Krisztina Kupa – László Imre Komlósi – Miklós János Szerdahelyi

Evidence for a second-order latent construct of self-directed learning readiness in virtual teams in Hungary

KRISZTINA KUPA
PhD Candidate
Széchenyi István University,
Hungary
Email: kupa.krisztina@sze.hu

LÁSZLÓ IMRE KOMLÓSI
Professor
Széchenyi István University,
Hungary
Email: komlosi.laszlo@sze.hu

MIKLÓS JÁNOS SZERDAHELYI
PhD Candidate
Széchenyi István University,
Hungary
Email: mszerdahelyi@gmail.com

The study focuses on the development of virtual teams from the perspective of individuals by extending the theory of self-directed learning (SDL) beyond the extant research in nursing education and applying it to a sample of adult population working in virtual teams in Hungary. After finding the necessary theoretical steps to connect SDL with virtual teams, research was conducted to validate existing instruments or, if this is impossible, to develop a new SDL instrument for virtual teams. The results confirm the viability of the SDL theories in the context of teams that mostly work remotely. While the validity of known SDL readiness (SDLR) instruments developed for nursing education could not be reliably confirmed on the sample of working adults in virtual teams, it is supported by the conventional three-factor SDLR construct with a reduced item number. In this study, the authors advance a new measurement tool, referred to as SDLR9, which, while mirroring the three original factors known in the literature, also points to a higher-order latent SDLR variable.

KEYWORDS: individual learning, self-directed learning readiness, virtual teams

Virtual teams, especially after the onset of the pandemic, became integral parts of several organisations. The tasks and processes that companies believed could not be performed remotely were proven to be suitable for execution away from the office, even from one's home. Theories and academic articles on virtual teams have been published for several decades. This is echoed in *Bell* and *Kozlowski*'s famous article, 'Virtual teams are here, and they are here to stay.' (*Bell–Kozlowski* [2002] p. 45)

Regarding virtual teams, there are several (organisational, leadership, team, individual, etc.) aspects from which team development and learning can be analysed. At the individual level, how individuals' attributes and personality traits can contribute to the success of their learning, which directly influences the process of team development, should be explored. In this study, we examine how the concept of SDL and *Fisher*, *King*, and *Tague*'s [2001] SDL readiness scale (SDLRS) model can be applied or adapted to virtual teams. Our goal is to test the results of a data collection performed in Hungary on a sample of 200 adults working in virtual teams, as well as to either confirm the applicability of *Fisher*, *King*, and *Tague*'s [2001] original 40-item SDLRS model or develop our own SDLRS model through confirmatory and exploratory factor analyses (CFA and EFA) and internal consistency measures.

In this study, we summarise the theoretical background of virtual teams, SDL, and SDLRS (Sections 1 and 2); give an overview of the data collection and statistical analysis methods (Section 3); present and discuss the empirical findings of our data analysis and propose a SDLRS model (Sections 4 and 5); and provide our conclusions (Section 6).

1. Virtual teams

When discussing virtual teams, the definition of teams in the traditional sense should first be introduced. *Cohen* and *Bailey* [1997] define a team as a set of individuals who are seen as a complete social entity (e.g., department, corporation, etc.) and are jointly responsible for the outcomes of the tasks they independently perform to reach a common goal. The members work together, use their different skills, and provide support to each other, sometimes meshing their functions to reach the team's goal. According to *Berry* [2011], teams generally have four attributes that are common among all teams:

– The team has a shared membership mindset, and it usually has definable and limited membership.

– The team members function independently with a shared purpose, which is either constructed by the team or given to them.

– The team members are jointly responsible for the outcomes.

– The team members manage their relationships across and between organisational boundaries collectively.

Virtual teams have the same basic concept as traditional teams: they are a set of individuals sharing the responsibility of performing tasks as a complete social entity. However, two additional attributes of virtual teams should be added to the characteristics of traditional teams (*Berry* [2011]):

– The team members may be geographically dispersed.

– The team members mostly rely on computer-mediated communication rather than face-to-face communication.

Virtual teams do not differ in their purposes or goals from traditional teams introduced previously, only their ways of working do, that is, using information and communication technologies, and the fact that the team members are not necessarily located in the same office (in many cases, not even on the same continent) or face-to-face meetings are not necessary or possible during the execution of their tasks (*Bell–Kozlowski* [2002]). The technology-mediated nature of virtual teams is present in several studies, noting that without technology, teams cannot have a virtual nature (*Lipnack–Stamps* [2000], *Kupa* [2020a]).

The virtual nature of these teams is a complex and multidimensional construct because, even if there are two teams using the same technology, the extent to which the technology is used defines which of them (if either) can be considered as a virtual team. Nowadays, every team uses technology to a certain extent. Emails and other video and chat applications have become significant communication tools for almost all teams. Thus, for the sole reason that a team uses emails and Zoom, the virtual nature cannot be defined, as these can also define a team that conducts only certain activities virtually (i.e., uses emails for tracking purposes, chats in the loud office, etc.). This means that almost every team adopts some ‘virtualness’ in its nature, but to qualify as a virtual team, technology is insufficient; without geographical dispersion, these teams cannot be considered virtual (*Berry* [2011], *Kupa* [2020a]).

