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Revitalizing the Oddi Continuing Learning Inventory

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Abstract. The Oddi Continuing Learning Inventory (OCLI) is one of the most popular instruments for measuring self-directed learning (SDL). Although several previous studies have validated it, an exploratory application of confirmatory factor analysis had not been attempted; such an analysis provided new insights. Responses from 159 students from Aalborg University, a Problem-Based Learning institution known for its high degree of self-directed project work, were analyzed. This investigation examines all previously suggested factor structures against commonly applied measures and further develops the most promising, identifying a new three-factor structure reaching standard thresholds of model fit. The newly identified underlying dimensions of the OCLI—internal locus of control, the ability to be self-regulating, and avidity for learning—simplify the interpretation of the factors and help mitigate some of the instrument's previous problems. This will serve to keep the OCLI relevant as an instrument for measuring self-directed learning in the future. We recommend further studies to revise the OCLI, rephrasing and reconceptualizing items that have aged poorly as well as investigating the pattern of the reverse-coded items. Lastly this paper suggests that other statistical instruments might be revitalized through the application of similar methods, taking advantage of the advances in computation and statistical analysis.

Keywords: self-directed learning; validation; scale purification; quantitative analysis; confirmatory factor analysis

1. Introduction

For decades, researchers in adult education have tried to identify students' characteristics and aspects crucial to their success in learning. Few aspects have received as much attention as self-directed learning (SDL), albeit in many different but somewhat overlapping conceptualizations such as self-regulated learning and lifelong learning (Leary et al., 2019; Saks & Leijen, 2014).

An aspect that SDL shares with the rest of adult education is the inclination toward qualitative research in contemporary scientific publications. While the last few decades have seen a return from a heavily theoretical to a more empirical focus, this has almost exclusively been the result of a rise in published qualitative studies (Clair, 2011; Taylor, 2001). In the most recent studies looking at the field through three leading journals, Boeren et al. (2018) found that only about one sixth of the published articles applied quantitative methods. The vast majority of these reported only descriptive statistics, apparently not applying any deeper analysis (Boeren et al., 2018). A more detailed analysis of the most referenced articles in the same journals from 2005 to 2012 found that while 62% had used some form of qualitative analysis, only 7% had used quantitative methods and 5.3% mixed methods (Fejes & Nylander, 2015). While there are certainly many valuable insights to be gained from qualitative research, the application of a pluralism of methodologies within a field ensures that topics can be explored from different perspectives and angles, and a better representation of quantitative studies in adult education would allow for broader studies of general characteristics involving an increased number of subjects, enhancing the generalizability of the results (Robson & McCartan, 2016). Daley et al. presented similar sentiments in an article calling for a renewed discussion of methodological diversity and further quantitative research in adult education research, concluding with three recommendations (Daley et al., 2018). To these we would add that in other disciplines there have been trends showing an interest toward making inferences from quantitative studies. A prerequisiste for a similar endeavor in the field of adult education, however, is that there are validated instruments that capture essential constructs that are of importance to causal analysis.

One of the resources that could be applied advantageously to this end and to mitigate the methodological skew in adult education is the vast array of standardized scales and statistical instruments already developed. While such instruments might hold great promise for both research and practice, they do, however, need to be rigorously validated and their theoretical interpretations refined.[i] Within SDL, one such instrument is the Oddi Continuous Learners Index (OCLI), which we in this article make an effort to validate cross-culturally through an analysis of responses from Danish students enrolled at Aalborg University. There are several reasons for returning to measures such as the OCLI, one being the relative ease with which we can now conduct the statistical analyses needed to discuss the validity of the scales in more detail. When Oddi developed the OCLI, conducting even single computations of the factor structure of the scale could take a considerable amount of time (Oddi, 1984). Conducting the same analyses today takes much less time, and it is thus easier to refine the scales by examining several different models. In addition, the developments in the field of scale validation have led to the invention of several new fit indices that enhance our knowledge surrounding the relationship between indicators in the measures (Brown, 2006).

Initially, we will present a review of the background for the development of the instrument and the previous efforts to validate it. After the review we will present our analysis of the instrument, in which we examine both instrument

reliability, construct validity, and possible interpretations of the results through confirmatory factor analysis.

