The Difference of Invariance, Reliability of The Student Engagement Scale (ESE) In Distance-Learning During Covid-19 Pandemic in Light of Some Students' Characteristics

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Abstract

This study aimed to test the factor structure of the measure of student participation in distance education. The study population consisted of all teachers in public education and faculty members in higher education in the Kingdom of Saudi Arabia by applying it to a sample of bachelor's and graduate students at the college of Education at umm al-Qura University. The (ESE) was applied to a random sample representing the study population consisting of (216) respondents. The results of the study showed that the scale consists of three main factors, with showed a high degree of construct validity through fit indices of the confirmatory factor analysis. The results have shown a gradual consistency of the measure's invariance that reaches the high level of the Measurement Invariance across the gender and study groups variables.

Keywords:
Factor Structure, Student Engagement Scale, E-learning, Distance Learning, Covid-19.

1. Introduction

The sudden invasion of the world by the Covid-19 virus has led to a temporary halt to education systems, with schools, universities and other learning spaces closed as one of the largest gathering places through which the virus can spread, and in order to ensure continuity of education by governments that have sought to provide educational platforms that provide distance education to students at home, and with this rapid shift in education, ministries of education, partners, experts and researchers in education must ensure that Achieving its goals and objectives[1]–[4]. In view of the efforts made to ascertain the quality of distance education during the Covid-19 pandemic, distance education is not the result of the educational process, but is present and used in many training and educational institutions, where universities hold courses and programmed through distance education, for example, some Saudi universities have replaced the distance education enrolment programmed, distance education is used to learn languages through specialized centers, and to conduct tests. International such as IELTS and TOEFL, In Saudi Arabia, the national center for assessment applies all its tests remotely instead of paper tests[5]–[7].

Therefore, there is already a good experience of distance learning that has proven to be useful in several educational programs and tests, not to mention distance learning through online applications such as YouTube. etc.

However, classroom attendance education is the approved basic education, supported by distance education in certain ranges or spaces, and with the emergence and outbreak of COVID-19, which is spreading at a tremendous speed with clusters, including attendance classes, the need for distance education has become necessary. Distance education has been limitedly used, becoming an alternative to in-class attendance education, and those involved in the educational process and students have had to keep pace with this. Change and interact with it, where the educational process differed from what they are accustomed to, and became the educational process and associated curricula and tools through distance education, which are undoubtedly different from in-class attendance education, which made educational institutions prepare platforms that contribute to the progress of the educational process and prevent its interruption, including my school platform in general education, and blackboard in university education[8]–[11].

In the light of the above, it should be ascertained how effective distance education is and the participation of students and stakeholders, the difference between it and attendance education, its success, knowledge of the pros and cons and improvement of the educational process through distance education[4], [12]–[16].

There is considerable debate about the effectiveness of the distance education program compared to attendance education, and the lack of research on distance education, as well as the lack of information on the evaluation of these programs, adds to the debate about the effectiveness of distance education[4], [17]–[21].

In this sense, the current study problem can be identified by answering the following key question: Does the stability of the disparity in the measure of student participation in distance education differ during the Corona pandemic? The main question is defined by the following

sub-questions:
- What is the nature of the factor structure of the measure of student participation in distance education?
- Does the scale's evidence vary by gender?

This study provides a new entry point in measuring invariance by using confirmatory factor analysis of multiple groups, helping researchers to apply it to other models and metrics.

This study provides an objective measure in determining the extent to which the variance in its working structure is consistent and identifying the working components using the statistical method used to analyze multiple confirmatory factors, which can be a means of helping those who wish to use the same statistical method on similar research.

2. Theoretical Consideration

2.1 The concept of distance learning and the reality of student interactions through it

Distance learning environments are being adopted and integrated with face-to-face education by an increasing number of educational institutions to provide flexibility for students. Although blended synchronous learning environments have been around since the early 2000s, there has been little research done on student experiences in these environments, specifically regarding teacher-student and student-student interactions. Scientific reports indicated that six million students were taking at least one distance learning course as of 2015, which is 30% of all students. About 42% of students enrolled in a distance education course take distance education courses exclusively. The proportion of students taking online courses has increased by 11% over the past three years, while overall enrollment rates have declined. Significant increases in online education enrollment are not isolated to certain types of institutions as twenty-eight percent of undergraduate students are distance learners in public institutions, 23% in private non-profit institutions, and 57% in the for-profit private sector[15], [16], [22]–[25].

In March 2020, colleges and universities around the world moved to online distance learning in response to the changes imposed by the coronavirus pandemic. As a result, the students who joined the full-time study mode, regardless the gender and educational levels, were transferred to distance learning via the Internet, and many of them had the distance learning experience as their first experience. There have been many views on its effectiveness and how this compulsory exposure to online learning will affect students' attitudes towards distance education and their interaction with it and the differential of performance according to the variables of sex and academic level. As some claim that switching to the e-learning system will speed up the adoption of online education, while others believe that it may hinder their acceptance of it[26]–[29].