The past two decades have brought about significant growth in the use of virtual teams, with its peak reached in 2020 due to the coronavirus disease 2019 (COVID-19) pandemic. According to *Gartner* [2020], 88% of global organisations have encouraged their employees to work from home since the beginning of 2020,

irrespective of whether they were affected by the virus or not. Moreover, 97% of organisations decided to cancel business-related travel, thus making it impossible to conduct face-to-face meetings. *Bakonyi* and *Kiss-Dobronyi* [2020] conducted a survey in Hungary, where 73% of the participants responded that they had been asked by their employers to work from home for a certain period. This shows that the significance of virtual teams has increased even further; however, the longer-term effects of the COVID-19 pandemic are yet to be determined. Evidently, despite the current pandemic, the number of virtual teams deployed by companies have been growing for some time due to globalisation, innovation, and better access to infrastructure.

There are several reasons why companies have opted to set up virtual teams within their organisations. The benefits arising with virtual teams are, amongst others, flexibility, cost efficiency, better utilisation of time and space, and maximising the expertise of the globally dispersed talent pool. Meanwhile, these benefits pose several challenges to teams, such as overcoming a lack of personal connections, different cultural backgrounds, language barriers, and technological issues (*Kupa* [2020a]). The leader's role is to help the team overcome these challenges and, at the same time, exploit the benefits and opportunities. Leaders should also focus on performance management, team development, and learning. However, due to the lack of face-to-face interactions, the latter is difficult to perform (*Bell–Kozlowski* [2001]) and requires the willingness and positive attitude of the individual team members.

Learning is a part of all stages of team development; however, it is often hindered when using various virtual tools for communication that are present in virtual teams. *Zakaria*, *Amelinckx*, and *Wilemon* [2004] note that since learning is not purely based on verbal or written communication, the lack of face-to-face contact, that is, the limited number of non-verbal clues, decreases the chance of success of the team's learning activities. In this sense, individuality becomes even more significant in virtual teams when it comes to learning – individuals must be ready and able to search for and process information independently and effectively. SDL readiness, as discussed in the next section, is a good indicator for assessing this individuality and, if adapted correctly, could help leaders in developing efficient teams.

2. SDL

2.1. SDL theories

Learning is a major focus in several disciplines; however, it is difficult to establish a single satisfactory definition for it because of the different perspectives adopted by each discipline. The most common definition describes learning as a change in behaviour based on previous experiences (*Barron et al*. [2015]). In organisations and teams, this is not different: former experience can be decisively present in online training, reading books, talking to co-workers, or solving problems and finding solutions.

In the case of virtual teams, the learning limitations are due to the lack of face-to-face contact. Although more explicit knowledge is easier to pass on, learning often draws on tacit knowledge, which is much more challenging. Owing to these limitations, there is a growing need for individuality and independence in virtual teams when it comes to learning. SDL and self-regulated learning (SRL) focus on how individuals approach their individual learning, what strategies they set, and how they manage their own learning. (*Kupa* [2020b]) In this study, the term SDL is used to describe this phenomenon.

Notably, SDL is defined by the learning strategies that individuals adopt to achieve their learning goals. This includes identifying and assessing their training and learning needs, setting objectives, and evaluating their performance and the outcomes of their learning activities. In SDL, individuals take the initiative, they do not depend on others to tell them how to approach learning, they are able to formulate their own goals, and overall can be trusted with efficiently managing their time and resources. Furthermore, SDL differs in pedagogical research and team research, as the environment and structure of the learning are different; in education, there is a set curriculum, and there are classes available; however, in an on-the-job team environment, individuality and ownership are much more significant (*Knowles* [1975], *Kupa* [2020b]).

Although individuality and independence are the core attributes of SDL, both *Greg* [1993] and *Garrison* [1997] argue that SDL can also enable corporations and teams to utilise peers, members, or anyone who can be considered as a learning resource to enhance the effectiveness of learning. Some prominent studies (*Chicchinelli et al*. [2018], *Pardo–Han–Ellis* [2016]) have also found correlations between SDL and students' academic outcomes. Notably, SDL can be used to enhance both private and professional knowledge irrespective of institutional, geographical, or situational differences (*Abdullah et al*. [2008]), which also confirms its importance in virtual team settings. With the rapid improvement in diverse technolo-

gies, online and virtual learning tools are readily available for learners. They are also frequently used by virtual teams (*Kupa* [2020b]).

