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The psychometric efficiency of students' attitudes scale towards online-learning in light of IRT

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Abstract

This study aimed to construct a scale to investigate students' attitudes towards online learning in light of Item Response Theory (IRT). An analytical descriptive approach was adopted. A scale consisting of 33 items was developed, and after ensuring its validity and reliability, it was transformed into an electronic version via Google Drive. Social media websites were used to distribute the survey to the targeted population. The selected sample comprised 596 students from Jordanian universities during the academic year 2023/2024. After administering the scale to the main sample, exploratory factor analysis was conducted, revealing that a single trait underlies the performance on this scale, indicating the assumption of one-dimensionality. The scree plot supported this finding. Both content and construct validity were confirmed. The reliability coefficient, measured by Cronbach's Alpha, was 0.853, which is considered suitable for the study sample. Additionally, the standard measurement error was calculated at 0.005, indicating an appropriate reliability indicator. Reliability within the framework of IRT was also high, reaching 0.842. The results from Exametrika V55 software showed good fit indices for the scale items to the Graded Response Model (GRM), except for one item, which was omitted from the scale.

Keywords: Exametrika, Graded response model, Item response theory, Online learning, Psychometric efficacy, Student attitudes.

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Contribution of this paper to the literature

This study contributes to the existing literature by providing empirical evidence of the psychometric efficacy of the research instrument. Its primary scientific contribution lies in offering a measure of students' attitudes toward online learning that researchers can utilize. Furthermore, this study presents rigorous and systematic standardization procedures that enhance the validity and objectivity of measurement in online learning research.

1. Introduction

The education requirements and needs have changed along with the significant growth in technology over the past few decades, which has eventually impacted teaching approaches. To prepare future generations for creativity, excellence, and competition in a range of scientific subjects, the Jordanian government is committed to creating an exceptional educational system that aligns with emerging global educational needs. Also emphasized is the fact that prosperity cannot exist without education. As a result, it is imperative and unavoidable that education be continued at all times. Rapid technological advancements in recent decades have accelerated the shift to new educational models, such as blended learning and online learning (Gonzalez & St. Louis, 2018).

Social media platforms, learning management systems, and other technological applications can be utilized to give institutions the ability to engage with students in two ways: by providing instructions and methods to assist their learning (Adnan & Anwar, 2020; Kaur, 2020). Some students are unable to attend classes in traditional classrooms for various reasons, which is why online learning has become so important. Distance learning, which allows for group contact through telephone audio and video conferences, is currently an opportunity for both educational and personal development (Ferrer, Ringer, Saville, Parris, & Kashi, 2022).

Since evaluating learning processes and measuring their results effectively is becoming increasingly important, there is a growing need for fair, accurate, and valid evaluations to gauge students' proficiency in various university courses. As higher education institutions embrace e-learning, it becomes necessary to evaluate students' learning in a way that provides a trustworthy electronic educational evaluation (Toquero, 2020).

Based on a concept that advocates for the liberation of education from constraints, distance learning has accepted numerous changes in educational programs, means, structures, and decisions. Additionally, it promotes a more comprehensive education for all students, regardless of age, and the idea of equal opportunity. With technology, distance learning has been given limitless boundaries in terms of time, location, material, testing, and attendance. People who are unable to access the traditional educational system because of their economic, geographic, social, or professional circumstances are thus given the opportunity to receive an education; the success of this depends on the university's preparedness, the faculty's willingness, and the degree to which they possess the competencies required for this (Masalimova et al., 2022).

In this context, Mailizar, Almanthari, Maulina, and Bruce (2020) indicated that the majority of institutions now incorporate "learning management systems" into their curricula, but in the wake of the epidemic, a wide range of electronic platforms have also been employed, such as Microsoft Teams, Zoom, and others. In this vein, Basilaia and Kvavadze (2020) pointed out that faculty members have numerous difficulties when instructing remote learning, including administrative and budgetary difficulties, professional difficulties, e-learning planning and evaluation, and more. One of the things that prevents distant learning from being fully and successfully implemented is a lack of knowledge about it. For example, some faculty members are reluctant to employ this method in the classroom. This is because they must put in more work and prepare more thoroughly in order to handle this system.

