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Milica R. Manojlović[1],
Matija U. Gvozden,
Jelica Ž. Milojičić

Univerzitet u Beogradu, Filozofski fakultet, Beograd, Srbija

Оригинални научни рад

Construction and validation of learning style assessment instrument SU-19

***Abstract**: The aim of this study was to construct and validate a new instrument for assessing high-school students' learning styles. The instrument consists of 7 dimensions that measure a person's approach to learning through 52 items. A total of 801 pupils took part in the study, 160 of which were gifted scholarship students. Results confirm sound psychometric properties and validity of the scale. Exploratory factor analysis identified 7 factors that explain 46% of the total variance: Time management, Individuality, Relating ideas, Deep meaning, Strategies, Abstractness and Motivation. Confirmatory factor analysis confirms the basic factor structure while highlighting room for improvement. The scale significantly contributed to the prediction of general academic achievement and grades in specific subjects. Discriminant analysis demonstrated the instrument's ability to differentiate between gifted students and the general student population with an 82.4% success rate. We conclude that our instrument can be used to assess the klearning styles of students and can serve as a useful tool for predicting individual academic achievement.*

***Keywords**: learning styles, studying, school achievement, high-school students, validation*

Introduction

Theoretical background and existing learning styles models

Learning styles are defined as differences in the preferred ways in which individuals learn (Pashler et al., 2008) and they influence the ways one perceives, interacts with, and responds to information and to the learning environment (Kaminska, 2014). Learning styles are perceived as relatively stable through life (Veres et al., 1987) and are shaped by certain life experiences, genetic predispositions, and current environmental requirements (Kolb & Kolb, 2005). Many contemporary models assume that learning styles are influenced by a complex interac-

1 milicamanojlovic84@gmail.com

tion of individual characteristics (cognitive, emotional, and physiological) and environmental factors (Dunn, 1990, Gholami & Bagheri, 2013).

Over time, a large number of different learning style models have been developed (Coffield et al., 2004; Massa & Mayer, 2006), while the question of the stability of the construct itself has been neglected (Husmann & O'Loughlin, 2018). One reason for the existence of so many different operationalizations lies in the fact that most of them show poor criterion validity (Pashler et al., 2008). Traditionally, learning styles have been conceived as being mutually equal in their value but different in application, i.e. more suited to different types of material or personal preference (Pashler et al., 2008; Kolb & Kolb, 2005). Most proponents of learning styles are advocates of what Pashler and colleagues call the *meshing hypothesis* — the view that an individual's learning will be more successful if the way information is presented matches his or her learning style. Experimental research that has been conducted to test the meshing hypothesis has generally returned mixed results (Pashler et al., 2008). Another way to test this hypothesis is through school grades. Although some studies have shown that achievement in various academic disciplines can successfully be predicted based on the learning styles of individuals that the authors consider more or less compatible with the particular subject matter being taught (Lynch et al., 1998), empirical support for the meshing hypothesis remains limited (Pashler et al., 2008). Only a handful of currently existing instruments manage to predict students' achievements (Entwistle & Tait, 2013) and in most cases, the score from one instrument can only be used in predicting achievement in a specific scientific area (Jamali & Mohaffyza, 2017). Additionally, despite certain progress in the last decades, the tendency to describe learning styles only through a few dimensions and categorize individuals in categories based on almost arbitrary cut-off scores still prevails (Kolb & Kolb, 2005; Felder & Silverman, 1988; Felder & Soloman, 2012). The aim of our study, among other things, was to apply a dimensional approach to learning which would be better suited to encompass individual differences in the ways in which people learn.

When constructing our instrument, our goal was to build up on existing research while overcoming the flaws of the existing learning styles models. In doing this, we based ourselves primarily on Kolb's experiential learning model (Kolb & Kolb, 2013) and the ASSIST (*Approaches and Study Skills Inventory for Students*) model by Entwistle and Tait (2013).

One of today's most prominent learning styles models is Kolb's experiential learning model (Kolb & Kolb, 2013) which suggests that four different learning styles – Divergent, Convergent, Assimilative, and Accommodative – can be differentiated based on the ability to perceive abstractness in information and how it is processed – experimentally (analogous to logical, deductive approach) or reflectively (based on intuition). In the last 20 years, the ASSIST model (Entwistle & Tait, 2013) has gained significant popularity as well as empirical backing. In contrast to earlier models, the ASSIST model does not consider different learning styles to be equally valuable and productive. Rather, it seeks to classify individuals based on how they actually approach the material during the learning process, in terms of genuine interest in the given material and depth of processing. In this regard, this model distinguishes between a surface, deep, and strategic approaches to learning (Entwistle & Tait, 2013), with the deep and strategic approaches being more conductive for adequate learning than the surface approach.

There is a noticeable lack of learning styles instruments constructed for the Serbian-language area. The only instrument available to us is the Goals and Strategies in Learning instrument by Opačić and Mirkova (Ser. *CSU-Ciljevi i strategije u učenju*) (Opačić & Mirkov, 2010). The model proposes six dimensions which differentiate individuals' learning styles – Planning, Satisfaction, Consolidation, Rote learning and Self-confirmation. Previous research

indicated that the instrument has sound psychometric properties and factor validity (Opačić & Mirkov, 2010). The instrument was included in the battery of instruments used for validation.