There are several approaches and divisions for further classification of the SDL domain. According to *Barnard-Brak*, *Lan* and *Paton* [2010], SRL skills include goal setting, time management, task strategies, and environmental structuring. *Hon*, *Lee*, and *Ye* [2021] extended these with mood adjustment, self-evaluation, and help-seeking. Another classification, which will be the focus of this study, is based on *Guglielmino*'s [1997] SDLRS, which has been later adjusted and adapted by *Fisher*, *King*, and *Tague* [2001]. In conformity with *Fisher*, *King*, and *Tague*'s [2001] analogy, there are three main SDL domains: self-management, self-control, and the desire for learning. Self-management refers to the ability of learners to identify their needs, set their goals, and allocate their energy and time to learning. Self-control means the self-determination of SDL learners, meaning that the learner is an independent individual capable of analysing, planning, implementing, and assessing his or her learning activities without the control of others. The desire for learning indicates the strong motivation of learners to acquire knowledge. (*Fisher–King–Tague* [2001], *Kupa* [2020b])

2.2. SDL measures and Fisher's SDLRS for nursing education

Several instruments have been developed to measure SDL, such as the SDLRS (*Guglielmino* [1997]), which is one of the first methods that has been used to measure self-direction in learning and has been validated in several academic studies. One of these is the SDLRS for nursing education (SDLRSNE; *Fisher–King–Tague* [2001]), which is an adaptation of *Guglielmino*'s [1997] SDLRS for the nursing education sector, and it has been validated in several academic studies.

Similar instruments include *Cheng et al.*'s SDL instrument [2010] and *Williamson*'s self-rating scale [2007]. They have also been translated into various languages and adapted for different scenarios, thereby authenticating the scientific interest in this type of measure through several applications, but mostly in pedagogical research. These instruments have several limitations in terms of validity, reliability, and repeatability. This paper focuses on the validity of the SDL measures (specifically the SDLRSNE, as discussed in Section 2.3). However, it should be noted that because of the niche fields (education and nursing) that the validation, reliability, and repeatability studies focused on, these measures need to be further tested in these fields and adapted to other environments, markets, and conditions. Furthermore, the reliability of the SDLRSs, whether they test the general attitude towards learning or the self-directed nature of learning, is also a factor to be considered in future research.

2.3. Fisher's SDLRSNE

Fisher, *King*, and *Tague* [2001] reviewed the available literature and compiled a list of attitudes, abilities, and personality characteristics of self-directed learners. The complete list consists of 93 items, among which a significant number of items were drawn from other SDLRSs, such as *Guglielmino*'s [1997], *Knowles*'s [1975], and *Candy*'s [1991] measurements. The Delphi technique was used by an expert panel to gain consensus among the characteristics required for SDL. For an item to be retained, at least an 80% consensus had to be achieved (*Fisher–King–Tague* [2001]).

Out of the 93 items brought to the panel, 40 items remained after the principal component analysis (PCA) and factor analysis. These items were divided into three subscales as follows (*Fisher–King–Tague* [2001]):

Self-management:

1. I manage my time well.
2. I am self-disciplined.
3. I am organised.
4. I set strict time frames.
5. I have good management skills.
6. I am methodical.
7. I am systematic in my learning.
8. I set specific times for my study.
9. I solve problems using a plan.
10. I prioritise my work.
11. I can be trusted to pursue my own learning.
12. I prefer to plan my own learning.
13. I am confident in my ability to search for information.

Desire for learning:

14. I want to learn new information.
15. I enjoy learning new information.
16. I have a need to learn.
17. I enjoy a challenge.
18. I enjoy studying.
19. I critically evaluate new ideas.
20. I like to gather the facts before I make a decision.
21. I like to evaluate what I do.
22. I am open to new ideas.
23. I learn from my mistakes.

24. I need to know why.
25. When presented with a problem I cannot resolve, I will ask for assistance.

Self-control:

26. I prefer to set my own goals.
27. I like to make decisions for myself.
28. I am responsible for my own decisions/actions.
29. I am in control of my life.
30. I have high personal standards.
31. I prefer to set my own learning goals.
32. I evaluate my own performance.
33. I am logical.
34. I am responsible.
35. I have high personal expectations.
36. I am able to focus on a problem.
37. I am aware of my own limitations.
38. I can find out information for myself.
39. I have high beliefs in my abilities.
40. I prefer to set my own criteria on which to evaluate my performance.

Fisher, *King*, and *Tague* [2001] aimed to use this scale in nursing education to assist nurse educators in diagnosing their students' learning needs and thus implement teaching strategies that best suited these needs. Owing to the generic wording of the questions, however, the questionnaire can be used not only for nursing educators or specifically in education but also to support virtual teams in their learning path.

Fisher and *King* [2010] revisited the SDLRSNE to provide evidence of construct validity for the subscales, which resulted in making 11 items from the list redundant, while keeping the factor structure similar. For the purposes of the present examination, the original 40-item list was chosen as the basis for further analysis.

The aim of this study is to bring together the theories of virtual teams and those of SDL to provide a resource that plays a significant role in the success of teams pertaining to individuals. Through data collected from the adult working population and extensive statistical analysis, our goal is to gather supportive evidence for the applicability of SDLR beyond student populations and to confirm that the original or a modified version of the SDLRSNE scale is applicable in virtual teams. If such confirmation is impossible, then our objective will be to explain the differences in terms of context.

3. Data collection and statistical analysis methods

The 40-item SDLRSNE developed by *Fisher*, *King*, and *Tague* [2001] was chosen as the focus of this study to test whether the same scale and factor structure could be applied to virtual teams. The SDLRSNE is chosen to be the instrument tested, as it has been validated several times and the wording of the 40 statements is simple enough to be understood for those who speak English as their second language. The original English questionnaire was peer-reviewed by a panel of Hungarian PhD students of the Széchenyi István University. Based on this exercise, the questionnaire was administered to the original 40 items in English for data collection purposes. Although *Fisher* and *King* [2010] reduced the 40 items to 29 in their re-evaluation study, we decided to retain all the original questions, thus providing a larger pool of questions to be analysed and used for model development.

