The measurement of motivation and self-concept
within the framework of Students' approaches to learning

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Abstract

Motivation and self-concept count among the educationally most relevant factors and the evaluation of many educational interventions requires their valid measurement. The present large-scale nationally representative study aimed to examine the psychometric properties of a shortened version of the Students' Approaches to Learning questionnaire measuring ten distinct motivational and self-concept constructs. The study drew a nationally representative sample (final N = 6,209) from a population of 11 – 12-year-old Czech students. The assessment of construct validity indicated that (1) the structural relations between the constructs, (2) the specific predictive relations to achievement and grades, as well as (3) the distinct differences in constructs' latent means between genders and students of the academic and mainstream track were mostly consistent with theory-derived predictions. The data showed that the nomological network of the measure maps relatively well onto the observed relations. Although not intended for individual assessment, the measure allows for psychometrically sound group inferences in relatively diverse student populations.

Keywords: motivation, self-concept, Students' Approaches to Learning, validity, academic track

The measurement of motivation and self-concept in the framework of Students' Approaches to Learning

Among the many theoretical constructs that likely contribute to educational outcomes, previous research frequently focused on self-concept and motivation. From a theoretical standpoint, self-concept and motivation are closely linked. Academic self-concept represents self-related beliefs and expectancies about the ability to succeed in academic tasks and is considered a prerequisite of achievement motivation (Shavelson, Hubner, & Stanton, 1976; Wigfield & Eccles, 2000). Broadly, it reflects both beliefs about general ability based on past performance and interactions with the environment and also expectations about the ability to perform academic tasks yet to come, called self-efficacy (Bandura, 2001; Bong & Skaalvik, 2003; Shavelson, Hubner, & Stanton, 1976). Apart from these two distinct temporal facets, academic self-concept has a hierarchical structure, with global self-concept being driven by relatively unrelated domain-specific self-concepts like verbal or math self-concept (Marsh & Shavelson, 1985). These become gradually more differentiated and complex during development (Byrne & Shavelson, 1996; Marsh & Ayotte, 2003).

Previous research has shown that self-concept is associated with various educational outcomes, well-being, and future occupational prospects in general (Craven & Marsh, 2008; Marsh & Hau, 2003; Nagengast & Marsh, 2012). On the other hand, motivation, as a process of initiating and maintaining goal-directed behavior, has also been studied extensively from various perspectives within several theoretical frameworks. The most frequent theoretical standpoints refer to the distinction between intrinsic and extrinsic motivation (Deci & Ryan, 1985), how implicit theories orient individuals toward specific goals, triggering goal-specific behavioral patterns (Deci & Ryan, 1985), or how expectations and self-directed beliefs guide behavior (Wigfield & Eccles, 2000). Past research has shown that motivation factors show

moderate-to-strong interrelations with achievement as well as self-concept (Skaalvik & Rankin, 1996), more specifically, that academic motivation predicts later academic achievement (Guay et al. 2010).

Present study

The present psychometric study sought to evaluate the construct validity of a shortened version of the Students' Approaches to Learning questionnaire (SAL) in a nationally representative sample of Czech sixth graders. Although SAL is referred to as a theoretical framework, it is largely a carefully assembled, theoretically non-overlapping set of rigorously developed measures (see Marsh et al., 2006), that aim to validly screen some of the most important affective constructs in the field of educational psychology. The ten theoretical constructs mainly fall under the rubric of motivational preferences and self-related beliefs and cognitions. These include the following constructs: instrumental motivation, effort/perseverance, self-efficacy, control expectations, interest in reading, interest in math, competitive learning, verbal self-concept, math self-concept, and academic self-concept. For a detailed theoretical treatise of these constructs, see Marsh et al. (2006).

Rather than examining the validity of each of these constructs in isolation, we aimed to test these measures simultaneously within a single structural model. Such an approach provides a much more stringent test with respect to concurrent and discriminant facets of construct validity. Although most of these constructs originate in distinct theoretical frameworks, it is an empirical question of whether the scales actually measure different constructs. Moreover, to provide evidence for the identity of these latent constructs, the tested nomological network (see Cronbach & Meehl, 1955) has to show a specific pattern of relations between SAL constructs and academic achievement. Namely, (1) motivation and self-concept constructs should show stronger links within domains; (2) subject-specific self-concept and interest constructs should correlate much stronger within the subject domains

compared to correlations between domains; (3) according to the internal/external frame of reference model (Marsh, 1986), subject-specific self-concept constructs should be dissociated despite strongly linked achievement in those subjects; (4) both motivational and self-concept measures should be positively associated with grades and performance in achievement tests; (5) grades should be more closely linked to self-concept in both subject domains than the actual academic achievement, as measured by standardized achievement tests; (6) girls should exhibit higher interest and self-concept in language and reading while boys should evince the same in math. Marsh et al. (2006) tested all these predictions in a large cross-cultural study utilizing the PISA 2000 data. While PISA samples 15-year-old students, the current psychometric study tested the construct validity and reliability of the SAL questionnaire in a markedly younger, nationally representative sample of 11- to 12-year-old Czech students.

Establishing measurement properties of the given SAL scales, in this substantially younger age, is especially important. This age is namely still marked by the transition to secondary education. It is a critical stage, coinciding with early adolescence, where the students are at various risks (see Evans, Borriello, & Field, 2018). Nearly every second student at this age starts falling behind the expected progress (Galton, Gray, & Ruddock, 1999; Akos, Rose, & Orthner, 2015) and is more prone to psychological disorders (see Evans, Borriello, & Field, 2018). Higher educational demands tend to cause a drop (irrespective of gender) in motivation and self-concept during the transition to secondary education (Coelho, Marchante, & Jimerson, 2017; Arens, Yeung, Craven, Watermann, & Hasselhorn, 2013; Wigfield, Eccles, Mac Iver, Reuman, & Midgley, 1991). It is, therefore, crucial to be able to reliably and validly monitor these—largely affective—factors at this age.