The overall aim

The goal of our research was to construct and validate an instrument for assessing learning styles. The motivation for the construction of the new scale arose from the lack of instruments that offer extensive and prognostically valid operationalizations of this construct. Previous research shows that the predictive validity of the construct is often lacking - despite the fact that there are a large number of operationalizations, most of them do not successfully predict academic achievement (Entwistle & Tait, 2013). In addition, the constructed instrument, unlike the previous ones that use a categorical approach, operationalizes learning styles through orthogonal dimensions that describe the way a person prefers to learn. We consider the dimensional approach to be a more comprehensive way of describing learning styles. It also enables insight into which aspects of the construct significantly contribute to the prediction of school achievement. Lastly, our goal was to examine the validity of the newly constructed scale on a sample of Serbian high school students. We examined the factorial, diagnostic and prognostic validity of this instrument. Our aim was to examine not only the internal structure, but also the instrument's ability to predict school achievement, differentiate the gifted from the general student population, and determine one's educational profile.

Constructing the instrument

When constructing our instrument, we based ourselves primarily on learning styles operationalizations offered by Entwistle and Tait (2013), and by Kolb and Kolb (2005), while attempting to overcome their shortcomings. Our instrument – Learning Styles (Ser. *Stilovi učenja* – SU-19) initially consisted of the following four dimensions – Depth, Organisation, Abstractness, and Individuality. A pilot study was carried out and the dimensions showed good metric characteristics, as can be seen in Appendix 1.

Depth

The first dimension refers to how actively an individual processes the given material while learning, how much effort the individual puts into understanding the material, and how many diverse strategies and techniques they use. The dimension is to some extent analogous to the *deep approach* dimension of the Entwistle and Tait model (Entwistle & Tait, 2013). This dimension includes three facets.

The first facet, *relating ideas*, refers to the individual actively connecting the material that they are learning with their existing knowledge. The second indicator, *deep meaning*, refers to the level of mental engagement, and the effort of the person to understand the essence of the material. Our assumption is that active processing leads to a deeper and more comprehensive understanding of the material. The first two indicators are analogous to the indicators of the deep approach from the Entwistle and Tait model (2013). The third indicator, *strategies*, refers to the various ways in which the individual organizes the material in order to make his or her learning more efficient and effective. The described indicator has not been found in previous conceptions of the learning style construct, but we believe that it could contribute to understanding the differences in the ways people learn. People who are characterized by low depth show a more passive approach to learning, based on mechanical memorization, without trying to understand the essence of the material and reorganize it in a more meaningful way.

Organisation

The second dimension is analogous to the *strategic approach* of Entwistle and Tait, but with minor changes at the level of individual indicators included in this instrument. Entwistle and Tait have

four indicators, one of which has been empirically proven to be redundant, so we decided to disregard it (Entwistle & Tait, 2013). The first indicator, *time management*, refers to the ability to effectively organize time dedicated to learning. The second indicator refers to the *understanding of academic requirements* and refers to the individual's awareness of academic requirements and obligations. The third indicator is *motivation*, which we define as the existence of a desire to achieve high results and striving to achieve one's goals in the academic setting. Although it differs to some extent from other indicators of this dimension, Entwistle and Tait believe that people who are more ambitious will invest more effort in organizing learning materials, and thus justify the inclusion of this indicator in this dimension.

Abstractness

The third dimension refers to one's preference for abstract or concrete material. We relied on Kolb's (1985) ideas, with some modifications since the original model draws a distinction between an individual's preference for abstract or concrete *material* and their preference for a concrete or abstract *approach* to the material. We have reduced their two dimensions to one, basing our decision primarily on empirical findings that suggest that splitting preferences for a certain type of material and approach is unjustified (Duff & Duffy, 2002).

Individuality

The fourth dimension is used to determine whether an individual prefers to study alone or in a group. The given dimension is our addition that wasn't included in the existing models, which we believe is relevant to our construct. We believe that everyday experience strongly suggests that there are stable differences among individuals with regards to their preference for individual or group learning, and leading authors in the field have long pondered the inclusion of such a dimension (Kolb & Kolb, 2005).

Method

Sample

The battery of tests was given to a convenient sample of 855 Serbian high school students (75.5% female). We had 160 individuals in the sample that can be characterized as "gifted". These are the individuals who receive a scholarship from the Serbian Ministry of Education, Science, and Technological Development, whose informed consent we have provided for participation in this research. Due to incomplete and inconsistent answers in the questionnaire, 54 respondents were excluded from the analysis. The largest number of the respondents attend Grammar schools – scientific department (36.8%), followed by Grammar schools - socio-linguistics module (22.6%), high school of economics (14.9%), vocational high schools (12.7%), medical high schools (8.5%) and art high schools (4.5%).

Instruments

The battery of instruments used in this study includes the test that was validated - SU-19 (Learning Styles 2019), as well as the HEXACO Personality Inventory (Lee & Ahston, 2016), Kolb Learning Style Inventory – Version 2 (Kolb, 1985), Scale of Disintegration (20-item version) (Knezević, Savic, Kutlesic, and Opacic, 2017) and Inventory of goals and learning strategies of Opačić and Mirkov (2010). In addition, the respondents provided answers to behavioral items that related to time spent in learning, average midterm grade, as well as midterm grades in Serbian language and Mathematics.

Procedure

The questionnaire was distributed online, via Google Forms platform. Adolescents whose parents were informed had access to the questionnaire. In the introductory part of the battery of tests, pupils were introduced to the purpose of the research and provided informed consent.

Results and discussion

Exploratory factor analysis

The suitability of the collected data for factor analysis was confirmed through the Kaiser-Mayer-Olkin measure and Bartlett's sphericity test. Kaiser-Mayer-Olkin measure was .905 for the entire model, and above .805 for individual items which indicate a satisfactory level of representability (Field, 2013). Bartlett's test showed statistical significance as well. Although Guttman-Kaiser criterion (Eigenvalue >1) suggested a 14-factor solution which would explain 47.992% of the total variance, Cattell's scree test and Horn's parallel analysis weren't congruent with that conclusion. Relying on Horn's parallel analysis, a seven-factor solution was retained for further analysis, which was the most interpretable and most stable one. We fixed the number of factors on seven and repeated the analysis (Maximum likelihood, Oblimin) (Table 1).