2. Background

Several statistical instruments have been developed to try to assess SDL in people, but only two have gained notable success and prevalence. The Self-Directed Learning Readiness Scale (SDLRS) and the OCLI were found to make up more than 85% of all applications of statistical instruments to measure SDL in a recent meta-review. Guglielmino developed the SDLRS as a part of her doctoral dissertation to ascertain how ready individuals are for self-directed learning, based on several complementary skills, attributes, and attitudes (1977). In the years following the development of the SDLRS, a debate about whether SDL should be conceptualized as an instructional method or a personality characteristic emerged (Brockett & Hiemstra, 1991). The consequence of either understanding would mean that a measurement of an individual's propensity for SDL would either be through a role adopted during learning, encompassing certain skills and attributes, or as a state attained through psychological development (Brockett & Hiemstra, 1991; Brookfield, 1984; Oddi, 1987). The OCLI was developed by Lorys Oddi, partly as a reaction to this debate and criticisms of previous instruments, but primarily because of a difference of approach. Oddi argued that the current models overemphasized aspects such as self-management and the use of particular methods and approaches, so instead focused on cognitive and emotive elements such as developed attitudes and resultant behaviors. Oddi held the assumption that SDL should be conceptualized as a personality trait that determines certain behavioral tendencies characterized by initiative and persistence in learning over time, and developed the OCLI to identify what she called "self-directed continuing learners" (Oddi, 1986, 1987). When Oddi developed the scale, she initially conducted a literature review and deduced three underlying personality dimensions, all existing as continuums with one end conducive and the other non-conducive to SDL. The three dimensions— (1) proactive drive versus reactive drive, (2) cognitive openness versus defensiveness, and (3) commitment to learning versus apathy or aversion to learning—became the basis for 100 questionnaire items formulated by Oddi. Oddi gradually reviewed and reduced the number of items through content validation, expert reviews, evaluations of individual items, item-total score correlations, item-subscale score correlations, and a factor analysis, ending up with the final instrument consisting of 24 items (Oddi, 1984).

2.1. Factor validations

Several efforts to validate the OCLI have been undertaken since its original development; they inform our approach. These efforts can be divided into 1) factor validations, examining the factor interpretations of the instrument, and 2) construct validations, examining the extent to which the instrument correlates with other closely related measures, where associations are expected. Oddi conducted an explorative factor analysis upon finishing the OCLI, which revealed a three-factor structure, differing from her suggested theoretical dimensions. Oddi interpreted these factors as: "a general factor relating to

several other elements of self-directed continuing learning, such as the ability to work independently and learning through involvement with others," "ability to be self-regulating," and "avidity for reading" (Oddi, 1986, p. 103). Building on the work of Oddi, Jack E. Six showed that the factor structure found by Oddi was replicated across another sample. He compared two sets of derived factors from different samples to analyze to which degree they correlated and found that the factor structures co-varied on individual factors from .93 to .99 level, thus successfully demonstrating the replicability of the OCLI across samples (Six, 1989). The stability of the factor structure has also been tested in a different cultural context and was largely replicated in a German sample. The analysis showed that the OCLI performed slightly worse on a German sample, attaining a lower reliability, and the factor structure identified by the authors had about two thirds of the items loading on factor structures similar to those of Six and Oddi, where the most notable difference was that several items related to social aspects of SDL were moved from factor 1 to factor 3 (Straka, 1996). The appropriateness of a three-factor structure was brought into question by Harvey et al. who found that a four-factor structure constituted the best fit when testing the instrument through an explorative and subsequent confirmatory factor analysis. The structure identified by Harvey et al. has the notable advantage that the explained variance and number of items are spread almost evenly across the four factors, thus simplifying interpretation (Harvey et al., 2006).

While much of the factor structure is stable across the different analyses, they all build on the exploratory work of Oddi and largely replicate her procedures. To be able to, in the most appropriate manner, accommodate testing several three- and four-factor structures as well as the other mentioned issues, we have chosen to apply a confirmatory approach in an exploratory fashion in our analysis, which allows us to test all the identified factor structures and continue working on the one with the best fit. Using confirmatory factor analysis in an exploratory fashion is recommended in a case like ours when no single compelling model can be suggested (Long, 1983). If none of the previously identified structures meet the chosen thresholds of the applied measurements, "scale purification" will be conducted. This procedure removes items from the instrument based on their lack of sufficient correlation with the rest of the items until a satisfactory factor structure is attained (Wieland et al., 2018). A similar approach has been applied on a different cultural sample in Korea in the most recently published analysis of the factor structure of the OCLI; it resulted in a three-factor model including 15 items, reaching common thresholds for a number of fit indices (Han & Lee, 2009).