Although the sampling frame was the population of Czech students, Marsh et al. (2006) have shown that the inferred measurement properties of SAL are very similar across

25 OECD countries (including the Czech Republic). It may, therefore, be rational to assume that the results can be generalized beyond the population of Czech or Central European sixth graders. This assumption is, however, not testable against present data.

Extrapolating validity claims to the measurement of populations for which the measure was not originally intended requires either an inferential leap or data. That is because the relations between the items and the measured constructs may easily change over the levels of populations' characteristics. That even includes the possibility that some of the hypothesized constructs are the realization of different processes or are not yet differentiated at all. In this psychometric study, we aimed to provide novel empirical evidence for or against the use of SAL scales in the given younger age. Given the high potential utility of SAL for the comprehensive measurement of motivational and self-concept factors in the educational practice, data are needed to back up the inferences drawn from such measurement.

Specifically, we set out to test whether the sample of younger students shows an identical factor structure and whether the same (above-described) pattern of theoretical predictions involving SAL factors and external criteria (performance in achievement tests and grades) also holds for this age. We also tested whether the SAL scales show adequate reliability for group comparisons, whether they have the same measurement properties in both genders, across students attending different types of school (mainstream "basic schools" vs. eight-year gymnasia¹), and across levels of socio-economic status. With respect to motivation and self-concept constructs, students tend to vary significantly over these

¹ The Czech education system is characterized by an early tracking of students by ability. Even though many methods of nationwide and school-specific tracking exist in the system, eight-year gymnasia represent the most selective type of institution, accounting for approximately 11% of the students' population in Grade 6. The selection for gymnasia is highly biased by socio-economic status, even after controlling for student achievement (Straková & Greger, 2013, Straková, Greger, & Soukup, 2017). Eight-year gymnasia are similar to academic school types in England known as secondary grammar schools and even more to academic gymnasia in the old German tripartite school system, which continue to dominate the academic track despite many other types of schools having evolved in Germany over time (Becker, Neumann, & Dumont, 2016).

dimensions (e.g., Meece, Glienke, & Burg, 2006; Chmielewski, Dumont, & Trautwein, 2013).

The inferences based on group comparisons are, however, only valid if the same attribute relates to the same set of observations in the same way in each group; that is, observed group differences in raw scores need to map well onto the group differences in theoretical attributes (Borsboom, 2006). In the present study, we chose to examine whether the observed scores comply with specific invariance restrictions related to three key educational population characteristics (see Sammons, 1995), gender, socio-economic status, and type of school (tracking by ability). Only after establishing measurement invariances is it justified to interpret the measurement of the given constructs across different levels of these student characteristics without additional layers of (potentially violated) assumptions.

In contrast to Marsh et al.'s study (2006), we accounted for the dependencies in observations caused by the inherently hierarchical structure of the data, where students are nested within classes, and those are nested within schools. Together with additional screening procedures for careless responders or careful model fit inspection, we aimed to provide a stringent test of the validity implications drawn from the results of SAL when administered to younger students.

Last but not least, we tried to adhere to rigorous and accountable research practices. By openly sharing our code and SAL data, any colleague can reproduce our analyses and freely implement our code into their own analytic workflow.

Method

Participants and procedure

The total sample of this study² comprised 141 basic schools (sixth-graders; 4,798 students) and 43 multi-year gymnasia (“first-graders”; 1,745 students) sampled across the entire Czech Republic, totaling 6,543 students (the sampling frame was represented by 3,423 basic schools and 209 multi-year gymnasia). The selected schools were drawn from the original representative pool of 177 schools that took part in the nationwide TIMSS and PIRLS 2011 international assessments. A stratified two-stage cluster random sampling design was used. First, schools were randomly sampled from the population of all Czech schools attended by eligible students, using sampling probabilities proportional to the size of the school. Second, one or more intact classes of students were selected from each of the sampled schools. Above that, we supplemented the sample of basic schools by eight-year gymnasia using the same stratified two-stage cluster random sampling strategy. To account for oversampling (academic track students made up 28% of the total sample), we weighted the data using sampling weights (described in the Analysis section). The detailed sampling strategy for the present study is described in Greger, Straková & Martinková (2020); the sampling for the 2011 TIMSS and PIRLS international assessments is outlined in Jonas & Foy (2011). The data collection was carried out by a specialized research agency employing trained research administrators.

Absence in the regular and follow-up testing session or refusal to participate ($N = 333$) brought the final sample size of students participating in the study down to $N = 6,209$. Another 13 participants were excluded for failing to answer at least two-thirds of the SAL items. Finally, 29 subjects were excluded for having an uninterrupted string of more than 20

² The present study is part of the large-scale national longitudinal project CLoSE (Czech Longitudinal Study of Education), which tracks and studies the fourth graders who participated in the TIMSS and PIRLS 2011 international assessments.

consecutive identical responses for the 34 SAL items, likely indicating careless responding. After these exclusions, the effective sample size for the analyses was $N = 6,167$, with girls representing 49.02% of the sample. With respect to age, the mean of the present sample was 11.82 years ($SD = .41$). A total of 4,572 students in the final sample attended mainstream schools, 1,624 students attended eight-year gymnasia.

We declare that the subjects were treated in accordance with established ethical standards, as stipulated in the Declaration of Helsinki.