As it can be seen from Table 1, all factors showed satisfactory levels of reliability with Cronbach's alphas all above .70. The structure of the components almost perfectly corresponded to the facets that were initially proposed in the construction and validation section. The only exception are the items from the facet *Understanding academic requirements*– all seven items showed factor loadings below or around .30 in the seven-factor model as well as in eight, nine, and six-factor solutions that were also tested. This implies that this type of academic-oriented behavior, despite our initial assumptions, does not represent a significant aspect of learning styles. Following our initial idea of four factors, the second-order factor analysis was conducted, but without any success. Firstly, only Bartlett's sphericity test was significant, whereas the KMO measure was below satisfactory (KMO=.660). Although according to the Guttman-Kaiser criterion two factors were extracted, loading distributions were far from interpretable. Moreover, an inspection of the Scree plot further brings into question the existence of a second factor. This result was expected after inspecting intercorrelations between the factors, which range from -.190 to .592, and predominantly are not significant (Appendix 2).

The Confirmatory factor analysis was performed in order to ascertain the stability of the factor structure. The analysis was conducted in AMOS GRAPHICS 21. The obtained chi-square measure was significant ($\chi 2(1476)= 5910.503$, $p<.001$), but due to the fact that the chi square measure is known to be overly sensitive in these conditions, the adjusted chi-square measure (calculated by dividing the chi-square measure by the degrees of freedom) was used and it was in the acceptable range (adj. $\chi=$

Table 1
SU-19 – Means, Standard deviations, Cronbach's alphas, and component loadings

Factor	*M*	*Sd*	*Alpha*	*Factor loadings*	*Explained variance [%]*
Time management	3.09	1.00	.907	.571 - .791	16.359
Individuality	3.40	1.10	.898	.616 - .839	9.362
Relating ideas	4.04	0.83	.776	.367 - .718	6.280
Deep meaning	3.46	0.76	.778	.307 - .700	5.050
Strategies	3.67	0.73	.770	.316 - .664	3.562
Abstractness	2.83	0.83	.766	.500 - .669	2.908
Motivation	3.88	0.79	.721	.305 - .489	2.432

Note: M – Mean, Sd – Standard deviation, Alpha – Cronbach's Alpha

4.004). RMSEA measure was in the acceptable range (RMSEA=.059) indicating a low error in measurement. The goodness-of-fit index and the Comparative fit index were .770 and .771, respectively, which is lower than the suggested values ranging from .90 to .95, suggesting our model struggles somewhat to explain all the variance in the data.

Convergent and divergent validity

Convergent and divergent validity of our instrument was examined via correlations between the factors extracted on our instrument on the one hand, and the personality traits of the HEXACO model, and the Disintegration Scale on the other (Table 2). The convergent validity of the Abstractness dimension was examined via correlations with the dimensions of Kolb's model of learning styles (Table 4). Finally, factor analysis was performed on Opačić and Mirkov's CSU instrument, hence we took into consideration the correlations between the factors extracted on our instrument and the factors extracted on the CSU instrument (Table 5). It should be emphasized that due to the significant sample size (N = 801) many correlations reached statistical significance, although in terms of absolute size they are not interpretable in many cases.

SU-19 and HEXACO

When it comes to correlations between SU-19 factors and basic personality traits, the highest correlations were found with Conscientiousness and Openness to experience. This is interpreted as confirming convergent validity, given that many authors consider those traits to be the core of learning styles (Katz, 1988). The factors of Time management and Motivation correlate highly with Conscientiousness. It is reasonable to assume that people who organize their environment better and who are characterized by perfectionist tendencies will be more motivated to achieve success and will be better at organizing their own learning time. The expected correlations between Relating Ideas and Deep meaning with the dimensions of Openness and Conscientiousness were also obtained. We believe that it is reasonable to expect that people who delve deeper into the learning material and who invest more energy in finding meaningful connections between different topics are, on average, more conscientious and open to new experiences. Also, a moderate correlation between factor Strategies and Openness was obtained, which is in line with the previous research findings (Fazeli, 2012; Marcela, 2015) that suggest that individuals who score higher on Openness tend to use more diverse and efficient cognitive strategies when learning. Proponents of the Five-factor mod-

Table 2
Correlations between SU-19 one on the one hand and HEXACO-100 and disintegration scale on the other

Factor	H	E	X	A	C	O	DELTA
1 Time organisation	.092**	.140**	.196**	-.005	.583**	.056	-.194**
2 Individuality	-.068	-.205**	-.288**	-.129**	.050	.099**	.014
3 Relating ideas	.128**	-.146**	.107**	.010	.322**	.316**	-.335**
4 Deep meaning	.153**	-.006	.141**	.026	.344**	.448**	.-064
5 Strategies	.141**	.215**	.170**	.080*	.372**	.219**	.024
6 Abstractness	.052	-.035	-.191**	.045	-.057	.102**	.-139**
7 Motivation	.034	.155**	.197**	-.058	.547**	.126**	-.141**

*p < .05, **p < .01

el of personality believe that an individual's learning style can be mostly explained by the traits of Conscientiousness and Openness (Costa & McCrae, 1998). An individual's learning style, it is claimed, is determined by these two traits. On the other hand, Table 3, which depicts correlations between individual facets of Conscientiousness and Openness on one side and SU-19 factors on the other, suggests that our factors cannot be reduced to personality traits. They reflect specific aspects of learning styles that are linked to, but not equivalent to, personality traits.