2.2 Importance of Distance Education

The importance of distance education stems from the reality of the requirements that are achieved, including meeting the increasing demand from the segments of society for education, the population increase and the associated increase in the number of learners and the desire to multiply their forms of study. The importance of distance education also lies in the necessity of compatibility with the tremendous development and continuous change in knowledge technology and new technologies, and the pursuit of new discoveries in educational technology as well as the need to follow the professional movement in society from the development and retraining of employees. Because of the increased spending on education, which requires a new type of education that costs less than traditional education, and this is what distance education achieves. Perhaps it is also important to communicate with the community, in the sense of activating community service in the field of training and education and contributing to eradicating illiteracy and educating adults and girls in the Arab world[30]–[43].

2.3 Measurement Invariance

There are four types of equivalence of measurement invariance:

1. **Configural Invariance**: This test answers the question; Does the test measure the same hypothetical composition (same underlying structure)? It is considered the simplest level where the groups have the same factor structure, which is the same number of latent factors to which the same number of items are related. The availability of this level is not sufficient as a guide to the measurement invariance for the test across groups, since the two groups have the same conception of the construct. Also, the lack of this level of invariance indicates a difference in the meaning of the construct.

2. Weak invariance test: This test answers the question: Is the strength of the relationship between items and factors equivalent? In order to ensure that there is the same latent structure, we restrict the saturations of items to be equal across groups, which means that individuals' responses to items are the same way because the strength of the relationship between items and underlying factors is the same across groups. The availability of this level gives us weak evidence of measurement invariance for the test.

3. Strong Invariance Test: In addition to restricting the factor saturations, we restrict Intercept, which is the degree of the item when the degree of the factor is zero. Availability of this level of

invariance means that individuals with the same degree of factor zero provide this level of invariance on the same degree observed regardless of their belonging to a particular group. The lack of this level of invariance means that the difference in the observed scores of individuals is not due to the different levels of their latent trait, but rather because they belong to a certain group due to the influence of external factors that are not related to the hypothetical construct.

4. **Strict Invariance** test: This test answers the question Is there the same level of measurement error on every item across groups?

3. Methodology

Based on the main objective that the study seeks to identify, which is to know the extent of the participation and interaction of the students of Umm Al-Qura University during the distance education process, as well as to validate the structure of the factor structure of the scale of student participation in distance education, the descriptive survey approach is the most appropriate for such a study.

3.1 Population and Sample

The population of the current study consists of all students of Umm Al-Qura University for the academic year 2021. There was an estimated (216) student body of Umm Al-Qura University for the current academic year 2021, Sample labeled in Table 1 and 2 according to gender and level of study.

Table 1. Sample according to gender

Description	Sample	Percentage
Male students	136	%62.9
Female Students	80	%37.1
Total	216	%100

Table 2. Sample according to the study level

Study Level	Sample	Percentage
Graduate	114	%52.8
Undergraduate	102	%47.2
Total	216	%100

3.2 Measure

Designing a tool to measure student engagement in traditional education is not easy, and the matter becomes more complicated when designing a tool to measure student engagement through in distance education. So, this study used a tool designed by Young and Bruce [44], which consists of three factors with a total of 23 items, and each factor contains some items as shown in the Table 3.

Table 1. Scale items based on factors

Factor 1 Student- Teacher Interaction	Factor 2 Students-Students Interaction	Factor 3 students- content Interaction
I can call the teacher when I need him	I commit to working with my colleagues to help each other learn	I learn systematically.
The teacher responds to my questions when I ask him.	I cooperate with my colleagues regarding courses.	I make a lot of effort in the virtual room
I trust the teacher's ability to handle inappropriate situations	I help my classmates when they need so.	I finish and do the required reading.
The teacher presents the scientific material well and in an organized manner.	I communicate personally with my colleagues.	Complete the required reading
The teacher presents the course requirements consistently	I feel fun when I interact with my colleagues in the virtual room	I visit the distance education website regularly
The courses instructions are clear to me.	I share my personal interests with others.	I will get good marks in the courses
The teacher is responsive and active during the discussion sessions in the virtual hall	Actively participate in the discussion seminars in the virtual hall.	I am fully prepared to learn everything related to the scientific content.
Feel alone in the virtual hall.	Initiate inquiries and ask questions in discussion groups	

Young and Bruce [44] conducted a study before using this tool in their study, and the internal invariance of each factor was 0.87, 0.90 and 0.80, respectively.

