The Psychometric Properties of Effectiveness Scale in Distance-Digital

Deyab A. Almaleki

Department of Evaluation, Measurement and Research, Umm Al-Qura University, Makkah, Saudi Arabia

Abstract
This study intended to test the structure of the latent factor of an effectiveness scale and the stability of invariance across groups of students' classifications (gender and levels of education). In the large, non-clinical sample (850), students completed the effectiveness scale. The (CFA) confirmatory factor analysis was used to investigate the factor-structure of the measure, and multiple-group confirmatory factor analysis (MGCFA) model was used to test the stability of invariance across groups of students' classifications. The findings of the CFA indicated support for the original four-factor model. Additional analyses of the MGCFA method support the measurement (configural, metric and strong) invariant and practical invariant components of this model. There was an invariant across gender. There was partially invariant across groups of levels of education. The scale exists in groups of levels of education assess the same concepts of, excluding Items 15 and 10. Given that this study is the first investigation for the structure of the effectiveness scale.

Key words:
Digital Scale; Effectiveness; Factor Analysis; Factorial Invariance

1. Introduction

The Corona pandemic has resulted in the evaluation process being done electronically and remotely, through the application of methods and evaluation tools by digital devices and the Internet to evaluate students with learning difficulties, and to know the extent of their progress and their achievement of the objectives of the educational process. This requires careful observation of the point from which the teacher starts the evaluation of each student with learning difficulties according to the available capabilities, and through short daily individual sessions, in addition to the breadth of the evaluation process and not being limited to the level of academic achievement but rather in raising the level of communication and community interaction skills. So, Distance Evaluation process may be faced with many obstacles, and from this standpoint, the current study seeks to find out what is the effectiveness of applying tools and methods of distance evaluation for students with learning difficulties from the teachers' point of view [1]–[7].

Education is the basis for building the future generation, and to raise the level of our students, we need to advance the educational process in the way we aspire to and strive to achieve our goals, especially students with learning difficulties. Their benefit in the classroom differs from the regular students as they do not benefit enough and this may be due to several reasons, including the inappropriate teaching strategies, curriculum and methods used with their abilities and capabilities, and this faces us with a real problem [8]–[11].

The group of those with learning difficulties is one of the groups that need intensification of the learning process through training, practice, and the use of various evaluation tools, as it requires a lot of effort and time for both the teacher and the student to know the progress and the extent to which the desired goals are achieved [1], [12].

The importance of studying the group of students with academic learning difficulties is that they face problems in employing appropriate strategies to solve various educational problems. They may employ primitive and weak strategies to solve arithmetic problems and comprehend them, as well as in speaking or written expression [13], [14]. A large part of these difficulties is due to the lack of organization processes which enables a person to gain many experiences, so he needs to carry out the process of organizing these experiences in a successful way [15]. They also face language problems where they do not understand the voice messages addressed to them, or vice versa, as they may not be able to send accurate voice messages to others [5], [16].

Given the importance of using technology to improve the learning process for students with learning difficulties, Neroni et al. [10] noted that using technology improves skills and build literacy abilities. Clark [17] also indicated that the use of technology increases the effectiveness of learning, reduces effort and burden for students with learning difficulties, and improves their motivation.

Although teachers were keen in direct learning before the Corona pandemic to use computers and technology in the learning and explanation process and to emphasize their importance, as the study of Reynolds et al. [18] showed that female teachers use technology at a higher rate than average, but there are difficulties in controlling the behavior of students with difficulties learning as well as the presence of several obstacles, the most prominent of which is the difference in students' abilities and their strengths and weaknesses [5], [19]. As a result of the Corona pandemic, the teaching and learning process has moved from school to

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home and has shifted from direct interaction between teacher and learner to indirect and distance electronic interaction [20], [21]. Therefore, the evaluation process and the use of appropriate tools for distance education must be suitable for the characteristics of students with learning difficulties [8], [22], [23].

