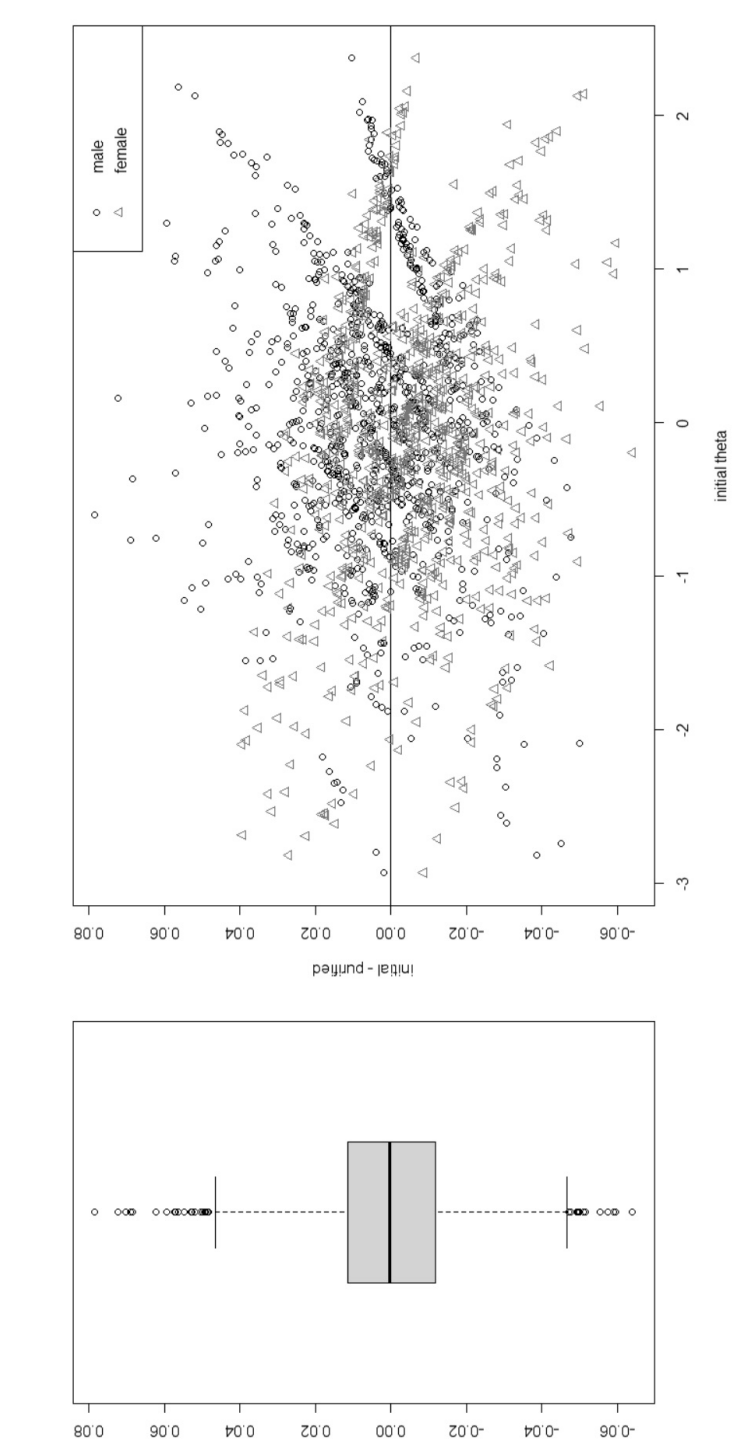
Discussion

This paper examined the initial evidence of construct validity of the SRL survey developed to measure SRL strategies of elementary school students. The evidence based on the exploratory and confirmatory factor analyses resulted in a shorter version of the SRL survey, combining items for managing environment, time, and learning strategies in a single factor. Time and environment management items are typically grouped into one subscale in such well-established surveys as MSLQ (Pintrich et al., 1993) and the DAACS SRL survey (Lui et al., 2018). However, these items cross-loaded on the learning strategies factor, which mostly focuses on cognitive operations students should do to understand new information. For instance, the item *"I summarize what I read"* requires students to understand the text they read and generate a short version of that text, which probably also requires planning when (time) and where (environment) they will read and summarize. Another explanation could be that students at the beginning of the fourth grade are not good at differentiating between various cognitive and non-cognitive strategies due to their neurological development (Uytun, 2018).