The correlations of our factors with other personality traits never exceed a value of .3, which can be taken as confirmation of the divergent validity of our construct. Although some correlations reach statistical significance, that is to be expected due to the large sample size. However, it is interesting to note that a moderate negative correlation was obtained between the Relating ideas factor and the results on the Disintegration scale. We believe that this connection is meaningful, considering that the Scale of Disintegration includes tendencies towards a general executive disorder which would surely make it difficult for a person, among other things, to see meaningful connections between parts of the material that they are trying to learn. As expected, the factor of Abstractness showed the lowest correlations with personality traits, given its predominantly cognitive nature.

SU-19 and Kolb's model

When taking into account the relationship between SU-19 and Kolb's model of learning styles (Table 4), our main focus was on our dimension of Abstractness. Although on a theoretical level Kolb postulates two orthogonal dimensions, in conducted research the four poles of these dimensions are treated as 4 factors, and an analysis is made on those 4 factors. Abstractness was negatively correlated with Active Experimentation and Concrete Experience. However, there were no positive correlations with Reflective Observation and Abstract Conceptualization. The obtained correlations between our factor of Abstractness and Kolb's dimensions are lower than expected, however, we believe that this is a consequence of the very specific way in which Kolb operationalized his model. Namely, we believe that there is a gap between the theory which underlies Kolb's learning style model and the way it is operationalized in the relevant questionnaire. The first

Table 3
Correlations between SU19 and HEXACO facets

Factor	C1	C2	C3	C4	O1	O2	O3	O4
1 Time organisation	.296**	.492**	.376**	.422**	.083**	.146**	.003**	-.088**
2 Individuality	-.184**	.050	.077*	.123**	.078*	.044	.019	.171**
3Relating ideas	-.140**	.389**	.276**	.294**	.209**	.300**	.136**	.322**
4 Deep meaning	.006	.429**	.321**	.250**	.341**	.406**	.254**	.330**
5 Strategies	.282**	.345**	.273**	.149*	.253**	.143**	.208**	-.008
6 Abstractness	-.152**	-.057	-.075*	.033	.154**	.014	.017	.112**
7 Motivation	.180**	.538**	.468**	.326**	.143**	.134**	.052	.030

Note: C1 – Organisation, C2 – Diligence, C3 – Perfectionism, C4 – Prudence, O1 – Aesthetic Appreciation, O2 – Inquisitiveness, O3 – Creativity, O4 - Unconventionality

*p < .05, **p < .01

two dimensions - Concrete Experience and Reflective Observation - are operationalized in a way that we believe does not correspond to their theoretical essence, in a way that is also very far from how we conceived our dimensions. On the other hand, the dimensions of Abstract Conceptualization and Active Experimentation are closer to our assumed dimensions, but include items that we have arranged in different dimensions within our instrument, which can explain the diverse and low correlations we have obtained.

SU-19 and the CSU

A very high positive correlation of our factor Time Management and the Planning factor of the CSU Model was obtained. This is expected and understandable, given that both factors refer to the same concept – the organisation of learning time. Moderate positive correlations were found with Self-affirmation and Consolidation. Also, the low correlations between our factor named Individuality and the factors of the CSU model suggest that our factor represents an aspect of learning that is not included in the CSU model. We want to draw attention to the high correlation between the Deep meaning and Satisfaction factors which would suggest that a deeper approach to the material implies that a person enjoys learning and is interested in that material. The relationship of our factor Strategies with the factors of the CSU model suggests that people who use a variety of strategies while learning are also better at organizing the material, that learning gives them some satisfaction, and they devote more energy to consolidating what they have learned. Based on the low values of obtained correlations, our factor of Abstractness seems not to be covered by the CSU model. Finally, the correlations between the Motivation factor and the CSU instrument factors would suggest that people who are motivated to succeed in the academic environment, plan their time better and enjoy the material they learn. Also, the obtained correlations suggest that there is a close relationship between motivation and the desire for self-affirmation, which shapes the way in which individuals learn. All this justifies the conclusion that the convergent validity of our instrument has been confirmed - the SU19 dimensions are highly correlated with the dimensions of the CSU model as well as with the expected personality traits.

Diagnostic validity

The diagnostic validity of our instrument was examined by testing whether the instrument allows us to distinguish students who could be character-

Table 4
Correlations between SU-19 and Kolb's inventory.

Factor	Concrete experience	Reflective observation	Abstract conceptualization	Active experimentation
1 Time organisation	.071*	-.002	.124**	.303**
2 Individuality	-.174**	-.036	.114**	-.143**
3 Relating ideas	-.054	-.103**	.330**	.010
4 Deep meaning	.135**	-.017	.372**	.085*
5 Strategies	.158**	.125**	.138**	.263**
6 Abstractness	-.100**	-.006	.066	-.355**
7 Motivation	.075*	-.003	.202**	.257**

*p < .05, **p < .01

Table 5
Correlations between SU-19 CSU inventory.