The advantages of using modern technologies and computers in the learning process for this group are effective, but there are challenges facing students with special needs in higher education both electronically and remotely, as the study of Churiyah et al. [24] mentioned, the lack of awareness of lecturers of the characteristics of this class. While the study of L'Ecuyer [25] focused on identifying the obstacles facing higher education students with special needs, and the appropriateness of the tools provided in the distance learning environments that they use. The study mentioned the need of this group for an appropriate environment for distance learning, including the availability of technologies including devices and also the need for access to recorded lessons and explanations and the ability to download them for easy reference without the need for internet connection [1]–[3], [26]–[36].

2. Theoretical Consideration

Several studies have mentioned below some assessment tools and methods in the field of learning difficulties and the mechanism of their application .

- Written, oral and practical tests are used to measure the student's performance in the field of targeted information.
- Different types of observation methods, write-off lists, and behavior evaluation are used to measure the student's performance in skills and behaviors required according to his needs.
- Employing various types of tests to ensure the student's performance level, progress, or stability, according to the required follow-up and evaluation methods.
- The application of tools and methods of the evaluation process for students with special educational needs is distinguished by its uniqueness, according to the nature of the needs of each group.
- The student with special educational needs is given sufficient time that is suitable with his abilities and his writing or reading abilities during the educational evaluation process.
- The evaluation process can be done individually or collectively for students with special educational needs according to their needs and characteristics.
- The evaluation process for students with special educational needs can be done according to the method of continuous evaluation, each according to his abilities and capabilities
- If it is not possible to use the tools and methods specified in this organization, the teacher can evaluate his students in the way he deems appropriate for their characteristics and needs and distribute the evaluation scores according to that if this is done in coordination with the school administration.
- In the case of the multiplicity and diversity of the student's needs, appropriate evaluation methods should be considered in accordance with the evaluation materials for each category (the organizational rules for special education institutes and programs)

Evaluation methods vary and include tests and tools such as written and oral exams, presentations, samples of students' writing, portfolios, homework, projects and products, and notes. Teachers should be skilled in selecting appropriate methods for educational decisions [42].

The study of Stonard [40] and García-Alberti et al. [22] indicated that there are two objectives for evaluating students with special needs, namely evaluation in order to facilitate the learning process and knowing the strengths and weaknesses of students with special needs, and evaluation to measure learning outcomes, as the teacher should diversify the tools of Evaluation so that he can make appropriate and accurate decisions about the learning process of students with special needs and their mastery of the learning process, by answering the question: What am I trying to evaluate, for what purpose, and what is the most appropriate method, which include various standard-reference tests, spoken-reference tests, self-evaluation, and peer evaluation.

3. Methods

The methodology used in this study was a single group pretest (survey) only design. The scale instrument as described below was administered via an online survey administration. The application following Human Subject Institutional Review Board (HSIRB) and the study protocol was approved.

3.1 Research procedure

The study was conducted at one state university. The sample was selected using the convenience sampling technique, with UQU chosen to represent a sample of Saudi universities. Participants were randomly selected and contacted from UQU's e-mail list and directed to a survey-hosting site (Survey Monkey). The site was open for five weeks during the fall semester 2019. A total of 850 participants responded. There were no major deviations from histogram, however, in scatterplot there were 27 cases extreme values larger or lower than most of cases, so might these values have influence points, but after conducted analysis of Leverage, Jackknife, to see that influence. I found that 27 cases greater than cut off for the leverage method (0.0195) and the standardized residuals greater than -3. and deemed multivariate outliers then were removed from analysis leaving 850 cases.

3.2 Measures

Participants completed a standardized measure that has been extensively used in earlier studies and has shown adequate psychometric properties. Demographic questionnaire. To obtain the participants ' background characteristics, a brief demographic questionnaire was used. Items in this survey asked for sex, marital status, and current study degree. Effectiveness. A short (4-item) effectiveness measure developed by Almaleki et al. [32] was used in this study. The responses scale format was recorded on a 7-point Likert scale. The authors reported internal consistency reliability estimates of $\alpha = 0.890$ indicating this measure is applicable in research settings.