The relations of the SRL strategies with the scales of self-efficacy for math and reading have resulted in significant yet low correlations, which contributes to the discriminant evidence. This finding supports numerous research studies indicating that SRL and self-efficacy are related to each other yet measure different constructs (Schunk & DiBenedetto, 2016). In this instance, self-efficacy is closer to the construct of motivation (Bandura, 2006), whereas SRL focuses on the behavioral and

Figure 4

Likelihood of Selecting Response Categories by Attribute Levels Depending on Student Gender (n = 1877)



cognitive strategies needed to study well. The correlations between SRL and subscales of subjective well-being were higher than correlations with self-efficacy, yet still significant and low, contributing to the discriminant evidence. However, the subscale of satisfaction with school indicated a stronger relationship with SRL (0.49) and provided preliminary convergent evidence. Based on this observation, it can be concluded that when students are satisfied with their school, they use more SRL strategies. Nevertheless, the standards of educational and psychological testing suggest the use of another instrument measuring the same construct to establish convergent evidence (American Educational Research Association et al., 2014), which should be considered in future research studies. At the same time, research evidence suggests that the constructs of subjective well-being and self-efficacy are related to self-regulation (Davis & Hadwin, 2021).

The reliability evidence for the 12-item SRL Strategies survey suggested good coefficients both for the scale development and survey confirmation models. Good reliability coefficients for the SRL Strategies survey contribute to the internal consistency evidence of the whole scale. As a result, the SRL Strategies scale can be used both for diagnostic assessment of strategy use among elementary school students and for research purposes for further statistical analyses.

Further IRT analysis allowed for a fine-grained examination of the 12-item SRL survey's response categories and item functioning. The results based on the S-χ^2 item-fit statistic indicated that the model does not fit the data well. There are two misfitting items – Items 2 and 9. Hence, response categories of Item 1 mostly cover the lower end of the latent SRL trait. This finding supports the earlier results of EFA and CFA analyses showing that Items 1 and 2 focusing on managing environment are problematic and require possible revisions. All other items resulted in acceptable response categories functioning and item discrimination estimates.

Further examination of response processes by gender and location revealed that female students responded differently for Items 2, 5, and 6 than male students. That is, within the range of the same aptitude levels, female students were less likely to select higher response categories than male students. Item 2 asks students to report if they are distracted by the toys, phone, and other things while studying, and it seems that girls are less likely to select *often* and *almost always* than boys. Existing research confirms gender differences in elementary school students when it comes to distractions with girls being more often engaged in on-task behaviors rather than boys (Godwin et al., 2016). Similarly, it seems that girls are more likely to plan when (Item 5) and how often (Item 6) to study rather than boys. Differential item functioning was not identified by students' location, suggesting that items function similarly across schools located in a large city, small towns, and rural areas.

Based on the evidence observed above, we can conclude that the scale development resulted in acceptable evidence of construct validity for the SRL Strategies survey with 12 items. The survey confirmation study on a sample of elementary students from Moscow confirmed the one-factor structure and resulted in acceptable reliability estimates.

This study has some inherent limitations such as students' young age, which might have led to the issues with response processes observed in some items. Since

the study is part of a large longitudinal project combining multiple surveys and instruments, it was not feasible to add another SRL survey, which limits findings of validity based on convergent and discriminant evidence. Another limitation is the factor structure of the SRL survey. At the survey development stage, the survey included four distinct types of strategies. The evidence from the CTT analyses showed that the subscales of environment management and help-seeking require further revisions and development of the survey. In this article, we decided to remove the help-seeking scale to revise and develop it. As future research, our team has been working on the revisions of these subscales. While Item 2 from the environment management scale had issues with response scale ordering, it was decided to keep it and revise it for future use due to the reasons outlined above. Yet another limitation is that the current version of the SRL survey focuses only on the cognitive and behavioral strategies (G) and a motivational sub-process of self-efficacy (C) of SRL shown in Figure 1. Further development of the SRL scales should include subscales measuring metacognition and motivation along with other subprocesses outlined in Figure 1.

Currently, the revised version of the SRL survey is used for the second wave of data collection for the longitudinal project of school failure. Once data are available, the authors are planning to check the internal structure of the revised survey using confirmatory factor analysis as part of survey model confirmation (Johnson & Morgan, 2016). Also, the revised SRL survey should be examined using the sample of older students to check for validity evidence with another population of students.

Conclusion

This study reports on the first phases of development and validation of the SRL Strategies survey for elementary school children. The initial results provide evidence of the construct validity of the unidimensional SRL Strategies survey with 12 items. Further data collection and analyses are required to check for and identify the bifactor structure of the survey by adding other subprocesses from Figure 1. However, the current SRL strategies scale can be used both to measure the strategies and provide actionable ideas on how to promote these skills in elementary school children.

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