The aim of this research is to test the hypothesis based on the original 40-item SDLRSNE as an instrument to appraise the suitability of applying the SDLRS in virtual teams with the same subscales. If this hypothesis is rejected, we will develop our own SDLR construct.

3.1. Data collection

The convenience sample was collected through a questionnaire prepared in Google Sheets that was circulated online on social media platforms, such as several professional Facebook groups and LinkedIn (the questionnaire was also shared by volunteers). Participation was encouraged as a contribution to important research topics; it was voluntary and no reward was promised or given in return. The participants were asked to evaluate the items using a five-point Likert scale, to the degree to which individual items reflect their own characteristics. A score of 1 indicated ‘strongly disagree’, whereas a score of 5 indicated ‘strongly agree’. Several demographic and clarification questions were asked. The respondents were categorised as working in virtual teams if over 30% of their time was spent working and cooperating virtually with their teammates.

By the end of October 2020, 199 responses had been collected, and no further responses were recorded afterwards. Of the 199 responses, 146 fulfilled all the required conditions to be considered in the data analysis, that is, the participant works at least 30% of his or her time virtually vis-à-vis teamwork. Table 1 presents the characteristics of the total population of respondents and the chosen population from a demographic perspective.

Table 1

Demographic data of respondents, 2020

Population of respondents	Gender	Age (years)	Time spent in current team	Number of direct team members	Percentage of virtual cooperation
Total (*N* = 199)	Female: 111 Male: 86 Other/Prefer not to say: 2	18–24: 8 25–34: 111 35–44: 67 45–54: 10 55–64: 3	0–3 months: 19 4–7 months: 10 8–11 months: 19 1–3 years: 96 4–6 years: 38 7+ years: 27	2–4: 29 5–7: 68 8+: 102	0–10: 10 11–20: 16 21–30: 27 31–40: 19 41–50: 13 51–60: 29 61–70: 23 71–80: 18 81–90: 17 91–100: 27
Selected (*N* = 146)	Female: 80 Male: 65 Other/Prefer not to say: 1	18–24: 6 25–34: 80 35–44: 52 45–54: 6 55–64: 2	0–3 months: 15 4–7 months: 7 8–11 months: 16 1–3 years: 66 4–6 years: 31 7+ years: 11	2–4: 20 5–7: 53 8+: 73	0–30: 0 31–40: 19 41–50: 13 51–60: 29 61–70: 23 71–80: 18 81–90: 17 91–100: 27

3.2. Data analysis

Data from the final sample of 146 working adults were subjected to both EFA and CFA, as well as PCA. Cronbach's alpha was calculated for the original scale, confirming its usability; however, neither did the PCA, EFA, and CFA support the original SDLRSNE factor structure (*Fisher–King–Tague* [2001]) on our sample, nor did the three one-factor congeneric model versions of the SDLRSNE (*Fisher–King* [2010]) result in a good fit. Subsequently, EFA was used to establish a new factor structure for all or at least most of the original 40 items. Additionally, CFA was repeated after removing items with the lowest factor loading. However, due to low correlations, no meaningful solution was found at this level of inquiry. Finally, CFA was applied to maintain the original three-dimensional factor structure but with a much-reduced item count. Content validity was determined by selecting the best items covering the core content of each dimension. Symmetry was considered to give equal weights to each subscale, and the three factors were analysed together – as opposed to the congeneric

models (*Fisher–King* [2010]) – to legitimise the three subscales belonging to one questionnaire despite the relatively low correlation among the dimensions. The data analysis process carried out in this study, in practical terms, could be interpreted as the creation of a short form of the original SDLRSNE because the reduced scale captures most of the original construct in terms of context. However, if we consider virtual teams, the developed SDLR9 scale can be regarded as a new construct. All analyses were performed using the RStudio statistical software (*RStudio Team* [2020]).

4. Results

Given our data on adult working populations from a cross section of virtual teams, we first aimed to test the known SDLRSNE models in the literature. We conducted factor analysis as an experiment to confirm the established SDLR theory, while acknowledging that several modified scale versions had already been published and perhaps our analysis would lead to a new one. We first resorted to CFA to test the three-factor 40-item SDLRSNE model developed by *Fisher*, *King*, and *Tague* [2001] and the three one-factor 29-item congeneric models used 10 years later by *Fisher* and *King* [2010] to confirm the basic factor structure of the SDLR construct. The results of our dataset of the adult population working in virtual teams were insufficient to confirm these models. The CFA results for the three-factor 40-item SDLRSNE showed a poor model fit (CFI[1] = 0.552, $RMSEA$[2] = 0.089, $SRMR$[3] = 0.101). The alpha values for the three factors were 0.81, 0.76, and 0.78 respectively. The CFA for the three one-factor congeneric models showed a poor fit for the first two factors, while a bad model fit for the third factor brings us, overall, to reject the models for virtual teams (Factor 1: CFI = 0.809, $RMSEA$ = 0.097, $SRMR$ = 0.072; Factor 2: CFI = 0.842, $RMSEA$ = 0.090, $SRMR$ = 0.073; Factor 3: CFI = 0.589, $RMSEA$ = 0.113, $SRMR$ = 0.090).