Table 1. Measuring the effectiveness of applying distance evaluation tools and methods for students with learning difficulties from the teachers' point of view

The first axis: The method of evaluation based on achievement portfolios
1. I explain to students the way the achievement portfolios are made
2. I use the achievement portfolios to assess the extent to which students have achieved the course objectives
3. I help students in organizing the achievement portfolio
4. I support students when viewing achievement portfolios
5. I use the pre-made observation cards when evaluating students
6. I allow students time to rest while performing the skill
The second axis: The method of evaluation based on the provision of sufficient time
7. I make sure to divide the test for students with learning difficulties in short periods
8. I strive to know the factors that may affect the students' response to learning difficulties (illness - family circumstances ... etc.)
9. I encourage students to improve skills in the virtual classroom
10. I can analyse observations about students' performance on the task at hand.
11. I make sure to allow enough time to complete the skill required of students
The third axis: The method of performance-based evaluation
12. The distance learning process facilitates the display of students' activities
13. Students repeat the skill mastered continuously
14. The distance learning process develops students' skills of language communication and expression
15. I use various evaluation tools to measure the skill required
The fourth axis: The method of evaluation based on knowledge and tests
16. I use technical means in addition to My School platform to test students
17. It is easy for me to provide immediate feedback to students with distance learning difficulties

3.3 Factor structure

The factor structure of the effectiveness scale was tested using confirmatory factor analysis (CFA) in SAS (version 9.4). Chi-square value and overall model fit indices were used to answer the first research question. Table 2 illustrates the procedure for the testing model structure and suggestions threshold values.

Table 2. Procedure for Testing Model structure

Test Name	Symbols	Statistics Guidelines
Chi-square value	χ^2	
Tucker-Lewis index	TLI	TLI $\geq$ 0.96 good fit
Comparative fit index	CFI	CFI > 0.95 good fit
Root mean square error of approximation	RMSEA	RMSEA: 0.00 - 0.05 very good fit RMSEA: 0.05 - 0.08 fair fit RMSEA: 0.08 - 0.10 mediocre fit

3.4 Invariance

The present study used (MGCFA) *multiple-group confirmatory factor analysis* model to exam invariance of the effectiveness scale across students' classifications (gender and status). Table II illustrates the order for testing measurement invariance starting with configural invariance (model 0). Model testing was evaluated by the chi-square difference test ($\Delta\chi^2$) between two groups, and RSMA, CFI, and TLI were used to evaluate all of the model fits. As previously referenced, the following criteria values suggested were used in this study: RMSEA: 0.00 - 0.05 very decent fit, CFI > 0.95 decent fit, and TLI $\geq$ 0.96 decent fit. Three levels of MIV were tested.

Table 3. Procedure for Testing Stability Among Models

M		Test Name	H_0	Symbol	$\Delta\chi^2$ Test	Test Statistics Guide
M 0	Measurement Invariance (MIV)	Configural invariance	$H_0: \lambda^1_{\text{group}} = \lambda^2_{\text{group}} = \cdots = \lambda^g_{\text{group}}$	λ : The number of factor patterns across g^{th} groups		If $\Delta\chi^2$ NS, model shows configural factorial invariance in place
M 1		Weak measurement invariance	$H_0: \lambda_j^{\text{group1}} = \lambda_j^{\text{group2}} = \cdots = \lambda_j^{\text{groupg}}$	$\lambda_j^{\text{group1}}$: The factor loading of j^{th} indicator variable in the group	$\Delta\chi^2{}_{M1-M0}$	If $\Delta\chi^2$ NS, model shows weak factorial invariance in place
M 2		Strong measurement invariance	$H_0: \tau_j^{\text{group1}} = \tau_j^{group2} = \cdots = \tau_j^{groupg}$	τ : The indicator variables intercept (means) of j^{th} indicator variable in the group	$\Delta\chi^2{}_{M2-M1}$	If $\Delta\chi^2$ NS, model shows strong factorial invariance in place

4. Results

The CFA mode related the construct, effectiveness scale was tested, and the model as labeled in Table 4. The model was examined for each level of gender, students' and status separately at a baseline model (four factor model) and pooled data at each of the measurement invariance levels and structural mean invariance.