Measures

Students' Approaches to Learning. The original SAL is a set of 52 self-report items that measure 14 of the most utilized theoretical constructs in educational psychology (Marsh et al., 2006). In this study, we used a shortened version of SAL composed of 34 self-report items that measure 10 factors related to motivation and self-concept, namely, instrumental motivation (INSMOT), effort/perseverance (EFFPER), self-efficacy (SELFEF), control expectations (CEXP), interest in reading (INTREA), interest in math (INTMAT), competitive learning (COMLRN), verbal self-concept (SCVERB), math self-concept (SCMATH), and academic self-concept (SCACAD). The original 14-factor SAL instrument was developed for OECD PISA 2000 based on literature reviews leading to the selection of 29 constructs, which were piloted among 15-year-old students in 22 countries (see Peschar, Veenstra, & Molenaar, 1999). Our shortened 10-factor version of SAL did not include three constructs that measure learning strategies, namely, control strategies, memorization, and elaboration, plus one construct of cooperative learning, as we chose to focus on motivational and self-concept constructs, which show markedly stronger relations to academic achievement (Marsh et al., 2006). Each of the ten SAL scales was measured by 3 to 4 Likert-type items with four response categories. As shown by Gogol et al. (2014), the measurement of motivational-

affective constructs using scales with a small number of items may still have adequate psychometric properties.

Language aptitude test. A 26-item test with two variants was used to measure language aptitude. Multiple item formats were utilized. There were 13 multiple-choice items, 9 dichotomous items, and 4 open tasks. The tasks required the participant to identify and correct various linguistic errors (morphological, lexical, syntactic, and semantic) in authentic texts.

Reading literacy test. The reading aptitude test comprised 19 tasks, half of them closed, the other half open-ended requiring a brief answer. The test utilized tasks from the PISA and PIRLS international assessments of reading literacy. Each of the two equivalent variants included three texts, each being associated with 3–12 tasks. The tasks focused on three domains of reading literacy: (1) information search, (2) information processing – in-text relations, and (3) text evaluation – linking with information not contained in the text.

Math aptitude test. The test included 24 tasks, covering three content domains: (1) numbers and operations involving natural numbers, (2) dependencies, relations, and data processing, and (3) geometry of two- and three-dimensional shapes. Most of the tasks were motivated by the TIMSS 2007 items for fourth grade (directly adapted, newly created as paired equivalent variants, or completely new).

Socio-economic status (SES). SES was computed using a formative factor model via principal component analysis. The indicators were the sum of the mother's and father's reported highest level of education achieved, mother's and father's occupation, and the number of books at home.

All the materials are in Czech and are available upon request.

Analysis

Latent models were estimated in the lavaan R package (Roseell, 2012). To account for the dependent observations due to a two-stage clustered sampling (students nested within classes nested within schools) and unequal selection probabilities (requiring the use of sampling weights³), the models were re-fitted using the lavaan.survey R package (Oberski, 2014) and the MLMVS estimator (Robust Maximum Likelihood Means- and Variance-adjusted). The analysis of ordinal endogenous variables (SAL items) has not yet been implemented in the lavaan package. A simulation study by Rhemtulla, Brosseau-Liard, & Savalei (2012), however, shows that even when regarding the indicators as continuous, the factor correlations are expected to be unbiased, and the model test stays robust to the violation of continuity assumption with just five response options. On the other hand, given four ordered categories and the present sample size, the estimates of factor loading are expected to be slightly downward biased.

Models were regarded falsified based on a significant value of the χ^2 test statistics (see Ropovik, 2015). Following the rejection of the exact model-data fit hypothesis, we carried out a set of careful diagnostic procedures to identify the possible local sources of causal misfit and assess whether the model can be seen as a reasonable approximation to a model that would fit the observed data exactly. Apart from the model test, we evaluated the global fit using the following approximate fit indices: *CFI*, *TLI*, *RMSEA*, and *SRMR*. Given the model complexity and sample size, the statistical power for detecting a generally poor fitting model (*RMSEA* > .08) converged to 1. Matrix of residuals and modification indices were examined to look for local sources of model misspecification.

³ The applied sampling weights factor in to retain the population distribution with respect to gender proportion and type of school.

To assess the degree of comparative evidence for the structural coefficients, we also calculated approximate Bayes factors. Bayes factors (*BF*) show whether there is comparative evidence either for *Ha* (effect present) or *H0* (effect absent), that is, whether the data are more consistent with *Ha*, *H0*, or inconclusive. The present study estimated *BF* based on a model-selection / information-criteria approach as proposed by Wagenmakers (2007), that is, by employing a *BIC* approximation that implicitly assumes a unit information prior. Apart from *BF*, we also estimated the respective posterior probability of each of these parameters. Posterior probability refers to the probability of the parameter not being zero (as opposed to the probability of the data under a null). The estimation of posterior probability assumed a 1:1 prior odds of *H0* and *Ha* being true, respectively.

The analysis was preceded by data screening to filter out careless responders (by looking for uninterrupted long strings of identical responses) and mistyped values, as well as by the visualization of the variables (with focus on kurtosis). None of the subjects were considered an outlier, and no data transformations were applied. There was a negligible amount of missing data (0.6%), which warranted treating missing data effectively as missing completely at random (MCAR). To impute the missing data, we used the bootstrapped expected maximization procedure.

All the analyses reported in this paper are intended to be fully reproducible. Data for the analyzed SAL items, R code, and analytic outputs (the supplementary material) are freely available at the Open Science Framework: <https://bit.ly/2FAiHYy> (The link has been temporarily anonymized for the purpose of this peer-review).

Results

Practically all the items of the SAL questionnaire were right-skewed (only one of the items was inversely scaled), with lower item values denoting positive appreciation.

Descriptive statistics, frequency tables for the items, and the matrix of polychoric correlations can be found in the supplementary materials.

Construct validity of SAL

A priori model. First, we tested the a priori 10-factor structure where the factors were allowed to intercorrelate. This model did not converge. Model diagnostics showed that the defined latent variables failed to explain away all the systematic covariance between the items “Mathematics is one of my best subjects” and “Because doing mathematics is fun, I wouldn’t want to give it up”. Superficially, the items’ content validity is very similar, but they load on different factors (Interest in Math, Math Self-Concept). This single misspecification (an unmodeled residual of .88) caused the convergence problem, so we allowed that error covariance to take values different from zero. Doing so reflects the ignorance with respect to the underlying source of this misspecification.