[1] Comparative fit index (CFI).
[2] Root mean square error of approximation (RMSEA).
[3] Standardized root mean square residual (SRMR).

Table 2

CFA of self-directed learning models

Models	χ^2	*df*	*p*	*CFI*	*TLI*	*RMSEA*	*SRMR*
Three-factor 40-item SDLRSNE model	2,666	780	0.000	0.552	0.525	0.089	0.101
Three one-factor congeneric models							
Factor 1	544	78	0.000	0.809	0.771	0.097	0.072
Factor 2	386	55	0.000	0.842	0.803	0.090	0.073
Factor 3	593	120	0.000	0.589	0.526	0.113	0.090
SDLR9 second-order factor model	352.28	36	0.000	0.097	0.096	0.049	0.049

Note. Tucker–Lewis index (TLI).

As the three-factor 40-item SDLRSNE model was originally arrived at through PCA (*Fisher–King–Tague* [2001]), we performed a similar analysis on our sample with varimax rotation for the three factors; however, the total variance explained by the model was only 30%. We aimed to map the construct's factor structure further using exploratory methods; thus, we resorted to EFA. We first computed Bartlett's test to ensure that the items were duly correlated for an EFA ($\chi^2 = 2{,}389$, $p = 0.000$) and then used a Kaiser–Meyer–Olkin test for sampling adequacy to ensure that our dataset had sufficient subjects (overall MSA[4] $= 0.78$). Subsequently, we computed the EFA for the three-factor model using oblique rotation (because factors within the same scale were expected to correlate) and the maximum likelihood factor math. Overall fit indices were insufficient to confirm the model ($CFI = 0.703$, $RMSEA = 0.080$), and the model accounted for only 30% of the variance of the items, as in the case of PCA.

Because the three-factor models known from the literature failed in our sample, we set out to estimate the number of factors for the EFA anew. To determine the number of factors, we used the Kaiser criterion with eigenvalues above 0.7 as per the newer approach and eigenvalues above 1.0 as per the traditional approach. The numbers of factors suggested by the Kaiser criterion to set for the EFA were six and five, respectively. We also computed a parallel analysis which compared data to randomised iterations to be able to select all factors with eigenvalues significantly above the randomised data. The results suggested that we use seven factors. Keeping in mind that parsimony dictates that simpler models with fewer factors are preferable over more complex ones, we perform the EFA for all suggested factors with the results shown in Table 3. As none of our new EFA models with all 40 items manifested a good model fit and explained sufficient cumulative variance, we tried to eliminate items with factor

[4] Measure of sampling adequacy (MSA).

loadings lower than 0.30. After several iterations, we abandoned the exploratory method and tried to perform the same item selection based on the factor loading results with CFA for the three-factor model. *Fisher* and *King* [2010] used a similar approach to arrive at the congeneric one-factor models, the difference being that, as per our logic, we aimed to keep the factor structure intact if we must eliminate items. The SDL model could not be confirmed using this approach either.

Table 3

EFA of SDL models

Model	*Cumulative variance*	*CFI*	*TLI*	*RMSEA*
Three-factor model	0.30	0.703	0.643	0.080
Five-factor model	0.37	0.826	0.761	0.068
Six-factor model	0.41	0.870	0.809	0.063
Seven-factor model	0.43	0.898	0.839	0.059

Finally, we changed our experimental approach from trying to keep most of the original items to using only as many items as necessary, and possibly keeping the original three-factor model. Based on the correlation table, we identified possible items, and considering the broadest possible content, we determined the best items for our subsequent CFA. Knowing that three items per factor are the minimum necessary, we aimed at a nine-item three-factor model with three items loading on each factor. We also experimented with second-order models driven by the idea that perhaps SDLR is a separate latent variable in individuals that explains their first-order latent factor levels. The model that we found mirrors the traditional factor structure with three correlated factors. However, SDLR is shown to be a higher-order latent construct that explains first-order factors. We think that our new model is significant because it confirms the legitimacy of the SDLR measure for virtual teams of working adult population, while at the same time it represents evidence for the higher-order SDLR factor.

5. Discussion

As per the standard of several published studies (*Newman* [2004], *Bridges–Bierema–Valentine* [2007], *Smedley* [2007]), internal consistency is a decisive factor when evaluating the SDLRSNE model. Based on the results, the Cronbach's alpha

scores support the applicability of the original 40-item SDLRSNE questionnaire in its original form on our sample of Hungarian adults working in virtual teams. However, a deeper analysis of the factor structure of the construct revealed the insufficiency of the original 40-item scale (*Fisher–King–Tague* [2001]), as several attempted methods of analysis (CFA, PCA with varimax rotation, and EFA with oblique rotation) did not support the applicability of the original SDLRSNE questionnaire for virtual teams. The revised scale of *Fisher* and *King* [2010], with three congeneric factors, was also not confirmed on our sample. Thus, our hypothesis that the same 40-item SDLRSNE could be applied to virtual teams must be questioned.