Table 4. Standardized factor loadings of the effectiveness symptoms scale pooled over all data

Items	Single-factor model	Single factor loading model
In the past month, on how many days did you have any of these feelings:		
1	I use technical means in addition to My School platform to test students	0.8236
2	It is easy for me to provide instant feedback to students with distance learning difficulties	0.8006
3	I make sure to split the test for students into short periods	0.7817
4	I strive to know the external factors that may affect the students' response process (illness - family circumstances, etc.).	0.6123
5	The distance learning process facilitates the display of students' activities	0.7267
6	Students repeat the skill mastered continuously	0.7543
7	The distance learning process develops among students the skill of language communication and expression	0.8990
8	I use various evaluation tools to measure the skill required	0.6781
9	I encourage students to improve skills in the virtual classroom	0.7678
10	I explain to students how the achievement portfolios are made	0.5967
11	I use achievement portfolios to evaluate students' achievement of course goals	0.9800
12	I help students in organizing the achievement portfolio	0.8723
13	I enhance students when viewing achievement portfolios	0.7665
14	I use pre-made note cards when evaluating students	0.9345
15	I can analyze observations about students' performance on the task at hand.	0.4341
16	I make sure to allow sufficient time to complete the skill required of students	0.9001
17	I give students time to rest while performing the skill	0.8771

The four-factor model of the effectiveness scale was investigated in the pooled data. It shows a very good fit in the present sample: $\chi 2$= 16.11, p-value= 0.3076, RMSEA= 0.02, CFI=0.98, and GFI=0.98. These findings show that the four factor-model fits the present set of data. Cronbach's alpha coefficient for this model was > 0.87.

As Tables 5 and 6 indicates four factor model was investigated in the CFA analyses: initial (four factor model for each subsample, e.g., male, female, and both groups together), and it shows a very good fit across all subsamples. We may infer that based on these findings; there is configural-invariance of the CFA model over the students' groups (gender and students' status).

After configural invariance was established across all subsamples, parameter invariance was supported at the metric level across all subsamples, and the different in chi-square was intended to test if the model resulted in statistical significance. As can be seen in Tables 5 and 6 the difference in chi-square value between M1 and M0 was not statistically significant. In addition, the change of less than .001 in the CFI, TLI, and RMSEA suggests at the metric invariance level the factor loadings were invariant across gender and students' status.

When metric invariance was established across all subsamples, the differentiation of chi-square among Model 2 and Model 1 across gender groups was not statistically significant, $\Delta\chi 2$= 5.670, p= 0. 2210, which indicates that there was invariant of the intercepts across sex groups.

Table 5. Examination for factorial-invariance (measurement and structural) across gender groups

Model	$\chi 2$ p-value	RMSA CFI TLI GFI	Model $\Delta\chi 2$ p-value
Group1 Male	1.769 0.7694	0.00 1.00 1.00 0.98	-- -- -- --
Group2 Female	4.234 0.3215	0.05 0.99 0.99 0.99	-- -- -- --
M0	5.786 0.8912	0.05 0.98 0.98 0.98	M0 -- -- --
M1	7.651 0.5471	0.02 0.98 0.98 0.98	M1-M0 1.5 0.8015
M2	13.321 0.4513	0.02 0.98 0.98 0.98	M2-M1 5.670 0.2210