Respecified model. The respecified CFA model converged normally but failed the model test; $\chi^2(80) = 614.76$, $p < .001$. The comparative fit indices showed a rather mediocre fit to the data; $CFI = .94$, $TLI = .93$, falling short of the conventional criteria proposed by Hu & Bentler (1999; see Ropovik, 2015). The entire CI width of $RMSEA$, on the other hand, fell within the region indicating a good approximate fit; $RMSEA = .033$, 95% CI [.032, .034]. $SRMR$ of .038 did not indicate much global absolute misfit either. However, given the beyond-chance deviations of the data from the theorized structure, further detailed model diagnostics were needed.

Local fit assessment. The inspection of residual matrix and modification indices pointed to the poor psychometric properties of one of the Verbal Self-Concept items, “I’m hopeless in Czech language classes”. This reverse-coded item exhibited high cross-loadings on other latent variables. Relatively strongest residuals were observed among the subject-specific factor items. Apart from these more pronounced residuals, there was a pattern of

weaker but significant residuals among the motivation-related and self-concept-related factors (but not so much between).

Due to a large N , the estimation procedure was well powered to pick up even quite small misspecifications. Overall, 35% ($N = 198$) of the residuals were significant at .05, while only 28 could be expected solely due to chance variation. Most ($N = 10$) of the high raw residuals ($>.1$, thus allowing a product of two rather salient loadings $\sim .3$) were associated with the item “I’m hopeless in Czech language classes”. There were only three other residuals (0.05%) with an absolute magnitude slightly larger than .1.

To test a more parsimonious latent structure, we also fitted a unitary factor model with all the SAL items loading onto a single dimension. The unitary factor model markedly departed from the observed data, with $\chi^2(80) = 3708, p < .001$; $CFI = .57$; $TLI = .56$; $RMSEA = .033$, 95% CI [.032, .034]. Comparing the two nested models, the χ^2 difference test (with $df = 46$) showed that the unitary factor model fitted the data significantly worse.

We also tested the unitary-factor structure in more homogenous subgroups of students, i.e., separately for basic schools and eight-year gymnasias, and for each of the quintiles of students’ socio-economic status. For none of the subgroups did the model test yield a χ^2 value smaller than 3702 ($df = 82$) – a degree of fit that is very similar to the test of the full single-factor model. Overall, the results of testing an alternative parsimonious factor structure show that the theoretical 10-factor model is a superior explanatory structure across the entire sample or in more homogenous subgroups. The 10-factor model showed relatively adequate, global approximate fit, with only 1 out of 34 items exhibiting severely unsatisfactory construct validity. Further details of model testing and diagnostics can be found in the supplementary material.

Model interpretation. With some reservations, the relatively adequate model fit allowed us to interpret the model coefficients. The factor loadings are reported in the

supplementary materials. The mean of the factor loadings was at .72. Seventy-one percent of items had a factor loading higher than .7, and 82% of loadings were higher than .6. None of the items misbehaved in terms of their loading. In line with Gogol et al. (2014), who showed that motivational-affective constructs may have adequate psychometric properties even with a small number of items per scale, the SAL factors in our study also showed relatively good overall reliability (in terms of internal consistency, see Table 1, diagonal values), ranging from McDonald's $\Omega = .72$ to $\Omega = .86$, with a mean reliability of $\Omega = .79$ ($SD_{\Omega} = 0.05$).

Almost all of the below stated results are described not because they represent novel findings, but because they address the evidence on the construct validity of the ten measured factors. Namely, the nomological network underlying the construct validation involves not only the assumptions about the existence of structural relations but also a set of assumptions about their strength (as linear relations or mean differences).

With respect to the relations between the latent factors⁴, the data showed a high subject-specificity of self-concept and interest constructs. This pattern was especially apparent in math-related factors. For instance, Interest in Math and Math Self-Concept turned out to be practically collinear (.91, with a shared variance of 83%), while the links between Math Self-Concept and verbal constructs were very weak ($< .16$, with a shared variance of 3%). Thus, the range of estimated correlation magnitudes was quite wide in the given population. There were also strong associations between domain-general self-concept and motivation constructs ranging from .61 to .93. Some of the latent constructs thus appear to be rather yet undifferentiated in the given age (see Table 1).

Lastly, Self-Efficacy turned out to be the best predictor of subject-specific interest and self-concept constructs. That holds even after controlling for the other latent variables.

⁴ As these are intercorrelations between latent factors (reflecting the true scores), the relationships are corrected for (1) unreliability by partialling out the random errors, and for (2) scale-specific method factors.

The full matrix of correlations between the latent variables is shown in Table 1, the partial correlation matrix can be seen in the supplementary material.

Table 1

Latent correlations and reliability estimates

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
[1] Instrumental Motivation	.72									
[2] Effort/Persistence	.77	.80								
[3] Self-Efficacy	.61	.76	.86							
[4] Control Expectation	.68	.86	.93	.78						
[5] Interest in Reading	.28	.36	.31	.34	.85					
[6] Interest in Math	.39	.50	.56	.50	.22	.73				
[7] Competitive Learning	.50	.51	.50	.53	.25	.50	.85			
[8] Verbal Self-Concept	.38	.47	.57	.53	.34	.17	.32	.74		
[9] Math Self-Concept	.31	.39	.57	.46	.12	.91	.41	.16	.82	
[10] Academic Self-Concept	.52	.63	.83	.75	.36	.56	.52	.66	.58	.76

Note. Estimates of scale reliabilities on the diagonal. All correlations between latent variables significant at $\alpha < .05$.