1.1. Attitudes

Rocklage and Fazio (2017) pointed out that attitudes are behavioral tendencies that an individual acquires through the experiences he goes through or the individuals he interacts with and believes to be role models for him. Attitudes have a prominent role in the behavior of the individual, so scientists are interested in constructing and measuring attitude scales.

Attitudes consist of three components. The first component is the cognitive component, which includes cognitive aspects, ideas, and beliefs about a particular topic. The cognitive component refers to the totality of information, knowledge, and judgments related to a particular topic and determines the individual's position on this topic. The second component is the emotional component, which is considered one of the most important components because it contains an emotional charge that affects the behavior of the individual in the situation in which he is acting. The third component is the behavioral component, which refers to the individual's intention or intent and the responses he will make towards the subject of the attitudes, whether by acceptance or reluctance to practice or to stop, such that the behavior of the individual can be predicted through intention or intent (Maio & Haddock, 2015; Stark, Flache, & Veenstra, 2013).

1.2. Item Response Theory (IRT)

Because IRT focuses on relating the respondent's reaction to a scale item with certain features and their aptitude to respond to that item, it is often referred to as the modern theory of measurement or the theory of latent traits. It also focuses on determining the position of the individual in relation to psychological and educational standards. It has been represented by a set of mathematical and statistical models that are used in analyzing items aiming to determine the relationship between an individual's performance in tests or measures and the traits or abilities he possesses, and then interpret or predict his subsequent performance. Each model or mathematical function is based on a set of assumptions for the relationship between the observed performance of the subject on the scale and latent traits (Hambleton, Swaminathan, & Rogers, 2006).

This theory is based on a set of assumptions, and a set of models emerges from it called the latent trait models. Each model is expressed with a mathematical function that determines the relationship between the individual's performance on the item of the scale and the ability that underlies and explains this performance (Zanon, Hutz, Yoo, & Hambleton, 2016).

1.3. Assumptions of IRT

The rapid development of IRT and its widespread use in several countries around the world, along with the large number of published studies about it and the models derived from it in specialized psychological and educational measurement journals, confirm the importance of this theory in the field of measuring educational and psychological traits. This theory is based on four main assumptions that must be fulfilled, as follows: (Alnasraween, Khazaleh, Abzakh, Shawareb, & Ajeely, 2023; Hambleton et al., 2006).

The one-dimensional assumption indicates that there is a single trait or ability that explains the performance of the subjects on the scale, meaning that all the items of the scale measure one dimension, i.e., the individual's answer can be interpreted as belonging to the ability that is measured by the items of the scale. To achieve this assumption, the presence of a dominant factor affecting performance on the scale is necessary, using factor analysis, where the examinees' responses are analyzed and the values of the latent roots and the proportions of the explained variance for each of the first and second factors are inferred (Steinberg & Thissen, 2013).

While the hypothetical local independence is equivalent to the one-dimensional assumption in theory that the examinee's response to one of the scale's items at any point on the trait continuum is not affected by the response to the rest of the items, the assumption of the item characteristic curve indicates the existence of a mathematical function that links the probability of a correct answer to the item with the ability of the examinee, which is measured by a group of items in the scale that was built for that purpose, and this curve takes the logistic shape and represents the shape of the letter S. While the assumption of speed in the answer indicates that the speed factor does not play a role in answering the scale items, the failure of individuals to answer the scale items is due to their low ability, not to the effect of the speed factor on their answers (Wetzel & Carstensen, 2015).

While the assumption of the item information function indicates the existence of a function that represents the relationship between two variables, namely the ability of the individual and the information provided through these items, and this function expresses the amount of information provided by the item at the level of ability that you measure, it is possible to determine the maximum height of the item information function curve at a certain level of ability by determining the maximum height of the item information function curve at a certain level of ability (Steinberg & Thissen, 2013).