Nonetheless, we aimed not only to confirm the applicability of SDLRSNE, but also to revise and change the SDLRSNE scale and test whether by using different techniques and approaches, as inspired by *Fisher* and *King* [2010], we could find the best scale for the SDLR construct for virtual teams, more specifically, for the working adult population of our sample. First, we tried to retain all items and recalibrate the factor structure, but the EFA results failed to point to any alternative factor structure. We then tried to maintain the factor structure but eliminate weaker items. Larger models with many items did not fit the EFA and CFA results. The statistical reason behind these failed models is that there is a low correlation between items in general in our sample. Finally, we found satisfactory models with low item numbers; thus, we propose the newly developed SDLR9 scale for the adult working population in virtual teams. The factor structure and nine items of the SDLR9 scale are shown in Table 4.

Table 4

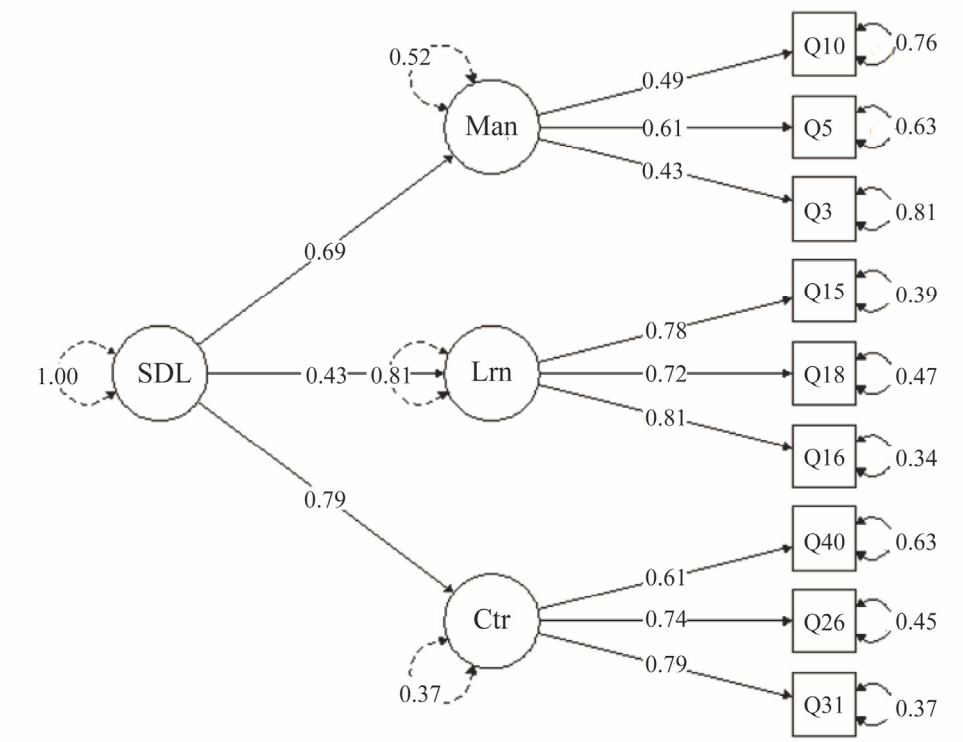
Factor structure of the SDLR9 scale

Self-management	Desire for learning	Self-control
I am organised.	I enjoy learning new information.	I prefer to set my own goals.
I have good management skills.	I have a need to learn.	I prefer to set my own learning goals.
I prioritise my work.	I enjoy studying.	I prefer to set my own criteria on which to evaluate my performance.

When this reduced item scale had been discovered during the analysis as a potential fit for the virtual teams, first, the applicability of the items had to be analysed. Interestingly, when comparing the SDLR9 and the 40-item SDLRSNE scales, it seems that the SDLR9 managed not only to reduce the number of questions while keeping the same factor structure, but was able to mirror much of the essence of the subscales intact even after radically reducing the item number. As noted in the theoretical analysis, self-management refers to the ability of learners to identify their

needs, set their goals, and allocate their time and energy to learning. The three items in this subscale reflect these requirements, as they cover the management, prioritisation, and organisational skills of the individuals. The desire for learning focuses on the strong motivation and preferences of learners to acquire knowledge: the reduced subscale in SDLR9 also concentrates on the need and motivation for learning. Regarding self-control, the original items revolved around the independence of the individuals in their learning path which can also be seen in the three-item subscale, as the wording emphasises the preference for individuality in their learning and goals.

The higher-order construct resulting from the SDLR9 scale



Note. SDL: self-directed learning readiness; Man: self-management; Lrn: desire for learning; Ctr: self-control; Q: reference to questionnaire items as numbered in Fisher's SDLRSNE (see Subsection 2.3.).