Measurement invariance

To establish whether the factor structure and psychometric properties hold across several subpopulations, we carried out tests of measurement invariance, using a mean- and variance-adjusted weighted least squares (*WLSMV*) estimator and modeling the indicators as ordered categorical, providing for rather conservative estimates. Measurement invariance was tested in a series of hierarchically nested models, gradually constraining (1) the configural structure of the latent-item relations, (2) factor loadings, (3) intercepts, and (4) error variances. Step 3, also called “strong invariance”, allows for the comparison of factor means. That is because participants with the same factor level have identical expected value on the indicators. Any group differences for the factors thus reflect real underlying differences rather than the way the latents were measured. Step 4 is not required for comparisons of

latent means but reflects the invariance in construct reliabilities (Beaujean, 2014). We tested the measurement invariance with respect to gender, socio-economic status (divided into quintiles), and type of school (mainstream schools vs. eight-year gymnasia).

For levels of gender and socio-economic status, the non-significant Satorra-Bentler scaled χ^2 difference test indicated that the full measurement model was consistent with strong invariance but not strict invariance. That warrants the unbiased interpretability of structural relations, comparison of latent means. However, the absence of strict invariance indicates that the groups (boys vs. girls; SES quintiles) differ with respect to the reliability of the measured constructs. With respect to the type of school, the data only failed to rule out weak metric invariance, i.e., equal factor loadings, which provides a firm ground for the interpretation of structural relations. This form of invariance refers to the absence of predictive bias due to differential item functioning. The lack of a strong metric invariance for the type of school, however, indicates that either there is a true difference in latent means or, if not, that it is reasonable to expect some bias in the comparison of latent means. On the other hand, the $\Delta RMSEA$ for the sequentially more restricted models did not exceed .003 for any of the three sets of invariance tests, which can be regarded as a relatively acceptable degree of absolute difference in fit (Meade, Johnson, & Braddy, 2008). Detailed results of measurement invariance tests can be found in the supplementary material.

Comparisons of latent means

In order to compare the latent means across genders (which represents part of the nomological network for the studied constructs), we constrained loadings and latent intercepts to be equal. We set girls as the reference group, thus fixing their factor means to zero while estimating the factor means for the boys. These magnitudes equalled the difference between the groups. For presentation, the differences were converted to standardized latent mean difference units (Cohen's d). Table 2 shows that all the differences

in latent means apart from Instrumental Motivation and Control Expectations are significant. Negative values denote higher mean values for girls, and positive values higher mean values for the boys (factors are scaled inversely). Girls reported a markedly higher interest in reading, boys a higher interest in math. Girls also reported spending more effort and being more perseverant, while boys had higher values of self-efficacy and competitive learning. Self-concept in language was found to be higher in girls, while the opposite was true for math.

Students at eight-year gymnasia showed lower latent means compared to mainstream schools, i.e., more positive values (factors are scaled inversely) for all factors with standardized effect sizes ranging from $-.07$ to $-.21$. From an interpretational standpoint, we considered all the comparisons to be independent, without the intention of generalizing inference. Should the reader wish to regard these as a family of tests, they should interpret the given p -values against a stricter threshold of $\alpha = .005$ (Bonferroni correction; α/k with $\alpha = .05$ and $k = 10$ tests).

Table 2

Comparison of latent means

	Gender			Type of school		
	<i>d</i> (ES)	<i>z</i>	<i>p</i>	<i>d</i> (ES)	<i>z</i>	<i>p</i>
Instrumental Motivation	0.01	0.67	.51	-0.12	-6.96	< .001
Effort/Persistence	-0.05	-2.53	.01	-0.11	-6.43	< .001
Self-Efficacy	0.11	6.30	< .001	-0.21	-11.87	< .001
Control Expectation	-0.01	-0.28	.78	-0.14	-7.91	< .001
Interest in Reading	-0.26	-14.71	< .001	-0.21	-11.96	< .001
Interest in Math	0.17	9.63	< .001	-0.15	-8.31	< .001
Competitive Learning	0.09	4.76	< .001	-0.07	-3.78	< .001
Verbal Self-Concept	-0.12	-6.69	< .001	-0.20	-11.34	< .001
Math Self-Concept	0.23	12.78	< .001	-0.20	-11.22	< .001
Academic Self-Concept	0.05	2.67	.01	-0.19	-10.62	< .001

Note. For gender, positive mean differences reflect more positive construct values for boys. For type of school, negative estimates reflect more positive values on a construct in 8-year gymnasium students. Cohen's *d* estimated assuming equal variances of latent scores in both groups.

Predictive validity

Lastly, we tested the predictive validity of each of the 10 SAL factors with respect to standardized achievement measures and grades in Math and Language.

The fit of the model did not deteriorate markedly due to the inclusion of language and math achievement measures; $\chi^2(82) = 650, p < .001$; $CFI = .93$, $TLI = .93$, $RMSEA = .033$, 95% CI [.033, .034], $SRMR = .038$. The achievement scores correlated rather strongly and showed a positive relation toward each of the SAL factors. There was a correlation of .60 between math and language achievement measures. Most of the relations were of small-to-medium magnitude, by Cohen's standards (1988). Self-efficacy and academic self-concept showed relatively strongest and most balanced links to math and language achievement. The Bayesian analysis indicated very strong (BF_{10} for the second weakest predictive SAL factor was equal to 277) comparative evidence in favor of the existence of all but one of the effects with posterior probabilities close to 1.

The pattern is almost the same for grades⁵, although the relations are generally stronger (mean correlations of .29 for math grades and .28 for language grades). Detailed results are reported in the supplementary material.

Discussion

The aim of the present psychometric study was to examine the validity of the shortened version of the Students' Approaches to Learning questionnaire (SAL) in a population of students transitioning to secondary education. The theoretical framework of this measure (Marsh, 2006) involves 10 of the most educationally relevant constructs falling under the rubric of motivational preferences and self-concept. The nomological network (see Cronbach & Meehl, 1955) of this measure involved specific structural links between its constructs, specific predictive relations to achievement and grades, as well as distinct differences in the constructs' latent means.