1.4. Graded Response Model (GRM)

Models differ in terms of the mathematical formula used, and the nature of the data is a criterion for classifying item response models in terms of the nature or type of response (dichotomous and polytomous models). The current study focuses on the GRM, which is one of the multiple response models (Samejima, 2011).

These models are used in grading items with multiple responses or grades. Multiple response models provide more information about individuals' ability or attitude levels than can be obtained from binary responses (Wetzel & Carstensen, 2015).

The GRM was suggested by Samejima (1969), which is based on the 2-parameter model (2PL). The model represents the curved relationship between individuals' ability levels and the probability of their responses in each answer option; it is not required in this model that all items include the same number of categories.

Each item, according to this model, has one discrimination parameter (α_i) and a set of parameter thresholds, symbolized by the symbols β_1, β_2, $\beta 3$, and β_4. The number of these parameters is less than the number of response parts, which corresponds to the number of procedural characteristic curves for the options of this item. If the number of response options is five, such as a Likert scale, and the scores for these options are 1, 2, 3, 4, 5, then the number of operating characteristic curves for the item is equal to 4. Each of these curves has a discrimination coefficient and threshold parameters β_1, β_2, β_3, and β_4 (Sijtsma & Molenaar, 2002).

The GRM assumes that response categories are distributed across the continuum of the attribute and that there are an infinite number of response categories according to their gradation on the Likert scale, which are arranged according to the strength of their measurement of the attribute to be measured. For example, the five-step scale includes: strongly agree (score 5), agree (score 4), neutral (score 3), disagree (score 2), and strongly disagree (score 1). An individual who chooses "strongly agree" has a more positive attitude toward the trait to be measured than an individual who chooses "agree," and so on (Steinberg & Thissen, 2013).

1.5. Statement of Problem

Psychological and educational scales developed using the classic test theory of measurement suffer from a lack of objectivity and accuracy, given the importance of measuring students' attitudes towards online learning.

This research used the GRM as one of the IRT models because of its significant importance in developing scales with acceptable psychometric properties, which may allow for the comparison between different groups of individuals so that the ability of the individual to whom the test or scale is applied can be estimated and compared with other individuals' abilities.

Typically, implementing IRT-based methods can provide more detailed information about individual scale items, which is useful when determining the final item content. Eventually, the current study attempted to answer the following questions:

The first question: What are the validity indicators of the student attitudes scale towards online learning?

The second question: What are the reliability indicators of the student attitude scale towards online learning?

The third question: To what extent do the items of the students' attitudes scale towards online learning fit the Graded Response Model?

1.6. Significance of the Study

The importance of the current study stems from its topic, novelty, and seriousness, as it seeks to construct a scale with good psychometric properties using the GRM within the framework of IRT. This study may shed light on the use of GRM, as this model can help improve the quality of scales. Moreover, this study may introduce a scale with accepted psychometric characteristics that researchers can use in their future research.

2. Procedural Definitions

2.1. Online Learning

A form of learning that relies on the use of information and communication technology networks in teaching and learning. It is a set of ethical processes and practices designed to facilitate learning and improve performance. It relies on the integration of learning theory outcomes with information and communication technology tools and environments, and through the use of digital media, electronic articles, interactive tests, and educational forums, to create an integrated educational technology system that achieves flexible and collaborative learning (Alarifi & Song, 2024).

2.2. Graded Response Model (GRM)

A model that can be applied to multi-category items with a specific logistic response form, where responses fall on multi-category items arranged in a logical order. In this model, two parameters are assumed: the discrimination parameter and the difficulty parameter. Moreover, this model can be used in the evaluation of students' performance on tests or attitude scales (Keller, 2014; Linden & Hambleton, 1997).

2.3. Review of Related Work

Alkursheh (2024) conducted a study to investigate the factorial structure of a scale designed to evaluate university students' attitudes toward hybrid learning. A total of 889 male and female university students in Saudi Arabia participated in the study. The findings showed that the scale had noteworthy psychometric features, as evidenced by high reliability coefficients and strong validity indicators.