2.2. Construct validations

Oddi also tested the construct validity of the OCLI by arguing that SDL should, based on theoretical assumptions, correlate positively with the internal locus of control as measured by the Internal-External Scale, participation in educational activities measured by the Leisure Activity Survey, and four subscales of the Adjective Checklist (ACL) purporting to measure more complex aspects of personality.* Further, it should not correlate in either direction with IQ measured

* For a more thorough examination of the instruments see Oddi (1984, pp 141–166).

by the Shipley Institute of Living Scale. By distributing these instruments alongside the OCLI, she analyzed whether her assumptions held true, largely attaining support for the construct validity of the OCLI. Boyer et al., in a newer meta-analytical review that analyzes the research on SDL and related constructs, identified studies suggesting that generally, SDL as a theoretical construct correlates with internal loci of control, motivation, support, self-efficacy, and increased performance, and found that the OCLI, in particular, correlates with measures of self-efficacy, support, and increased performance (2014). The authors also notably concluded that the connection between SDL and motivation is still unclear, and more research is needed (Boyer et al., 2014). This concluding remark is echoed by Oddi's conclusions about the OCLI's construct validity, in which she suggests that it should be distributed along another measure of motivation for further study, and by Guglielmino, who holds the same reservations about the SDLRS (Guglielmino, 1977; Oddi, 1984). For these reasons, and to be able to assess whether the translated OCLI behaves as expected – e.g., correlates positively with motivation – a measure of motivation was included in our data collection. We distributed the Academic Motivation Scale (AMS) as a measure of motivation and GSE as a measure of self-efficacy alongside the OCLI. The AMS has been used extensively and has proven to be a reliable and valid instrument for measuring student motivation in a similar cultural context (Støen Utvær & Haugan, 2016; Vallerand et al., 1992, 1993). Because of the aforementioned positive correlation between the OCLI and self-efficacy, the General Self-Efficacy Scale (GSE) was selected to help assess the construct validity of the translated OCLI (Schwarzer & Jerusalem, 1995).

This article aims to present the results of a validation of a Danish translation of the OCLI. This is part of an attempt to revitalize quantitative measures in adult education research by testing the instrument developed in the 1980s and its stability on a present-day sample. Our validation encompasses common model fit measures, assessing a potential factor analysis, a construct validation, and the instrument's correlation with other instruments measuring theoretical constructs known to correlate with SDL or the untranslated OCLI.

3. Method

The data used for this study was collected at Aalborg University, which teaches based on a problem-based learning (PBL) curriculum focusing on work in project groups since its establishment in 1974. PBL can be considered one form of self-directed learning (SDL) as it emphasizes the responsibility of the students for taking the learning experiences into their own hands as well as highlighting the importance of acquiring the ability to learn throughout their lives even after leaving university and joining the labor market. As part of continuing the improvement of the pedagogical model of the university, a project was enacted that focused on examining how PBL might be adapted to better suit the needs of future students and of those employing the university's alumni.

For the pilot study that we report on in this paper, 159 students (77 students from construction engineering and 82 students from sociology) participated. They were third- and first-year students, respectively, implying that the pilot was conducted among a group of students with working knowledge of the

university's expectations of self-directed learning as well as a group who were still new to this form of learning experience. Although the OCLI score was slightly lower for the first-year sociology students, this difference was not statistically significant.

3.1. Measurement instruments

As mentioned above, Oddi as well as others have argued that in order to examine the construct validity of OCLI, it would be necessary to include other measures theoretically hypothesized as closely associated with self-directed learning in order to validate the appropriateness of the measurement instrument in a cultural setting other than the one in which it was developed (Boyer et al., 2014; Guglielmino, 1977; Oddi, 1984). For this reason, we have included the college version of the Academic Motivation Scale (AMS-C 28) and the General Self-Efficacy Scale (GSE) in our examination (Schwarzer & Jerusalem, 1995; Vallerand et al., 1992).

The OCLI was initially translated to Danish by both authors individually, and where discrepancies were still present, external assistance was brought in for comments. After a final translation was negotiated between the authors, the OCLI was sent with the original version for comments to an external academic with expertise in survey methodology who regularly publishes in both English and Danish scientific journals. Incorporating the external comments finalized the translation.

3.2. Statistical analyses

The responses to the three instruments were collected using the electronic questionnaire system, SurveyXact. Data were then transferred to STATA16, where the analyses were carried out (Statacorp, 2019). Total scores and standard deviations on the three instruments as well as the reliability of the scales (Cronbach's alpha coefficient) were calculated. After this, we started fitting the OCLI following the models suggested by Oddi (1984), Harvey et al. (2006), Six (1989), and Straka (1996). As part of this procedure, we used confirmatory factor analysis to provide several fit indices that indicated the degree to which the theoretical measurement model specified by us was appropriate for describing the data that we had collected among the students. We used four fit indices to evaluate the models and to make decisions as to which model best fit our data: a standard chi-square test was used to assess the models but due to the rigor in this type of test we supplied the analyses with the root mean square error of approximation (RMSEA) including confidence intervals, the standardized root mean residual (SRMR), and the comparative fit index (CFI) (Brown, 2006; Jackson et al., 2009). RMSEA is a so-called badness-of-fit index where a low value indicates a less bad fit of the scale, indicating a good fit of the data to the proposed model, while CFI is a goodness-of-fit incremental fit index which assesses relative improvements in fit by comparing a suggested model with a given baseline model (Kline, 2016; Shi et al., 2019). SRMR is a another badness-of-fit statistic, a standardized version of a root mean square residual and based on the general dissimilarity between observed and predicted correlations (Kline, 2016). SRMR is often applied alongside the CFI to mitigate issues of sensitivity inherent in either index (Hu & Bentler, 1999). Taken together, these four fit