Students' engagements are measured based on three types of interactions. The first factor is the role of the teacher in building society, followed by 8 items that show the extent of interaction between students and the teacher. The second factor is the role of classmates in building society, followed by 8 items as well, which are useful in measuring the extent of interaction between the students themselves. The third factor is the interaction with distance learning, and it followed by 7 items and is useful in measuring the interaction between the student and the content.

4. Results

To answer the study questions, confirmatory factor analysis (CFA) and multigroup confirmatory factor analysis (MGCFA) were used. The first question: What is the nature of the Factorial structure of the scale of student participation in distance education?

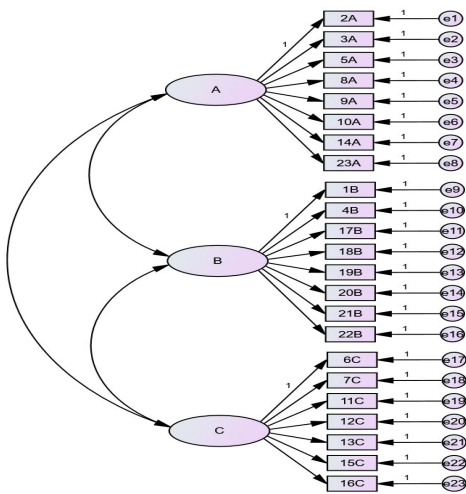Assumed factorial model for measuring tool as shown in figure 1.

Fig. 1. factorial model for measuring

To verify the suitability of the default model for the data, a confirmatory factor analysis (CFA) was used, the results of which are shown in Table 4.

Table 4. Suitability of the model structure

Fit Indexes'	Test value
Chi-squar,x2	926.110
Df	227
x^2/df	4.080
P(sig)	0.000
CFI	0.759
RMSEA	0.120
TLI	0.732
GFI	0.714

It is noted in Table 4 there is a statistical significance for the value of x^2 as well as the rest of the indexes weren't fit. To verify the fit of the model, (7) items (1, 4, 6, 7, 12, 21, 23) were deleted due to a significant decrease in the correlation coefficients.
Figure 2 shows the modified factor structure model after items deleted.
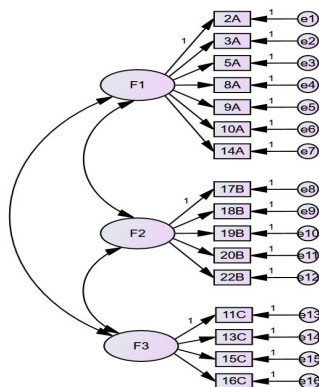

Fig. 2. Modified Factorial model
To verify the fitness of the modified model for the data, a confirmatory factor analysis (CFA) was used, the results of which are shown in Table 5.

Table 5. Suitability of the modified model structure

Fit Indexes'	Test value
Chi-squar,x2	149.175
Df	101
x^2/df	1.476
P(sig)	0.000
CFI	0.967
RMSEA	0.064
TLI	0.950
GFI	0.925

It is noted in Table (5) that we relied on the values of goodness of fit indexes and comparison, and from the indexes, the Root Mean Square Error of Approximation (RMSEA), whose value was (0.064), which indicates a good fit. The goodness fit index (GFI) was adopted, and its value (0.923) indicates excellent fit. The Comparative Fit Index (CFI) was adopted, and its value was 0.967, which indicates excellent fit. Also, the TLI index, whose value was (0.95), indicates an excellent fit. The chi-square indicator was statistically significant, but because it is affected by the sample size and the goodness fit of the rest of the indexes, we do not depend much on its result.

The second question: Does the structure of the scale differ according to some demographic variables?
To ensure that the scale achieves equivalence of measurement between the two groups, there is no variation in the scale (Invariance of the scale), the multi-group confirmatory factor analysis (MGCFA) method was used. In order to validate the suitability of the factorial structure, statistical indexes of the quality of fit were used, such as the Comparative Fit index (CFI), the root mean square error approximation (RMSEA) and some of the other indicators. All of them gave acceptable results and are close to the proposed criteria. To assess measure equivalence, formal equivalence was checked, and the three factors were restricted to be equal, to assess the equivalence of these factors across groups. Metric invariance was validated by restricting the saturations of the factors to be equal, assuming the saturations remain constant. We allowed each parameter to be freely estimated to detect a difference in saturations across groups. Scalar Invariance was also verified by requiring the values of intercepts for the items be equal (to be equivalent/ equal) across the sample. Therefore, it is assumed that the examinees, who have the same score on the scale, have equal values on the item which is a baseline for the trait measure.
The model was evaluated by fit index (CFI > 0.90), index (TLI > 0.90), index (GFI > 0.90), and index (RMSEA ≤ 0.08).