The SDLR9 scale also has excellent psychometric properties as a unified model confirmed by CFA, in contrast to the larger models proposed in the literature. Moreover, for the first time, we can propose the SDLR construct as a higher-order latent variable with the three original first-order factors. (See the figure.) A significant theoretical implication of the SDLR construct as a higher-order variable is that

SDLR has never been conceived as a unified personal resource that would work beyond the original first-order factors of self-management, the desire for learning, and self-control. The low correlations that we observe when considering all items explain not only why the larger models do not work specifically on our sample but also probably why previous investigations find it hard to fit all three factors in a one-factor analysis (*Fisher–King* [2010]). By radically reducing the item number and taking advantage of the more correlated items, one could argue that we arrived at a fundamentally different construct from the original SDLR model, as applied for nursing education. We do not necessarily contradict this observation primarily because the context of our research is outside of nursing and education. For working adults, specifically from the world of virtual teams, SDLR may mean somewhat different things, which are important for the management literature. Thus, we are confident in proposing the SDLR construct for virtual teams and the related SDLR9 scale not necessarily as a shorter version of the 40-item SDLRSNE scale but as an individual instrument. Content analysis of the SDLR9 scale would show that the essence of the original SDLRSNE model is captured rather well; therefore, given certain considerations, such as time constraint or repetitive measurement, the SDLR9 scale could also be conceived of as a short form of the SDLRSNE model. The higher-order factor structure evidenced in our model is an interesting development that would require follow-up investigation on other samples, but it has the potential to elevate research on SDLR to the next level.

6. Conclusion

Virtual teams require different skills and capabilities from their leaders and members. This study aimed to examine the level of individuals and analyse whether SDLRSs could be applied in virtual team settings. We collected a sample of 199 working adults from virtual teams in Hungary to test our hypothesis that the SDLRSNE scale of *Fisher*, *King*, and *Tague*'s [2001], previously tested only in nursing education, could be adapted without changes to our sample. Based on the results of the statistical analysis, this hypothesis had to be rejected, which could be explained by applying the scale to different types of learners (working adults who are learning on the job), another social group (working adults), and from a different country (not just Hungary).

Although our statistical analysis did not allow us to confirm our original hypothesis, this research resulted in the new SDLR9 scale. This model follows the

same three-factor structure as the original 40-item SDLRSNE, and the reduced number of items is still sufficient to reflect the requirements set forth in the academic literature on self-management, desire for learning, and self-control. Simultaneously, as a novelty, it proposes SDLR as a higher-order latent variable, which is not present in the previous models.

Our statistical approach to the SDLR construct has its limitations and advantages. For example, the breadth of content has been reduced due to the extreme brevity of the SDLR9 measurement tool, while, of course, the redundancies have also been removed. Shorter questionnaires tend to result in better response quality and are more suitable for complex research designs where multiple constructs are measured. The next step should be to validate the model on additional samples, collect data from working adults in virtual teams, and perform the same CFA and statistical methods. If the model performs consistently, it can serve as a great tool for the leaders of virtual teams in selection, learning, and development processes.

References

ABDULLAH, M. M. B. – KOREN, S. F. – MUNIAPAN, B. – PARASURAMAN, B. – RATHAKRISHNAN, B. [2008]: Adult participation in self-directed learning programs. *International Education Studies*. Vol. 1. Issue 3. pp. 66–72. https://doi.org/10.5539/ies.v1n3p66

BARNARD-BRAK, L. – LAN, W. Y. – PATON, V. O. [2010]: Profiles in self-regulated learning in the online learning environment. *The International Review of Research in Open and Distance Learning*. Vol. 11. Issue 1. pp. 61–80. https://doi.org/10.19173/irrodl.v11i1.769

BARRON, A. B. – HEBETS, E. A. – CLELAND, T. A. – FITZPATRIK, C. L. – HAUBER, M. E. – STEVENS, J. R. [2015]: Embracing multiple definitions of learning. *Trends in Neurosciences*. Vol. 38. Issue 7. pp. 405–407. https://doi.org/10.1016/j.tins.2015.04.008

BAKONYI, Z. – KISS-DOBRONYI, B. [2020]: *A COVID-19 járvány hatása a munkavégzésre Gyorsjelentés I.* Kutatási anyag.

BELL, B. S. – KOZLOWSKI, S. W. [2002]: A typology of virtual teams. *Group and Organization Management*. Vol. 27. Issue 1. pp. 14–49. https://doi.org/10.1177/1059601102027001003

BERRY, G. R. [2011]: Enhancing effectiveness on virtual teams: Understanding why traditional team skills are insufficient. *Journal of Business Communication*. Vol. 48. Issue 2. pp. 186–206. https://doi.org/10.1177/0021943610397270

BRIDGES, P. H. – BIEREMA, L. L. – VALENTINE, T. [2007]: The propensity to adopt evidence-based practice among physical therapists. *BMC Health Services Research*. Vol. 7. Article No. 103 (2007). pp. 103–112. https://doi.org/10.1186/1472-6963-7-103

CANDY, P. C. [1991]: *Self-Direction for Lifelong Learning: A Comprehensive Guide to Theory and Practice*. Jossey-Bass Publishers. San Francisco.

CHENG, S. F. – KUO, C. L. – LIN, K. C. – LEE-HSIEH, J. [2010]: Development and preliminary testing of a self-rating instrument to measure self-directed learning ability of nursing students.