The results generally suggest that the nomological network of this multi-dimensional measure maps relatively well onto the observed relations. Although the hypothesis of exact fit between the data and the latent measurement model of SAL had to be rejected, further examination of local fit did not show any pattern of severe causal misspecifications. However, there was mainly one item that showed markedly inadequate construct validity and may introduce a considerable amount of systematic, construct-irrelevant variance into any sum score of the Verbal Self-Concept subscale. Moreover, one of the Interest in Math items had a very large cross-loading on Math Self-Concept.

Apart from that, all the items behaved in accordance with the SAL's modeled theoretical structure. Despite the small number of items measuring each of the constructs (3–4), the scales also showed good reliability (in terms of internal consistency).

⁵ Grades for Language (averaged over Czech and English language grades) and Math.

With regard to the associations between the substantive latent dimensions, the data indicated high subject-specificity of self-concept and interest constructs, especially in the domain of math, as was expected based on past research (Byrne & Shavelson, 1996; Marsh & Ayotte, 2003; Marsh & Shavelson, 1985). We also found strong links between domain-general self-concept and motivation constructs. Excessive collinearity between some of the constructs like Math Self-Concept and Interest in Math, or between Self-Efficacy and Control Expectation, however, suggests that these constructs may still be undifferentiated in the given age. Given that previous research (Marsh et al., 2006) showed similarly strong interrelations between exactly these pairs of constructs even in substantially older age group (15 years), this raises the question of whether regarding the indicators of these constructs as measures of substantively distinct constructs is defensible. Doing so might be an example of a jingle-jangle fallacy (Kelley, 1927). While Self-Efficacy and Control Expectation are best regarded to be both self-concept constructs (Marsh et al., 2019), Math Self-Concept and Interest in Math reflect self-concept and motivational aspects. Although it has been argued that self-related beliefs about the ability to succeed in school may represent the precondition for achievement motivation (Shavelson, Hubner, & Stanton, 1976; Wigfield & Eccles, 2000), available data indicate that the affinity to the specific subject-domain of Math outweighs any discriminant validity for measuring self-concept and motivation, respectively, that the indicators of these two constructs may possess. No such collinearity between self-concept and motivational constructs was observed in the verbal domain, in line with previous research (Marsh et al., 2006).

The measure was shown to have invariant measurement properties across levels of gender, socio-economic status, and type of school (students from mainstream schools vs. eight-year gymnasia). For the former two, strong measurement invariance was concluded based on a non-significant χ^2 test. As these two student characteristics are known to be

strongly related to long-term outcomes (Sammons, 1995), it is important that the observed scores map in the same way onto the here examined theoretical attributes (see Borsboom, 2006). For the type of school, any inferences stemming from the comparison of latent means must, however, be made with caution, since the model test indicated that the data were consistent with beyond-chance differences in intercepts between the populations. Although interpreting structural relations seems warranted, lack of strong metric invariance means that one has to expect some degree of bias (but probably not of substantial magnitude) when interpreting the comparison of group means as the difference between the latent means.

The data showed expected differences in latent means – a higher interest in reading and verbal self-concept among girls, boys showing a higher interest in math and math self-concept; girls being more persistent and boys more self-efficacious and competitive; students attending eight-year gymnasias showing more positive values for all the studied factors in the given sample. Likewise, we found small-to-medium cross-sectional correlations between the motivational and self-concept factors and achievement measures and generally stronger links with grades. Although this was also found in past studies (Nagengast & Marsh, 2012; Marsh & Hau, 2003), there seems to be a temporal effect of motivation on later achievement, but not self-concept on later achievement (Guay et al. 2010).

Limitations

All the findings of the present study need to be interpreted in light of the following limitations. The character of the present sample implies some constraints on generality (see Simons, Shoda, & Lindsay, 2017) regarding the possible inferences drawn from the current study. This study was conducted in Czechia. Measurement properties in the examined age range in other cultures (primarily those more or less WEIRD; Western, Educated, Industrialized, Rich, and Democratic) may be expected to be different (Rad, Martingano, & Ginges, 2018). Furthermore, the present study sampled students attending mainstream

schools and eight-year gymnasia in order to test measurement invariance with respect to different tracking of students by ability. Although low-achievers are an integral part of the population attending mainstream schools, the current study does not provide a formal comparison of students selected in the lower-tier academic track. Including this specific subsample or samples from other cultures would provide a test to the boundary conditions of the findings presented in this study. It may well be possible that the measurement properties and structural relations between the studied constructs would be markedly different.

This study was primarily psychometrically-oriented, with the goal to assess the measurement properties of self-report measures of 10 educationally relevant motivational and self-concept factors. Interpretation of any substantive findings needs to consider the self-report nature of the measurement used to assess the target constructs and the biases and response patterns inherent in such measurement (Paulhus & Vazire, 2007). Lastly, the theoretical model required respecification. Any data-driven changes to the a priori model may, however, capitalize on chance and thus compromise the prospects of model cross-validation (MacCallum, Roznowski, & Necowitz, 1992). Although we tried to keep that at a minimum doing only one model respecification, there were still a bit too many beyond-chance model residuals (especially among the subject-specific factor items), suggesting the presence of probably more than one unmodeled causes/factors. Their absolute magnitude was not substantial, but still, it muddies the psychometric meaning of the modeled constructs.