It is clear from Table (6) the goodness fit index that the CFI index was higher than the value (0.90) and the RMSEA index was less than (0.08), which means that the formal heterogeneity was achieved. It becomes clear that the difference was not statistically significant between the metric model M1 and the structural model M0, which means that the metric invariance was achieved. Consequently, the metric invariance was validated, where the indicators show the fit of the model and its invariance from the formal model, which means that metric equivalence is achieved and matched. This shows the matching indexes, where the CFI index was equal to (0.96), (as it represents a good value) which is a good value, and the RMSEA value was equal to (0.052), a value less than (0.08), which gives an indication that the model fit the formal model. The scale did not achieve the strong invariance, (as the table illustrates the Scalar model gives significant statistical results and differences) as it is clear from the table that the Scalar model gives statistically significant results and differences, so the P-value was equal to (0.00), which means that there are differences between the metric and strong models, and this indicates that Scalar does not achieve the invariance of the scale. Thus, (it could be stated that) it can be said that the scale of the effectiveness of students' participation achieves equivalence of weak measurement according to the gender variable and does not achieve equivalence of strong measurement.

It is clear from Table (7) the goodness fit index that the CFI index was higher than the value (0.90) and the RMSEA index was less than (0.08), which means that the Configural was achieved. Where it becomes clear that the difference was not statistically (remarkable, considerable) significant between the metric model M1 and the structural model M0, which means that the metric invariance was achieved. Consequently, the metric invariance was validated, where the indicators show the fit of the model and its invariance from the formal model, which means that metric equivalence is achieved and matched. This shows the matching indexes, where the CFI index was equal to (0.96), which is a good value, and the RMSEA value was equal to (0.052), a value less than (0.08), which gives an indication that the model fit the formal model. The scale did not achieve the strong invariance, as it is clear from the table that the Scalar model gives statistically significant results and differences, so the P-value was equal to (0.00), which means that there are differences between the metric and strong models, and this indicates that Scalar does not achieve the invariance of the scale. Thus, it can be said that the scale of the effectiveness of student participation achieves equivalence of weak measurement according to the study level variable and does not achieve equivalence of strong measurement.

Table 6. Examination for factorial-invariance (measurement and structural) across gender groups

Model	χ^2	RMSEA	GFI	RMR	TLI	CFI	Model Comparison	$\Delta\chi^2$	**ΔCFI
Male CFA	145.179	0.079	0.89	0.049	0.93	0.95			
Female CFA	103.716	0.063	0.88	0.069	0.96	0.97			
Configural	248.957	0.052	0.88	0.060	0.94	0.95	M0		
Weak Invariance (Invariance (metric (p-value=.085)	311.421	0.052	0.88	0.060	0.93	0.96	M1-M0	62.464	0.01
Strong Invariance scalar (p-value=.00)	347.252								

Table 7. Examination for factorial-invariance (measurement and structural) across level of study groups

Model	χ^2	RMSEA	GFI	RMR	TLI	CFI	Model Comparison	$\Delta\chi^2$	**ΔCFI

Model	χ²							Δχ²	p
Male CFA	119.566	0.074	0.90	0.032	0.93	0.96			
Female CFA	102.731	0.062	0.90	0.062	0.95	0.97			
Configural	222.295	0.048	0.90	0.049	0.94	0.96	M0		
Weak Invariance (metric Invariance) (p-value=.088)	238.72	0.052	0.90	0.049	0.94	0.96	M1-M0	16.425	0.003
Strong Invariance scalar (p-value=.00)	275.507								

5. Conclusion

Verifying the factorial structure of the scale is important in the field of measurement and evaluation in order to determine the validity of the results obtained from that scale. The scale was shown a gradual consistency of the measure's invariance that reaches the high level of the Measurement Invariance across the gender and study groups variables and that consistent with Young and Bruce [44]. Researchers recommend conducting studies on other scales and measures to ascertain their factor structure. They also recommend using the confirmatory factor analysis method on similar scales at the level of different age stages and conducting tests to ensure the factorial structure of the student participation scale in the event of the return of in-person education. Finally, conducting tests to validate the extent to which the structure of the scales fit its theoretical structure (is a need), after confirming the psychometric properties of the scales.

6. Significant

The process of measuring student participation in distance education and its impact on the educational process is still not receiving the attention of researchers, in addition to the difficulty of evaluation and the weakness of its culture in Arab societies, including Saudi society. Therefore, this study may contribute to bridging the gap in this context, by providing a standardized measurement scale that can be used in measuring student participation in distance education at different levels in the Kingdom regarding the distance education system This helps those in charge of the educational process to know the difficulties and problems that teachers and students face in distance education, which helps them solve them in the future. It also helps in preparing and qualifying teachers and students in line with the needs of the Saudi society and in line with distance education in a way that achieves a good student engagement in distance learning.

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