International Journal of Nursing Studies. Vol. 47. Issue 9. pp. 1152–1158. https://doi.org/10.1016/j.ijnurstu.2010.02.002

CHICCHINELLI, A. – VEAS, E. – PARDO, A. – PAMMER-SCHINDLER, V. – FESSL, A. – BARREIROS, C. – LINDSTADT, S. [2018]: Finding traces of self-regulated learning in activity streams. In: *Association for Computing Machinery*: *Proceedings of the 8th International Conference on Learning Analytics and Knowledge*. New York. pp. 191–200. https://doi.org/10.1145/3170358.3170381

COHEN, S. G. – BAILEY, D. R. [1997]: What makes teams work: Group effectiveness research from the shop floor to the executive suite? *Journal of Management*. Vol. 23. No. 4. pp. 238–290. https://doi.org/10.1177/014920639702300303

FISHER, M. – KING, J. – TAGUE, G. [2001]: The development of a self-directed learning readiness scale for nursing education. *Nurse Education Today*. Vol. 21. Issue 7. pp. 516–525. https://doi.org/10.1054/nedt.2001.0589

FISHER, M. – KING, J. [2010]: The self-directed learning readiness scale for nursing education revisited: A confirmatory factor analysis. *Nurse Education Today*. Vol. 30. Issue 1. pp. 44–48. https://doi.org/10.1016/j.nedt.2009.05.020

GARRISON, D. R. [1997]: Self-directed learning: Toward a comprehensive model. *Adult Education Quarterly*. Vol. 48. Issue 1. pp. 18–33. https://doi.org/10.1177/074171369704800103

GARTNER [2020]: *Gartner hr survey reveals 88% of organizations have encouraged or required employees to work from home due to coronavirus*. https://www.gartner.com/en/newsroom/press-releases/2020-03-19-gartner-hr-survey-reveals-88--of-organizations-have-e

GREG, R. [1993]: Student perceptions about self-directed learning in a professional course implementing problem-based learning. *Studies in Higher Education*. Vol. 18. Issue 1. pp. 53–63. https://doi.org/10.1080/03075079312331382458

GUGLIELMINO, L. M. [1977]: Development of the self-directed learning readiness scale. Unpublished doctoral dissertation. University of Georgia. *Dissertation Abstracts International*. Vol. 38. Issue 11a. p. 6467.

HONG, J.-C. – LEE, Y.-F. – YE, J.-H. [2021]: Procrastination predicts online self-regulated learning and online learning ineffectiveness during the coronavirus lockdown. *Personality and Individual Differences*. Vol. 174. Article No. 110673. https://doi.org/10.1016/j.paid.2021.110673

KNOWLES, M. [1975]: *Self-directed Learning: A Guide for Teachers and Learners*. Association Press. New York.

KUPA, K. [2020a]: Challenges and benefits of virtual teams: A leadership perspective. In: *Komlósi, L. – Kelle, P. – Djukec, D.* (eds.): *58th International Scientific Conference on Economic and Social Development. Book of Proceedings*. Varazdin Development and Entrepreneurship Agency. Varazdin. pp. 193–202.

KUPA, K. [2020b]: Self-directed learning readiness in virtual teams. *Tér-Gazdaság-Ember*. Vol. 8. Issue 4. pp. 77–89. https://tge.sze.hu/images/dokumentumok/K%C3%B6tetek%20%C3%B6sszes%20cikkel/2020.%20VIII.%20%C3%A9vfolyam%204.%20sz%C3%A1m%20(angol)_cikkek/TGE_2020_8_evfolyam_4_szam_Kupa.pdf

LIPNACK, J. – STAMPS, J. [2000]: *Virtual Teams: People Working Across Boundaries with Technology. Second Edition*. John Wiley & Sons. New York.

NEWMAN, M. [2004]: *Problem Based Learning: An Exploration of the Method and Evaluation of Its Effectiveness in a Continuing Nursing Education Programme.* Project on the Effectiveness of Problem Based Learning. Research Report. July. Middlesex University. Middlesex. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.118.3649&rep=rep1&type=pdf

PARDO, A. – HAN, F. – ELLIS, R. A. [2016]: Combining university student self-regulated learning indicators and engagement with online learning events to predict academic performance. *IEEE Transactions on Learning Technologies*. Vol. 10. Issue 1. pp. 82–92. https://doi.org/10.1109/TLT.2016.2639508

RSTUDIO TEAM [2020]: *RStudio: Integrated Development for R*. RStudio. Boston. http://www.rstudio.com/

SMEDLEY, A. [2007]: The self-directed learning readiness of first year bachelor of nursing students. *Journal of Research in Nursing*. Vol. 12. Issue 4. pp. 373–385. https://doi.org/10.1177/1744987107077532

WILLIAMSON, S. N. [2007]: Development of a self-rating scale of self-directed learning. *Nurse Researcher*. Vol. 14. Issue 2. pp. 66–83. http://doi.org/10.7748/nr2007.01.14.2.66.c6022

ZAKARIA, N. – AMELINCKX, A. – WILEMON, D. [2004]: Working together apart? Building a knowledge-sharing culture for global virtual teams. *Creativity and Innovation Management*. Vol. 13. Issue 1. pp. 15–29. https://doi.org/10.1111/j.1467-8691.2004.00290.x