Factors	Planning	Satisfaction	Consolidation	Rote learning	Self-confirmation
1 Time organisation	.890**	.350**	.353**	-.145**	.161**
2 Individuality	.062	.098**	.034	-.171**	.111**
3 Relating ideas	.224**	.415**	.578**	-.483**	.113**
4 Deep meaning	.324**	.727**	.635**	-.362**	.150**
5 Strategies	.394**	.321**	.340**	.208**	.040
6 Abstractness	-.018	.004	-.043	-.178**	-.050
7 Motivation	.608**	.443**	.481**	-.080*	.439**

*p < .05, **p < .01

ized as "gifted" from the general student population. For this purpose, summary scores were used in canonical discriminant analysis, alongside our factors as predictor variables. A tabular presentation of the printout of this analysis can be found in Appendix 3. Box's M was significant, and the analysis was done on separate groups. One significant canonical discriminant function (canonical correlation = .411**) was obtained, which can explain about 17% of the variance of the difference between these two groups. Based on the original correlations of factors with the canonical function, we can conclude that gifted students differ from the general student population in that they have a deeper approach to the learning material, are better at connecting different parts of the learning material, have a stronger preference for abstract material and are also more ambitious. Examining the table of canonical coefficients, we see that the same factors have a relatively significant impact on the construction of the discriminant function. Based on the value of the structure factor and the factor Strategies, the conclusion is that gifted students use elaborated strategies less when they learn. Comparing these two groups by this dimension using the F test confirms this conclusion. The success rate of the classification is 82.4%, but this degree of success is a statistical artifact due to the large disproportion in the size of these two groups and the basic high success rate in the classification. The gifted students were successfully classified in only 22.7% of cases.

Also, the diagnostic validity of our instrument was examined by testing whether the instrument allows us to distinguish between students who attend different school orientations. For this purpose, summary scores on our factors as predictor variables in canonical discriminant analysis were used. A tabular presentation of the printout of this analysis can be found in Appendix 3. Box's M used to test the covariance equality hypothesis was significant and the analysis was done on separate groups. Two significant canonical discriminatory functions were obtained which explain about 15% of the difference between various high schools. The factors that were mostly associated with the first discriminant function were Relating Ideas and Abstractness, while the factors which were associated the most with the second discriminatory function were Motivation, Time Management, and Deep meaning. The success rate of the classification was 40.1%.

Predictive validity

One of the main shortcomings of the existing learning styles conceptualizations concerns their

poor ability to predict academic achievement. Our initial dimensions of Depth and Organization were conceived as a means of overcoming this shortcoming. We examined whether it would be possible to use the scores on the seven obtained dimensions to predict, using multiple regression analysis, the number of hours devoted to studying per week, the average midterm grade, and the midterm grades regarding individual subjects (Serbian language and Mathematics). Observing the value of the multiple regression coefficient (adj.R^2=.077, F(6, 793)=10.509, p<.001) we can conclude that our learning styles inventory allows us to predict the number of hours devoted to studying per week, although the percentage of explained variance is limited (just 8%). The only good predictors were Time management (r=.256 i β =0.184) and Motivation (r=.239 i β=0.133), which is understandable considering that they are closely related to the trait of Conscientiousness. Although we must refrain from making conclusions regarding cause-and-effect relationships, we believe that it would be reasonable to expect that persons who are more highly motivated to achieve academic success are willing to invest more time in studying, while better time management allows persons to spend more time studying during the day as well as use their time spent studying more efficiently.

Our inventory was more successful in predicting our respondents‘ average midterm grade (adj.R^2=.277, F(6, 793)=43.312, p<.001), although it is difficult to determine which dimension is key to explaining this relationship, considering that all of them, except Deep meaning, have shown themselves to be significant predictors. The greatest contributions come from the dimensions Relating ideas (r=.393 i β=0.280), Motivation (r=.389 i β=0.291), and Abstractness (r=.182 i β=0.129). When predicting the grades regarding individual subjects – a person‘s learning style explains 20.1% and 13.6% of the variance in the case of the person‘s grade in Serbian language (adj.R^2=.194, F(6, 793)=28.447, p<.01) or Mathematics (adj.R^2=.129, F(6, 793)=17.891, p<.000), respectively. Key contributors to these relationships are Relating ideas (Serbian language r=.288 i β=0.378; Mathematics r=.218 i β=0.273) and Motivation (Serbian language r=.179 i β=0.284; Mathematics r=.227 i β=0.289).

General discussion

We can conclude that our instrument has sound psychometric characteristics. The retained factors allow us to explain 46% of the original variance in the data. In terms of factor validity, our original dimensions of Individuality and Abstractness have been confirmed while five out of six facets of our original dimensions of Depth and Organization have also been confirmed, albeit as individual factors rather than facets of more general dimensions. We haven't been able to identify second-order factors, the results of the second-order factor analysis being uninterpretable. The Confirmatory factor analysis suggests that our factor structure is sound, albeit with noticeable room for improvement. Our model's convergent/divergent validity has largely been confirmed, while its capability to differentiate between groups of students who are enrolled in different types of high schools is limited. Nevertheless, our instrument has been shown to be a solid predictor of academic success which was one of our main goals in conducting this study.

The retained combination of the factors proved useful in predicting student academic achievement. The percentage of the explained variance has remained limited, suggesting that there are other relevant factors which need to be taken into account to explain academic success. As previous research on this topic has indicated, personality traits stand out as important factors, with a primary emphasis on Conscientiousness (Komarraju et al., 2011), as well as various aspects of intelligence (Soares et al., 2015). The research examining the importance of learning styles as a factor in predicting academic achievement generally suffers from the fact that learning styles are a very diverse concept.

The existing learning styles models have had limited success in predicting academic achievement (Pashler et al., 2008). The ASSIST model, which we relied on in constructing our model of learning styles, is an exception to this rule in the sense that it has been proven to be a useful predictor of academic achievement. In a study conducted by Entwistle and Tate (2013), a moderate positive correlation was obtained between the average grade in the first year of study and the strategic approach, a moderate negative correlation with the surface approach, while the correlation with the deep approach to learning was positive but low. It is interesting to note that the dimensions of our instrument - Relating ideas and Motivation, which would be conceptually close to the Strategic approach in the ASSIST model, were also determined to be the best predictors of academic achievement, while the contribution of the Deep meaning factor was not significant. We believe that this could suggest that a deeper interest regarding the material which is learned at school is not in itself sufficient to guarantee better academic success. The impact of this dimension would rather be indirect, in the sense that a deeper interest in the material would potentially, if other factors are present, encourage students to use more diverse techniques and to invest more effort in learning, which would only then lead to better achievement.