indices made it possible for us to evaluate the best version of the OCLI in our Danish context. Because of the cross-cultural translation, we drew most heavily on the work of Straka because the translation to a German context came closest to the situation in which we were using the OCLI. However, as suggested by Wielandt et al., it was necessary to conduct "scale purification" in a vein similar to Han and Lee, removing entire items from the scale instead of fitting numerous extra covariance terms between the items performing poorest (Han & Lee, 2009; Wieland et al., 2018). Finally, in order to examine the construct validity of the OCLI, we computed correlations between the total OCLI score and the AMS and GSE.

4. Results

4.1. Validation of the scale

Table 1 contains the results of the descriptive analysis of the OCLI and the two other measures included in our pilot. As can be seen from the table, the reliability of the OCLI was rather low, with a total coefficient of 0.68 in the overall sample but with as low a score as 0.59 among the construction engineer students. The average item-total correlation was 0.38—close to the mean reported by Harvey (2006). However, the individual correlations ranged from as low as -0.02 (item 21) to 0.56 (item 1). The coefficient alpha was clearly higher for the two other constructs (0.86 and 0.83, respectively), indicating that the OCLI's relatively low alpha score was not due to a general problem with the participants in the study but more likely related to the translation to a Danish context.

Table 1: Descriptive statistics of OCLI, AMS and GSE

	All (n=159)		**Sociology (n =82)**		**Construction eng. (n=77)**	
	Mean (Std)	**Chronbachs α**	**Mean (Std)**	**Chronbachs α**	**Mean (Std)**	**Chronbachs α**
OCLI-total	110.7 (12.5)	0.68	109.8 (13.6)	0.73	111.8 (11.1)	0.59
AMS	142.3 (20.2)	0.86	143.0 (21.3)	0.88	141.6 (19.1)	0.84
GSE	30.2 (4.3)	0.83	29.3 (4.0)	0.81	31.2 (4.4)	0.84

Table 2 reports on the factor scores from the confirmatory factor analysis that produced the best fit. The main difference between the three-factor model presented by Straka and our model was that we excluded many items due to low correlations and general bad fits (1996). This meant that items 3, 8, 9, 11, 15, 19, 21, and 23 were removed from our final model, whereas this was only the case for items 19 and 21 in Straka's three-factor model. This was the case in most of the versions of the OCLI, the reverse-coded items loaded on the same factor, which in our case was factor 2. When comparing the correlations between the individual items and the latent variable, we found similarities in our model to that of Straka. We interpret this as evidence that exclusion of the problematic items from the scale makes it possible to fit a version of the scale that produces reliable results.

Table 2: Factor structure of OCLI.

	Straka – 3 factor model			Clausen – 3 factor model		
OCLI-items	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 1**	**Factor 2**	**Factor 3**
1	.6387498			.6292107		
2	.3008753			.2682278		
3			.4231888			
4			.4500869			.438638
5	.4557258			.4627243		
6			.3631328			.4113728
7			.2719541			.3069611
8	.2900065					
9	.2742458					
10			.476421			.4378024
11	.4513803					
12 (R)		.4317774			.4315807	
13			.2656626			.3307074
14			.3210174			.4032973
15	.093144					
16	.213702			.2863036		
17 (R)		.6868287			.6765717	
18	.5377946			.6177122		
19						
20 (R)		.748563			.7632641	
21 (R)						
22	.3530351			.4454629		
23			.1936029			
24 (R)		.342474			.3290299	

NOTE: R = reverse coded. Standardized scores reported.

In Table 3 we show the procedure carried out for choosing the final model that was fitted to the data. As can be seen from the fit indices, only after removing the above-mentioned items does the fit of the model become acceptable; i.e., the chi-square statistic becomes insignificant (p = 0.22), the RMSEA falls below 0.05 (0.026), the SRMR is lower than 0.08 (0.061), and the CFI climbs above 0.95 (0.955). In the discussion, we speculate the reasons for the model to fit only after having excluded these items from the scale.