In conclusion, the present study shows that even for a younger population of 11- to 12-year old students, SAL maintains a relatively solid construct validity (relative to its complexity). Assessing motivation and self-concept at the age marked by the transition to secondary education is important, since it is a critical and challenging period in the life of the student (see Evans, Borriello, & Field, 2018), frequently associated with falling behind the expected progress (Galton, Gray, & Ruddock, 1999) and drop in these affective factors

(Coelho, Marchante, & Jimerson, 2017). Although the reliability of SAL scales does not warrant interpretation at the level of an individual student, it can be considered a psychometrically valid and comprehensive measure of 10 motivational and self-concept factors, which can be employed for research in relatively diverse student populations, allowing for sound inferences concerning the scores it yields.

Data availability statement:

Data, R code documenting the analytic workflow, and analytic outputs (the supplementary material) are freely available at the Open Science Framework: <https://bit.ly/2FAiHYy> (The link has been temporarily anonymized for the purpose of this peer-review).

References

- Akos, P., Rose, R. A., & Orthner, D. (2015). Sociodemographic Moderators of Middle School Transition Effects on Academic Achievement. *The Journal of Early Adolescence*, 35(2), 170–198. doi: 10.1177/0272431614529367
- Arens, A. K., Yeung, A. S., Craven, R. G., Watermann, R., & Hasselhorn, M. (2013). Does the timing of transition matter? Comparison of German students' self-perceptions before and after transition to secondary school. *International Journal of Educational Research*, 57, 1–11. doi: 10.1016/j.ijer.2012.11.001
- Artlet, C., Baumert, J., Julius-McElvany, N., Peschar, J. (2003). Learners for Life. Student Approaches to Learning. Results from PISA 2000. Paris: OECD.
- Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual review of psychology*, 52, 1–26. doi:http://dx.doi.org/10.1146/annurev.psych.52.1.1.
- Becker, M., Neumann, M., & Dumont, H. (2016). Recent Developments in School Tracking Practices in Germany: An Overview and Outlook on Future Trends. *Orbis scholae*, 10, 9–25. doi: 14712/23363177.2017.8.
- Beaujean, A. A. (2014). *Latent variable modeling using R: A step-by-step guide*. New York: Routledge.
- Bong, M., & Skaalvik, E. M. (2003). Academic self-concept and self-efficacy: How different are they really? *Educational Psychology Review*, 15, 1–40.
doi:10.1023/A:1021302408382.
- Borsboom, D. (2006). When Does Measurement Invariance Matter? *Medical Care*, 44, 176–181. doi: 10.1097/01.mlr.0000245143.08679.cc

- Byrne, B. and Shavelson, R. (1996). On the structure of self-concept for pre-, early-, and late-adolescents: A test of the Shavelson, Hubner, and Stanton (1976) model. *Journal of Personality and Social Psychology*, 70, 599–613. doi:10.1037//0022-3514.70.3.599.
- Chmielewski, A. K., Dumont, H., & Trautwein, U. (2013). Tracking Effects Depend on Tracking Type. *American Educational Research Journal*, 50, 925–957.
doi:10.3102/0002831213489843
- Coelho, V. A., Marchante, M., & Jimerson, S. R. (2017). Promoting a Positive Middle School Transition: A Randomized-Controlled Treatment Study Examining Self-Concept and Self-Esteem. *Journal of Youth and Adolescence*, 46(3), 558–569. doi: 10.1007/s10964-016-0510-6
- Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences (2nd ed.)*. Hillsdale, NJ: Lawrence Erlbaum.
- Craven, R. G., & Marsh, H. W. (2008). The centrality of the self-concept construct for psychological wellbeing and unlocking human potential: implications for child and educational psychologists. *Educational and Child Psychology*, 25, 104–118.
- Cronbach, L. J., & Meehl, P. E. (1955). Construct validity in psychological tests. *Psychological Bulletin*, 52(4), 281–302. doi:10.1037/h0040957.
- Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York, NY: Plenum.
- Galton M., Gray J., & Ruddock J. (1999). *The Impact of School Transitions and Transfers on Pupil Progress and Attainment*. London: Department for Education and Employment.
- Gogol, K., Brunner, M., Goetz, T., Martin, R., Ugen, S., Keller, U., ... Preckel, F. (2014). “My Questionnaire is Too Long!” The assessments of motivational-affective constructs

- with three-item and single-item measures. *Contemporary Educational Psychology*, 39, 188–205. doi:10.1016/j.cedpsych.2014.04.002.
- Greger, D., Straková, J., Martinková, P. (2020). Extending the ILSA study design to a longitudinal design: TIMSS and PIRLS extension in the Czech Republic – CLoSE study. In Nilsen T., Stancel-Piątak, A., Gustafsson, J.-E. (Eds.) *International Handbook of Comparative Large-Scale Assessment in Education. An extensive review of Perspectives and Findings*. Springer. In press.
- Guay, F., Ratelle, C. F., Roy, A., & Litalien, D. (2010). Academic self-concept, autonomous academic motivation, and academic achievement: mediating and additive effects. *Learning and Individual Differences*, 20, 644–653. doi:10.1016/j.lindif.2010.08.001.
- Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, 6(1), 1–55. doi:10.1080/10705519909540118
- Jonas, M., & Foy, P. (2012). Sample design in TIMSS and PIRLS. In M. O. Martin & I. V. S. Mullis (Eds.). *Methods and procedures in TIMSS and PIRLS 2011* (pp. 1–21). Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.
- Kelley, T. L. (1927). *Interpretation of educational measurements*. Oxford, England: World Book Co.
- MacCallum, R. C., Roznowski, M., & Necowitz, L. B. (1992). Model modifications in covariance structure analysis: The problem of capitalization on chance. *Psychological Bulletin*, 111(3), 490–504. doi: 10.1037/0033-2909.111.3.490
- Marsh, H. W. (1986). Verbal and math self-concepts: An internal/external frame of reference model. *American Educational Research Journal*, 23, 129–149. doi:10.2307/1163048.