Building on the above, we want to draw attention to the question of the validity of the indicators which we used as measures of success in this validation study. Grades in Serbian language and Mathematics, as well as the average semester grade, were used as measures of academic achievement. Regarding this, attention should be drawn to two problematic aspects. Firstly, our sample consisted of students from multiple different types of high schools where the relevant subjects (which were used as indicators of academic success) are almost certainly treated differently – both concerning the complexity of the subject matter, as well as the degree of the expected achievement. For example, we can ask ourselves whether a top grade in Mathematics in a grammar school means the same thing as a top grade in a music high school. Also, there are certainly significant differences between teachers' demands in different schools, the way they teach, and how they grade the students' work, which also calls into question the validity of using grades from high school subjects as indicators of academic achievement. In future research, we believe that it would be desirable to use as indicators standardized tests of achievement. This would provide a better picture of the true success of our instrument in predicting the academic achievement of an individual, which was the main guiding idea when we constructed it.

Finally, we would like to draw attention to the relationship between our learning styles model and the dimension of Conscientiousness of the HEXACO model. Except for the dimensions of Individuality and Abstractness, which did not significantly correlate with Conscientiousness, all other dimensions of our instrument had correlations with Conscientiousness in the range of .322 to .583. Even before we began, we actively considered the possibility that our factors, which should determine an individual's learning style, could actually be reduced to the trait of Conscientiousness, at least to a large degree. However, although there are significant correlations between the obtained factors and the Conscientiousness trait, we believe that our results suggest that learning styles are not reducible to the manifestations of Conscientiousness in an academic setting. Conscientiousness enables us to explain approximately 10% to 33% of the variance of our postulated dimensions. However, this suggests that an individual's learning style is also determined by other factors to a large degree, which would be the subject of future research.

To conclude, our model has succeeded in capturing the essential aspects by which people differ when they learn. We also have reason to believe that this instrument could serve as a useful tool for predicting individual academic achievement. The present instrument was constructed and validated on

a sample of high-school students, and as such, the items are primarily designed for the said audience. However, we firmly believe that the factor structure of the instrument would remain the same on the samples of both younger and older learners, with only the content of certain items requiring slight adjustment. Nevertheless, we advise future researchers who would be willing to use this instrument to be aware that individual academic achievement can only be partially explained by a particular individual's learning style, and that several other variables also play significant roles. Researchers must carefully decide on the type of variables that will be used as indicators of academic achievement, aiming to select the variables that represent an adequate assessment of an individual's ability in an academic setting. Also, the focus of the future research should be to examine the variables that would enable adequate comparisons between respondents. Finally, we believe that the proposed operationalization is a step in the right direction, but that further research is needed to determine the final set of relevant dimensions by which individuals differ when learning and consider in more detail the relationship of the proposed model with existing constructs.

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Милица Р. Манојловић
Матија У. Гвозден
Јелица Ж. Милојичић

Универзитет у Београду, Филозофски факултет, Одељење за психологију,
Београд, Србија

КОНСТРУКЦИЈА И ВАЛИДАЦИЈА ИНСТРУМЕНТА ЗА ПРОЦЕНУ СТИЛОВА УЧЕЊА СУ-19

Стилови учења се могу дефинисати као разлике у преферираним начинима на које појединци уче (Pashler et al., 2008). Прецизније, овај конструкт осликава разлике у преферираним начинима на које појединци перципирају и реагују на информације, као и окружење за учење (Kaminska, 2014). Временом је развијен велики број различитих модела стилова учења (Coffield et al., 2004; Massa & Maier, 2006), док је питање стабилности самог конструкта било занемарено (Husmann & O'Loughlin, 2018). Један од разлога за постојање толико различитих операционализација лежи у чињеници да већина њих показује лошу критеријумску валидност (Pashler et al., 2008). Ранија истраживања су третирала различите стилове учења као подједнако валидне, али диференцијално ефикасне када је реч о обради различитих типова информација (Pashler et al., 2008; Kolb & Kolb, 2005). Подршка хипотези преклапања – идеји да ће учење појединца бити успешније ако начин на који се информације презентују одговара његовом или њеном стилу учења – остала је ограничена (Pashler et al., 2008). Постојећи модели су имали ограничен успех у предвиђању школског постигнућа (Jamali & Mohaffiza, 2017), са изузетком неких новијих модела (Entvistle & Tait, 2013). Међутим, и даље је присутна тенденција да се стилови учења операционализују преко ограниченог броја категорија, у које се појединци сврставају на основу арбитрарних критичних скорова (Kolb & Kolb, 2005; Felder & Silverman, 1988; Felder & Soloman, 2012).

Циљ нашег истраживања био је конструкција и валидација новог инструмента за процену стилова учења. Првенствено смо се ослањали на Колбов модел искуственог учења (Kolb & Kolb, 2013) и АССИСТ модел (енг. Approaches and Study Skills Inventory for Students) Ентвистла и Тејтове (Entvistle & Tait, 2013). Циљ је био да направимо инструмент који би имао добре психометријске карактеристике, као и добру конструкт, дијагностичку и прогностичку ваљаност. Конструисани инструмент описује начине на који особа преферира да учи кроз сет ортогоналних и подједнако релевантних димензија, за разлику од претходних модела који користе категорички приступ. Испитивали смо факторску, дијагностичку и прогностичку ваљаност инструмента. Наш циљ је био да испитамо не само унутрашњу структуру већ и способност инструмента да предвиди школски успех, да раз-

ликује даровите ученике од опште популације ученика као и да одреди нечији образовни профил.