Table 3: Confirmatory Factor Analysis – Comparison of model fits

	Chi2	**Df**	**P-value**	**RMSEA (95% CI)**	**SRMR**	**CFI**
Oddi's 3-factor model	324.32	206	<0.01	0.060 (0.05-0.07)	0.084	0.708
Harvey's 4-factor model	396.39	252	< 0.01	0.060 (0.05-0.07)	0.108	0.662
Six' 3-factor model	253.54	149	< 0.01	0.066 (0.05-0.08)	0.087	0.715

Straka's 3-factor model	316.49	206	<0.01	0.058 (0.05-0.07)	0.083	0.713
Clausen 3-factor model	111.69	101	0.22	0.026 (0.00-0.05)	0.061	0.955

Finally, in Table 4 we find the correlations between OCLI and the two other constructs included in the pilot study, namely AMS-C 28 and GSE. Both of the measures correlate with OCLI in the expected direction; i.e., higher levels of self-directed learning (as measured by the OCLI) is associated with higher levels of general self-efficacy (0.57) and with higher levels of academic motivation (0.31).

Table 4: Correlations between OCLI, AMS and GSE.

	OCLI	**AMS**	**GSE**
OCLI	1.00		
AMS	0.31	1.00	
GSE	0.57	0.19	1.00

4.2. Factor interpretation

Evaluating the quality of a factor structure is a quantitative endeavor that must still account for a qualitative evaluation of the structure. The three-factor structure identified by our analysis includes 16 of 24 items from the instrument. Further, to allow readers to make their own interpretation of the meaning of the factors, we will present the items included here. The structure is adapted through confirmatory factor analysis from Straka's study, chosen because it provided the best model fit of the previously suggested structures. As such, we will highlight the differences in both by displaying the items included in his structure and excluded in ours, in *italic*, under each factor.

Factor 1:

1: I successfully complete tasks I undertake.

2: My work is beneficial to society.

5: My values and beliefs help me to meet daily challenges.

16: When I do a job well, it's because I have been prepared and have put in personal effort.

18: Once I start to work on a task, I keep working until it's done to my satisfaction.

22: I work more effectively if I have freedom to regulate myself.

8: I am able to resist the efforts of others to pressure me into doing something I don't want to do.

9: I regularly read professional journals.

11: I volunteer for new assignments.

15: I resist judging others (such as new managers or teachers) until I've had an opportunity to associate with them.

We interpret this factor as an expression of the respondents' "internal locus of control." Items 1, 16, and 18 are direct expressions of whether or not a person believes that when they make an effort, they succeed. Items 5 and 22 gauge the respondents' beliefs in their own internal directions, be it through the ability to self-regulate or through their values and beliefs. Item 2 is closely related to both the previous notions, but items 5 and 22 are internal expressions that predate any impact the respondent has on society, and items 1, 16, and 22 express a belief in the respondents' ability to work with the medium by which they impact society and their work. However, item 2 requires the respondent to evaluate the impact of said work.

Straka interpreted this factor as "self-awareness of one's autonomy and self-efficacy in conjunction with reading behavior" (1996). We reason that self-awareness is not the most appropriate interpretation of self-reported measures because it stipulates that respondents can adequately gauge their own autonomy, something we have no way of knowing. We take it as a matter of fact that what we measure are respondents' perceptions, and thus reason that the locus of control, the belief in whether or not one's own actions are impactful in terms of whether or not one achieves success, is a more appropriate interpretation.

Factor 2:
12: I'm not comfortable with my performance on an assignment until my supervisor, teacher, or colleague says it's acceptable.

17: I find it difficult to judge if I've performed well or poorly on a task such as giving a speech, writing a paper, or answering a test question.

20: When in school, I tend to have difficulty in estimating whether or not the teacher is going to like my work.

24: Being afraid to take a chance has prevented me from doing something I have wanted to do at some time in my life.

We interpret the second factor in our analysis as "the ability to be self-regulating." The factor is almost identical to a factor in the factor structures identified by Oddi, Six, Straka, and Harvey et al., and our interpretation is thus similar. All the mentioned analyses include a factor made up of these items—Oddi's without item 24 and Harvey's including item 21. Mutual for all of these factors is that they are made up exclusively of reverse-coded items and include any and all of these in the factor structure, a fact we will remark upon further in the discussion (Harvey et al., 2006; Oddi, 1984; Six, 1989; Straka, 1996).

Factor 3:
4: I make an effort to learn the meaning of new words I encounter.

6: I seek the views of others when I am curious about something.

7: I have a hobby (such as writing, painting, or making things) that provides me with a means of self-expression.

10: I select serious literature (such as history, biographies, or "the classics") for my reading pleasure.

13: I have been an eager reader since childhood.

14: After I read a book or see a play or a film/series, I talk to others to see what they think about it.

3: I seek involvement with others in school or work projects.

23: I make an effort to meet new people.