- Marsh, H. W. & Shavelson, R. (1985). Self-concept: Its multifaceted, hierarchical structure. *Educational Psychologist*, 20, 107–125. doi:10.1207/s15326985ep2003_1.
- Marsh, H. W., & Ayotte, V. (2003). Do multiple dimensions of self-concept become more differentiated with age? The differential distinctiveness hypothesis. *Journal of Educational Psychology*, 95, 687–706. doi:10.1037/0022-0663.95.4.687.
- Marsh, H. W., Hau, K.-T., Artelt, C., Baumert, J., & Peschar, J. L. (2006). OECD's brief self-report measure of educational psychology's most useful affective constructs: cross-cultural, psychometric comparisons across 25 countries. *International Journal of Testing*, 6, 311–360. doi:10.1207/s15327574ijt0604_1.
- Marsh, H.W. and Hau, K. (2003). Big-fish-little-pond-effect on academic self-concept. A cross- cultural (26 country) test of the negative effects of academically selective schools. *American Psychologist*, 58, 364–376. doi:10.1037/0003-066x.58.5.364.
- Marsh, H. W., Pekrun, R., Parker, P. D., Murayama, K., Guo, J., Dicke, T., & Arens, A. K. (2019). The murky distinction between self-concept and self-efficacy: Beware of lurking jingle-jangle fallacies. *Journal of Educational Psychology*, 111(2), 331–353. doi:10.1037/edu0000281
- Meade, A. W., Johnson, E. C., & Braddy, P. W. (2008). Power and sensitivity of alternative fit indices in tests of measurement invariance. *Journal of Applied Psychology*, 93, 568–592. doi:10.1037/0021-9010.93.3.568.
- Meece, J. L., Glienke, B. B., & Burg, S. (2006). Gender and motivation. *Journal of School Psychology*, 44, 351–373. doi:10.1016/j.jsp.2006.04.004
- Nagengast, B., & Marsh, H. W. (2012). Big fish in little ponds aspire more: mediation and cross-cultural generalizability of school-average ability effects on self-concept and

- career aspirations in science. *Journal of Educational Psychology*, 104, 1033–1053.
doi:10.1037/a0027697.
- Oberski, D. (2014). lavaan.survey: An R Package for Complex Survey Analysis of Structural Equation Models. *Journal of Statistical Software*, 57(1), 1–27.
<http://www.jstatsoft.org/v57/i01/>.
- Paulhus, D. L., & Vazire, S. (2007). The Self-Report Method. In R. W. Robins, R. C. Fraley, & R. F. Krueger (Eds.), *Handbook of Research Methods in Personality Psychology* (pp. 224-239). New York, NY: The Guilford Press
- Peschar, J. L., Veenstra, R., & Molenaar, I. W. (1999). *Self-regulated learning as a cross-curricular competency. The construction of instruments in 22 countries for the PISA main study 2000*. Paris: OECD.
- Rad, M. S., Martingano, A. J., & Ginges, J. (2018). Toward a psychology of Homo sapiens: Making psychological science more representative of the human population. *Proceedings of the National Academy of Sciences*, 115(45), 11401–11405. doi: 10.1073/pnas.1721165115
- Rhemtulla, M., Brosseau-Liard, P. É., & Savalei, V. (2012). When can categorical variables be treated as continuous? A comparison of robust continuous and categorical SEM estimation methods under suboptimal conditions. *Psychological methods*, 17, 354–373.
doi:10.1037/a0029315.
- Ropovik, I. (2015). A cautionary note on testing latent variable models. *Frontiers in Psychology*, 6, 1715. doi:10.3389/fpsyg.2015.01715.

- Sammons, P. (1995). Gender, Ethnic and Socio-economic Differences in Attainment and Progress: A longitudinal analysis of student achievement over 9 years. *British Educational Research Journal*, 21(4), 465–485. doi: 10.1080/0141192950210403
- Shavelson, R. J., Hubner, J. J., & Stanton, G. C. (1976). Self-concept: validation of construct interpretations. *Review of Educational Research*, 46, 407–441. doi:10.3102/00346543046003407.
- Simons, D. J., Shoda, Y., & Lindsay, D. S. (2017). Constraints on Generality (COG): A Proposed Addition to All Empirical Papers. *Perspectives on Psychological Science*, 12(6), 1123–1128. doi:10.1177/1745691617708630
- Skaalvik, E. M., & Rankin, R. J. (1990). Math, verbal, and general academic self-concept: The internal/external frame of reference model and gender differences in self-concept structure. *Journal of Educational Psychology*, 82, 546–554. doi:10.1037/0022-0663.82.3.546.
- Straková, J., & Greger, D. (2013). Faktory ovlivňující přechod žáků 5. ročníků na osmileté gymnázium. *Orbis scholae*, 7, 73–85.
- Straková, J., Greger, D., & Soukup, P. (2017). Factors affecting the transition of fifth-graders to the academic track in the Czech Republic. *International Studies in Sociology of Education*, 26, 288–309. doi: 10.1080/09620214.2017.1290541
- Wagenmakers, E.-J. (2007). A practical solution to the pervasive problems of p-values. *Psychonomic Bulletin & Review*, 14, 779–804. doi:10.3758/BF03194105.
- Wigfield, A., Eccles, J. S., Mac Iver, D., Reuman, D. A., & Midgley, C. (1991). Transitions during early adolescence: Changes in children's domain-specific self-perceptions and

general self-esteem across the transition to junior high school. *Developmental Psychology*, 27(4), 552–565. doi: 10.1037/0012-1649.27.4.552

Wigfield, A., & Eccles, J. S. (2000). Expectancy–value theory of achievement motivation. *Contemporary Educational Psychology*, 25, 68–81. doi: 10.1006/ceps.1999.1015

Yves Rosseel (2012). lavaan: An R Package for Structural Equation Modeling. *Journal of Statistical Software*, 48, 1–36. <http://www.jstatsoft.org/v48/i02/>.