У истраживању је учествовао укупно 801 ученик, од чега 160 даровитих стипендиста. Батерија инструмената укључивала је наш инструмент стилова учења, модел Искуственог учења Колбових (Kolb & Kolb, 2013), инструмент Циљеви и стратегије у учењу (ЦСУ) Опачића и Миркове (Орачић, Mirkov, 2010; инструмент који је посебно развијен за српско говорно подручје) и ХЕКСАКО инвентар личности (енг. Humility, Emotionality, eXtraversion, Aggreableness, Conscientiousness Opennes – HEXACO) (Lee & Ahston, 2016). Факторска анализа је као најоптималније сугерисала решење са седам фактора. Коначна верзија нашег инструмента састоји се од седам димензија које мере приступ особе учењу кроз 52 ставке. Експланаторна факторска анализа је идентификовала седам фактора који објашњавају 48% укупне варијансе: временска организација (α=.907), индивидуалност (α =.898), повезивање (α=.776), дубина обраде (α=.778), стратегије (α=.770), апстрактност (α=.766) и мотивација (α=.721). Конфирматорна факторска анализа потврђује основну факторску структуру уз налашавање простора за побољшање. Инструмент има добра психометријска својства и добру валаност. Корелације између нашег инструмента и инструмента Колбових биле су ниже од очекиваних, али су и даље биле интерпретативне, док су корелације са димензијама ЦСУ биле високе и очекиваног карактера. Коначно, димензије нашег инструмента су имале ниску корелацију са ХЕКСАКО димензијама (што је добар показатељ дискриминантне валидности), осим умерених корелација са димензијама Отворености и Савесности, што је било очекивано. Скала је значајно допринела предвиђању просечне оцене на крају полугодишта и оцена из појединих предмета, док је имала ограниченији успех у предвиђању количине времена утрошеног на учење. Дискриминациона анализа указује на добру способност инструмента да разликује даровите ученике и ученике из опште студентске популације са стопом успеха од 82,4%, док је имао ограниченији успех у разликовању ученика различитих типова средњих школа.

Можемо закључити да наш инструмент има добре психометријске карактеристике и добру валаност. Његова факторска структура је стабилна и задржани фактори објашњавају око 50% варијансе у подацима. Корелације са другим инструментима су очекиваног карактера, што је потврда валидности нашег инструмента. Осим тога, наш инструмент има солидан успех у предвиђању академског постигнућа ученика и може бити корисно средство у академским контекстима – углавном, али не искључиво, за средњошколце.

Кључне речи: *стилови учења, учење, школско постигнуће, средњошколци, валидација*

Appendix 1 - Pilot study

Table 6
Psychometric characteristics of the SU-19 instrument in the pilot study

	Alpha	KMO	H5
Depth	.87	.94	.51
Organization	.90	.97	.55
Abstractness	.81	.94	.48
Individuality	.91	.98	.69

Note: Alpha – Cronbach's Alpha, KMO – Kaiser-Mayer-Olkin measure of sampling adequacy, H5 – measure of homogeneity

Appendix 2 – Factor intercorrelations

Table 7
Correlations between factors of the SU-19 instrument

Factor	1	2	3	4	5	6	7
1 Time organisation		.029	.238**	.277**	.388**	-.041	.592**
2 Individuality			.092**	.060	-.190**	.194**	.053
3 Relating ideas				.515**	.089**	.117**	.320**
4 Deep meaning					.326**	-.067	.370**
5 Strategies						-.270**	.361**
6 Abstractness							-.044
7 Motivation							

*p < .05, **p < .01

Appendix 3 – Discriminant analysis

Table 8
Standardized coefficients of canonical discriminant function

	First function
1 Time organisation	-.158
2 Individuality	.090
3 Relating ideas	.457
4 Deep meaning	.524
5 Strategies	-.494
6 Abstractness	.323
7 Motivation	.300

Table 9
Structure matrix

	First function
1 Time organisation	.068
2 Individuality	.282
3 Relating ideas	.718
4 Deep meaning	.584
5 Strategies	-.263
6 Abstractness	.390
7 Motivation	.315

Table 10
Classification results – gifted and non gifted

Gifted		Predicted group affiliation		
		non-gifted	gifted	Total
Origina lN	non-gifted	470	181	651
	gifted	32	118	150
%	non-gifted	72.2	27.8	100.0
	gifted	21.3	78.7	100.0

Table 11
Classification results – different highschools

Type of highschool			Predicted Group Membership						Total
			Gymnasium (NS)	Gymnasium (SL)	High school (M)	High school (E)	High school (V)	High school (A)	
Original	N	Gymnasium (NS)	236	22	3	29	4	1	295
		Gymnasium (SL)	127	32	0	21	1	0	181
		High school (M)	47	6	6	12	0	0	68
		High school (E)	58	6	2	49	4	0	119
		High school (V)	68	10	2	21	1	0	102
		High school (A)	22	7	1	5	1	0	36
	%	Gymnasium (NS)	80.0	7.5	1.0	9.8	1.4	.3	100.0
		Gymnasium (SL)	70.2	17.7	.0	11.6	.6	.0	100.0
		High school (M)	69.1	8.8	4.4	17.6	.0	.0	100.0
		High school (E)	48.7	5.0	1.7	41.2	3.4	.0	100.0
		High school (V)	66.7	9.8	2.0	20.6	1.0	.0	100.0
		High school (A)	61.1	19.4	2.8	13.9	2.8	.0	100.0