We interpret this factor as an "avidity for learning." The factor is similar to Straka's third factor, which he interprets as "Reading avidity" and the "social dimension of self-directed learning." The exclusion of two items with no relation to reading has reduced the complexity of the interpretation. In our factor structure the two items that are theoretically most closely linked to the social dimensions – item 3, "I seek involvement with others in school or work projects," and item 23, "I make an effort to meet new people," – are, however, removed from factor three. The title "reading avidity" is largely borrowed from Oddi's original validation, in which she called her third factor the "avidity for reading" (Oddi, 1984, p. 169). We would contest that the factor should be reinterpreted, because it also includes items that relate to inclinations toward learning activities other than reading.

5. Discussion

Applying a confirmatory factor analysis, we identified a three-factor structure including 16 items as the best model fit on the data, reaching the commonly applied threshold for the chosen measures. We interpret these factors as "internal locus of control," "the ability to be self-regulating," and "avidity for learning." Our analysis of the construct validity of the OCLI shows positive correlations between the instrument and self-efficacy as measured by the GSE and academic motivation, as measured by the AMS. Both correlations and their directionality were as expected; they enforce the impression that the translation has not made the OCLI behave radically differently and also speak to its construct validity.

The close resemblance of our final factor structure to Straka's makes sense, given that the cultural backgrounds of the samples, German and Danish university students, were expected to hold close resemblances. The factor structure we suggest has a drawback in that it includes only 16, rather than 19, 22, or 24, items out of a total 24, as in previously suggested structures. It has the advantage of

living up to thresholds of commonly applied measures of model fit and of mitigating some of the difficulties of interpretation that both Oddi, Six, and Straka have highlighted. While Oddi's and Six's validations of the instrument were statistically sound, there was one major issue with the interpretation, namely the size of the first factor, which included almost two thirds of the items in the instrument, making it difficult to interpret in any meaningful way—a fact that Oddi herself remarked upon in her conclusions (Oddi, 1984). Straka's factor structure went some way toward solving the issue, reducing the number of items in factor 1 by 5, largely because items concerning social aspects related to SDL migrated to factor 3. Our analysis further reduces the number of items in factor 1, which now appears to be theoretically very unidimensional.

Our analysis focuses heavily on statistical measures and heuristics as indicators of quality, but another aspect of validation of statistical instruments is whether their interpretation bears any relation to theoretical meaning. Wieland et al. argue that theoretical criteria must complement the empirical when assessing the quality of a scale:

, and to this end a noteworthy aspect of our study is that a confirmatory factor analytical effort to provide the best model of fit on the data also produced an factor structure that's easier to interpret theoretically (Clausen, 2021; Wieland et al., 2018).

While it naturally becomes increasingly easier to attain a theoretically interpretable factor structure the fewer items you include, our results are an indication that the OCLI does in fact measure stable underlying constructs and also speaks to the merits of applying a similar methodology to validate comparable statistical instruments. While a similar approach was once applied to a validation of the OCLI, the results were not altogether similar. The application of the OCLI in a South Korean context resulted in a three-factor 15-item structure with eight items loading on factors similar to the ones presented in our analysis (Han & Lee, 2009).

The factor structure identified in this article could be used to gain further insights into students' self-directed learning, although researchers in adult education applying the OCLI should be wary not to overinterpret the results, given the modest degree of explained variance and internal consistency. These scores might, however, be mitigated by further addressing two potential issues with the instrument.

An issue replicated in all the factor analysis is the pattern of the reverse-coded items. There are five reverse-coded items in the OCLI, and all the factor analysis, including ours, identified one factor made up of only reverse-coded items, including all reverse coded items in the factor structure. This begs the question as to whether or not this is an artifact of respondent questionnaire-answering behavior or an actual analytical result (Weijters & Baumgartner, 2012).

Another issue that could be analyzed further is whether some of the items that are excluded in our factor structure may have aged poorly for various reasons and therefore may in the past have loaded significantly on underlying factors of

SDL, but have now become poor indicators. If the instrument was revised today, items like "I read an average of one or more national news magazines each week" and "I regularly read professional journals" might be examples of this. The general decline of news magazines, the increased exposure to international rather than national news outlets, and the rise of the internet as the main purveyor of news and disseminated research, such as professional journals, might make these poorer indicators of the types of behaviors and attitudes that they purport to measure. Another example is item 21: "I find it useful to think about people (or refer to them) according to categories (such as by education, occupation, or ethnic background)." It might be argued that the political and cultural climate of present-day western Europe and USA is such that referring to individuals according to their ethnic background, for example, would be considered wholly problematic. Relevant for the answers received on the questionnaire, answering such an item in a certain way might be perceived as highly inappropriate, making social desirability play a larger factor in answering the question.