Moreover, the chi-square difference between Model 2 and Model 1 in students' status groups was statistically significant, $\Delta\chi 2 = 26.210$, $p < .0001$, which shows that the intercepts are not completely invariant over the level of education groups. Following the recommendation to release one element at a time, beginning with the maximum MI, M2 is updated by releasing Item 15 intercept. M2B is the corresponding updated model (see Table 6). The value of chi-square dropped to 16,654 after releasing the intercept for element 15, and the change in chi-square for both M2B and M1 was still statistically significant, $\Delta\chi 2 = 5.308$, $p = 0.0270$. Therefore, there are invariant factor loadings and invariant intercepts throughout the students' status groups after freeing the intercept for Item 15. After continuing by freeing the next greatest MI, Model 2B is updated by removing the intercept restrictions from items 15 and 10. Model 2C is the corresponding updated model (see Table 6). The value of chi-square dropped to 12.760 after releasing the intercept for element 15 and 10, and the change in chi-square for both M2C and M1 was still statistically significant, $\Delta\chi 2 = 1.141$, $p = 0.2433$. Therefore, there are invariant factor loadings and invariant intercepts throughout the two groups except for four factors being intercepted (Item 15&10).

Table 6. Examination for factorial-invariance (measurement and structural) across levels of education groups

Model	χ^2 *p*-value	RMSA CFI TLI GFI	Model $\Delta\chi^2$ *p*-value
Group1 Single	3.563 0.3421	0.03 0.98 0.99 0.98	-- -- -- --
Group2 Married	0.678 0.4356	0.00 1.00 1.00 0.98	-- -- -- --
M0	3.456 0.5453	0.00 1.00 1.00 0.98	M0 -- -- --
M1	11.346 0.4512	0.03 0.99 0.99 0.98	M1-M0 7.890 0.0634
M2	37.556 <. 0001	0.09 0.96 0.96 0.99	M2-M1 26.210 <. 0001
M2B Item15	16.654 0.0241	0.07 0.98 0.99 0.99	M2B-M1 5.308 0.0270
M2C Items 15 & 10	12.760 0.2410	0.04 0.98 0.98 0.98	M2C-M1 1.414 0.2433

5. Conclusion

The current study was the first to test the factor structure of effectiveness scale. Second, the study investigated whether the factor structure of the effectiveness scale was invariant across students' classifications.

Based on the current findings, the four-factor model fit the data best. Such findings are more consistent with earlier research by Lyubomirsky and Lepper [43]. The four-factor model of the effectiveness scale was supported for gender and level of education. Thus, a total 17-items score can be computed and meaningfully interpreted as a unitary construct. The values of standardized factor-loadings for each element were highly positive, and statistically significant, varying from 0.596 to 0.980. The reported Cronbach's alpha coefficient for this model was > 0.87 and was generally higher than those reported by Almalek i[32] ($\alpha = 0.76$).

This study provided the first evidence for an effectiveness scale using the MGCFA technique. The scale model appeared as invariant throughout the variables of gender and level of education. The results indicated that in both groups the effectiveness scale may evaluate the same structures of the constructs and that the groups perhaps both have the same point of reference for effectiveness indications.

Achievement of metric-invariance suggested that the factor-loading for each element was equal over gender and level of education. These results showed that irrespective of classification groups samples respond similarly. Furthermore, the intercepts of every element on the latent factors appear that male and female groups are comparable concerning the findings of the scalar invariance examination. Moreover, there is some evidence of slight variability across level of education groups with respect to Items 15 and 10. This result shows that participants all have the very same reference point with respect to anxiety levels.

In conclusion, the effectiveness scale for the present sample of students was invariant across gender. The scale exists in both groups to assess the same concepts of (male and female). Moreover, there was partially invariant across groups of levels of education. The scale exists in both groups to assess the same concepts of, excluding for Item 15 and 10. Simulating these results will still be needed for future studies the results also evaluate high stages of factorial-invariance of effectiveness questionnaire through other populations focusing on other variables such as language, and race.

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Deyab A. Almaleki is an Associate Professor in the Department of Evaluation, Measurement and Research. Dr. Almaleki received his Ph.D. from Western Michigan University (USA) in 2016 in Evaluation, Measurement and Research. Since 2011, Dr. Almaleki has authored and co-authored in more than 20 peer-reviewed journal articles, and over 30 peer-reviewed presentations at professional conferences. Dr. Almaleki has extensive experience in educational and psychological research, research design, applied statistics, structural equation modeling, design, and analysis of psychological measurement.