Note: Gymnasium (NS) – Gymnasium – natural sciences and mathematics module, Gymnasium (SL) - Gymnasium – socia-linguistic module, High school (M) – Medical high school, High school (E) – High school of economics, High school (V) – Vocational school, Highschool (A) – Art high school

Appendix 4 - Items

Instrument

FACTOR – TIME MANAGEMENT

1. Unapred isplaniram šta ću i kada učiti.
2. Često počinjem da učim neposredno pred test. (R)
3. Rad uvek predajem u poslednjem roku. (R)
4. Pažljivo organizujem svoje vreme za učenje da bih bio/bila što produktiviniji/a.
5. Uglavnom kontinuirano učim tokom cele školske godine.
6. Mogu efikasno da organizujem vreme za učenje tokom dana.
7. Sklon/a sam odlaganju školskih obaveza. (R)
8. Obično napravim plan učenja tokom nedelje i redovno ga se držim.
9. Moje učenje više karakterišu povremeni naleti energije nego redovan pristup. (R)
10. Čak i kada napravim organizovani plan, posle određenog vremena odustanem od njega. (R)
11. Nemam nikakvu rutinu u načinu na koji učim. (R)

FACTOR – INDIVIDUALITY

1. Nakon grupnog učenja često osećam da bi bilo efikasnije da sam to vreme iskoristio učeći samostalno.
2. Više puta mi je pomoglo kad zajedno sa nekim pređem gradivo za ispit. (R)
3. Grupne sesije učenja su gotovo uvek neefikasne i predstavljaju druženje, a ne pravo učenje.
4. Često je korisno grupno učenje, jer uvek neko ima uvid u nešto što si ti predvideo. (R)
5. Najefikasnije učim samostalno.
6. Produktivniji/a sam u timu. (R)
7. Koristi mi da se preslišavam sa drugom ili drugaricom. (R)
8. Učenje je brže i efektivnije ako radim zajedno sa nekim. (R)
9. U radu sa drugima ću saznati značajne informacije koje su mi promakle u samostalnom učenju. (R)
10. Ne verujem da će u grupnom učenju biti dovoljno organizacije da se postigne nešto produktivno.

FACTOR – RELATING IDEAS

1. Zamara me da povezujem gradivo iz različitih lekcija ili predmeta. (R)
2. Uglavnom ne razumem kako je gradivo koje učim iz jednog predmeta povezano sa gradivom iz drugih predmeta. (R)
3. Svaki deo lekcije učim izolovano, ne trudim se previše da ih povežem. (R)
4. Dobar/a sam u povezivanju ranije naučenog sa novim gradivom.
5. Zbunjuje me kada se gradivo iz više predmeta preklapa. (R)

FACTOR – DEEP MEANING

1. Kada uočim da mogu da povežem novo gradivno sa starim, volim da bacim pogled na staro gradivo.
2. Kada usmeno odgovaram, u odgovore uklapam znanje iz drugih predmeta koji su povezani sa lekcijom.
3. Često učim iz više izvora kako bih bolje razumeo/la gradivo.
4. Lekcija koju čitam često me podstakne da dalje samostalno istražujem.
5. Zanimljive lekcije me često podstiču na duga razmišljanja o datoj temi.
6. Često mi se desi da ono što učim proširim informacijama sa interneta.
7. Ne udubljujem se previše u gradivo koje učim. (R)
8. Kritički pristupam gradivu koje treba da naučim.
9. Ne smeta mi da neku informaciju samo nabubam. (R)

FACTOR – STRATEGIES

1. Dok učim, formulišem pitanja na koja se trudim da pronađem odgovor.
2. Koristim raznovrsne tehnike koje mi pomažu da zapamtim informacije kada učim.
3. Zapisujem ključne stvari koje profesor kaže na predavanju.
4. Pomaže mi kad izdvojim sve bitne pojmove iz lekcije na jedan papir.
5. Nema potrebe da hvatam beleške. (R)
6. Često napravim shemu ili skicu, gde organizujem tematske jedinice radi lakšeg snalaženja.
7. Kada obnavljam neko gradivo, izdvajam male celine koje se odnose na različite bitne aspekte.
8. Profesor mi dosta olakša učenje kada prikazuje informacije putem shema i grafikona.
9. Kada učim, gradivo delim na smislene celine.
10. Pravljenje grafika, shema i prepričavanje lekcija je gubljenje vremena. (R)

FACTOR – ABSTRACTNESS

1. Volim da praktično isprobavam ideje i vidim da li bi funkcionisale u realnom životu. (R)
2. Ne volim lekcije o stvarima koje nemaju praktičnu primenu. (R)
3. Znanje koje se ne može praktično primeniti je beskorisno. (R)
4. Ono što je suštinski najbitnije jeste da li nešto funkcioniše u praksi. (R)
5. Kada da čujem za novu ideju ili pristup, odmah razmišljam kako bih je primenio/la u praksi. (R)
6. Volim da isprobavam stvari da bih video/la da li praktično funkcionišu. (R)

FACTOR – MOTIVATION

1. Težim da budem najbolji u odeljenju/klasi.
2. Nikada me nije zanimao prosek, samo da položim predmet. (R)
3. Ukoliko dobijem lošiju ocenu nego što sam očekivao/la, uložiću trud da je ispravim kako god je moguće.
4. Ukoliko sam odlučio/la da pređem određeno gradivo, preći ću ga makar mi ceo dan bio potreban za to.
5. Osećam da mi dobro ide, i to me motiviše da ulažem više truda u učenje.
6. Bitno mi je da imam osećaj da zaista dajem sve od sebe u pogledu školskog zalaganja.