The usefulness of the OCLI might be considered limited given its relatively low amount of explained variance and internal consistency. This is however a discussion and evaluation with many valid arguments in favor of or against the OCLI, especially given the complex nature of self-directed learning and the therefore tempered expectations one should have for the statistical properties of any instrument attempting to measure it or its underlying dimensions. The OCLI is the result of careful refinement and diligent work, but given the evolving context between the period in which it was developed, the early 1980s, and the early 2020s, subsequent refinement and revalidation could serve to improve it. As with any statistical instrument, it can be applied to gain insights into a given phenomenon as long as its statistical properties are kept in mind, appropriate qualifications are taken, and overinterpretation is avoided. These statistical properties are of great importance if quantitative studies are to increase in prominence in adult educational research.

6. Conclusion

Our confirmatory factor analysis found that none of the previously identified factor structures could meet the commonly suggested thresholds of the measurements included, whereas a new structure, identified through confirmatory factor analysis used in an exploratory fashion, could. Our structure reduces the number of items included, and factor 1 appears far more theoretically unidimensional than in previous structures. A positive point of emphasis of our results is that while our approach takes its point of departure in a rigorous application of statistics so as to attain a satisfactory model fit, it has also identified a more easily interpretable structure. Our results also show that the OCLI applied in a Danish context still performs as expected when distributed alongside other statistical instruments measuring related concepts, supporting the notion that it measures stable underlying constructs. Our results support the notion that the OCLI can be used to gain insights into students' attitudes and behaviors towards SDL, but also that conclusions drawn on the basis of the results should be tempered by the modest degree of explained

variance and internal consistency. We suggest that addressing the issue of the pattern of the reverse-coded items and updating the formulations of items that have aged poorly would improve the OCLI.

An important motivation for our analysis besides analyzing the OCLI was to gauge firstly whether the application of contemporarily common thresholds for evaluation of scale quality could help enhance statistical instruments developed before computation, and secondly if statistical advancements make these procedures easily available. To this end, we have shown that older instruments can be refined and purified by this type of analysis and approach and that such instruments can still play a role in understanding today's students.

7. References

Boeren, E. (2018). The Methodological Underdog: A Review of Quantitative Research in the Key Adult Education Journals. *Adult Education Quarterly*, *68*(1), 63–79. https://doi.org/10.1177/0741713617739347

Boyer, S. L., Edmondson, D. R., Artis, A. B., & Fleming, D. (2014). Self-Directed Learning: A Tool for Lifelong Learning. *Journal of Marketing Education*, *36*(1), 20–32. https://doi.org/10.1177/0273475313494010

Brockett, R. G., & Hiemstra, R. (1991). *Self-direction in adult learning: Perspectives on theory, research, and practice*. Routledge. https://eric.ed.gov/?id=ED359423

Brookfield, S. (1984). Self-Directed Adult Learning: A Critical Paradigm. *Adult Education Quarterly*, *35*(2), 59–71. https://doi.org/10.1177/0001848184035002001

Brown, T. A. (2006). *Confirmatory factor analysis for applied research*. Guilford Press.

Clair, R. S. (2011). Writing ourselves into being: A review of the Canadian Journal for the Study of Adult Education/La Revue Canadianne pour l'Étude de l'Éducation des adultes. *Canadian Journal for the Study of Adult Education*, *23*(2), 27–44.

Clausen, N. R. (2021). Progression of Self-Directed Learning in PBL: Comparing Consecutive Semesters at AAU. *Journal of Problem Based Learning in Higher Education*, *9*(1), 24–41.

Daley, B. J., Martin, L. G., & Roessger, K. M. (2018). A Call for Methodological Plurality: Reconsidering Research Approaches in Adult Education. *Adult Education Quarterly*, *68*(2), 157–169. https://doi.org/10.1177/0741713618760560

Fejes, A., & Nylander, E. (2015). *How pluralistic is the research field on adult education? : Dominating bibliometrical trends, 2005-2012*. https://doi.org/10.3384/RELA.2000-7426.RELA9063

Guglielmino, L. M. (1977). *Development of the self-directed learning readiness scale* [Doctoral dissertation]. University of Georgia. https://search-proquest-com.zorac.aub.aau.dk/docview/302856217?pq-origsite=primo

Han, J.-Y., & Lee, M.-Y. (2009). A Study on Validation of OCLI for Evaluating of Life-Long Learning Ability. *Journal of Engineering Education Research*, *12*(4), 75–83. https://doi.org/10.18108/jeer.2009.12.4.75

Harvey, B. J., Rothman, A. I., & Frecker, R. C. (2006). A confirmatory factor analysis of the Oddi Continuing Learning Inventory (OCLI). *Adult Education Quarterly*, *56*(3), 188–200. https://doi.org/10.1177/0741713605286167

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Jackson, D. L., Gillaspy Jr., J. A., & Purc-Stephenson, R. (2009). Reporting practices in confirmatory factor analysis: An overview and some recommendations. *Psychological Methods*, *14*(1), 6–23. https://doi.org/10.1037/a0014694

Kline, R. B. (2016). *Principles and practice of structural equation modeling*. http://site.ebrary.com/id/11096679

Leary, H., Walker, A., Lefler, M., & Kuo, Y.-C. (2019). Self-Directed Learning in Problem-Based Learning: A literature review. In M. Moallem, W. Hung, & N. Dabbagh (Eds.), *The Wiley Handbook of Problem-Based Learning* (pp. 181–198). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781119173243.ch8

Long, J. S. (1983). *Confirmatory Factor Analysis*. Sage Publications.

Oddi, L. F. (1984). *Development of an instrument to measure self-directed continuing learning* [Northern Illinois University]. https://search-proquest-com.zorac.aub.aau.dk/docview/303318103/abstract/2CF04F6547564F81PQ/1?accountid=8144

Oddi, L. F. (1986). Development and validation of an instrument to identify self-directed continuing learners. *Adult Education Quarterly*, *36*(2), 97–107. https://doi.org/10.1177/0001848186036002004

Oddi, L. F. (1987). Perspectives On Self-Directed Learning. *Adult Education Quarterly*, *38*(1), 21–31. https://doi.org/10.1177/0001848187038001003

Robson, C., & McCartan, K. (Eds.). (2016). *Real world research: A resource for users of social research methods in applied settings.* (4th ed.). John Wiley & Sons, Inc.

Saks, K., & Leijen, Ä. (2014). Distinguishing Self-directed and Self-regulated Learning and Measuring them in the E-learning Context. *Procedia - Social and Behavioral Sciences*, *112*, 190–198. https://doi.org/10.1016/J.SBSPRO.2014.01.1155

Schwarzer, R., & Jerusalem, M. (1995). Generalized Self-Efficacy scale. In *J. Weinman, S. Wright, & M. Johnston, Measures in health psychology: A user's portfolio.* NFER-NELSON.

Shi, D., Lee, T., & Maydeu-Olivares, A. (2019). Understanding the Model Size Effect on SEM Fit Indices. *Educational and Psychological Measurement*, *79*(2), 310–334. https://doi.org/10.1177/0013164418783530

Six, J. E. (1989). The Generality of the Underlying Dimensions of the ODDI Continuing Learning Inventory. *Adult Education Quarterly*, *40*(1), 43–51. https://doi.org/10.1177/074171368904000105

Statacorp. (2019). *Stata Statistical Software: Release 16* (Release 16) [Computer software]. StataCorp LLC.

Støen Utvær, B. K., & Haugan, G. (2016). The Academic Motivation Scale: Dimensionality, Reliability, and Construct Validity Among Vocational Students. *Nordic Journal of Vocational Education and Training*, *6*(2), 17–45. https://doi.org/10.3384/njvet.2242-458X.166217

Straka, G. A. (1996). Construct validation of the Oddi Continuing Learning Inventory. In *Current developments in Self-Directed Learning.* (pp. 65–80). Classic Book Distributors.

Taylor, E. W. (2001). Adult Education Quarterly from 1989 to 1999: A Content Analysis of All Submissions. *Adult Education Quarterly*, *51*(4), 322. https://doi.org/10.1177/074171301220873322

Vallerand, R. J., Pelletier, L. G., Blais, M. R., Briere, N. M., Senecal, C., & Vallieres, E. F. (1992). The academic motivation scale: A measure of intrinsic, extrinsic, and

amotivation in education. *Educational and Psychological Measurement*, *52*(4), 1003–1017. https://doi.org/10.1177/0013164492052004025

Vallerand, R. J., Pelletier, L. G., Blais, M. R., Briere, N. M., Senecal, C., & Vallieres, E. F. (1993). On the Assessment of Intrinsic, Extrinsic, and Amotivation in Education: Evidence on the Concurrent and Construct Validity of the Academic Motivation Scale. *Educational and Psychological Measurement*, *53*(1), 159–172. https://doi.org/10.1177/0013164493053001018

Weijters, B., & Baumgartner, H. (2012). Misresponse to Reversed and Negated Items in Surveys: A Review. *Journal of Marketing Research (JMR)*, *49*(5), 737–747. https://doi.org/10.1509/jmr.11.0368

Wieland, A., Kock, F., & Josiassen, A. (2018). Scale purification: State-of-the-art review and guidelines. *International Journal of Contemporary Hospitality Management*, *30*(11), 3346–3362. http://dx.doi.org.zorac.aub.aau.dk/10.1108/IJCHM-11-2017-0740

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