Koç, Garıp, Kerkez, and Abbak (2024) carried out a study aiming to develop a scale of distance learning attitudes among higher education students. The study participants included 875 university students from Turkish public universities. The results of the factor analysis revealed two factors containing 16 items that explained 56.9% of the total variance. Ultimately, the study produced a scale with good psychometric properties.

Demirel (2022) conducted a study to develop a valid and reliable scale of student attitudes toward online education. The scale was applied to 341 students in Turkey. The CFA and EFA were calculated. Six factors were identified. The corresponding Cronbach's alpha values for the factors were 0.84, 0.71, 0.85, 0.78, 0.79, and 0.77. The scale, which represents the sum of the elements, had a total Cronbach's alpha value of 0.93.

Auné, Abal, and Attorresi (2019) conducted a study using GRM to analyze the empathic behavior scale. The sample consisted of Argentine university students. The study findings showed that the threshold parameters tended to be located at low levels of the trait, whereas discrimination parameters were high. The analysis of the information function showed acceptable precision in low and middle empathic behavior levels.

Depaoli, Tiemensma, and Felt (2018) carried out a study using the multidimensional GRM, a quality-of-life survey for Cushing's syndrome, which highlights the main components for implementing the multidimensional GRM. Patients with Cushing's syndrome $n = 397$ completed the study instrument. Results from the multidimensional GRM supported a 2-subscale scoring process for the survey, showing that all items were deemed worthy contributors to the survey.

Almomani, Alnasraween, and Almosa (2020) conducted a study to investigate students' attitudes towards distance learning at Amman Arab University. There were 731 students in the study sample. A scale with forty-five items was constructed. The scree plot supported the study's findings, which indicated that there was only one dominant trait in the students' performance on this scale.

Yavuzalp and Bahcivan (2020) carried out a study aimed at using a scale of Online Learning Self-Efficacy to determine university students' self-efficacy perceptions in Turkey. The scale was administered to 2,087 college students to assess its construct validity. The study findings demonstrated that the scale possesses acceptable psychometric properties.

3. Methods

3.1. Study Methodology

An analytical descriptive approach has been used for its suitability for the purposes of this study.

3.2. Study Population

The Jordan University students in all faculties make up the study population; according to the Ministry of Higher Education's website, the number of enrolled students in online learning reached 474,618 during the academic year 2023–2024.

3.3. Study Participants

There were 596 male and female students in the study's sample. They were reached by converting the study scale to an electronic version via Google Drive, and then it was distributed through social media websites to students. Table 1 displays the study sample.

Table 1. The study sample, according to the faculty, included gender variables.

Variables	Scientific	Humanitarian
Faculty	240	356
Total	596	
Variable	Female	Male
Gender	345	251
Total	596	

3.4. Study Instruments

The researchers used quantitative approaches in gathering and analyzing the required data. In this study, a scale was specifically designed to assess the various attitudes of students. The distance learning assessment scale

was developed by referring to theoretical literature and previous studies, such as Isik, Karakis, and Güler (2010). The initial version of the scale consisted of 33 items. A five-point Likert scale was employed, with the following coding: strongly agree=5, agree=4, neutral=3, disagree=2, strongly disagree=1.

3.5. Validity and Reliability of the Online- Learning Scale

To ensure the validity of the study scale the following indicators were used:

First: content validity:

Presenting the scale to a panel of arbitrators in the areas of English language, measurement and evaluation, curriculum, and instructional strategies allowed for the validity to be confirmed. Nine arbitrators made some suggestions for changes. The elements were changed in response to their feedback, and the scale's final form included 33 items.

Second: Construct Validity:

The construct validity was verified by finding the correlation coefficients of the items with the total score. The results showed that the correlation coefficients were higher than 0.30 and positive, indicating that the test had adequate construct validity.

Third: The Reliability:

After being used on a pilot sample of 30 students for two weeks, the scale was used again, and the correlation coefficient between the two applications was determined to be 0.83, which is deemed appropriate for the current study. Additionally, the internal consistency value of Cronbach's Alpha was 0.89, indicating the reliability of the scale.

3.6. Study Limitations

This study was restricted to Jordanian University students for the second semester of the academic year 2023/2024. The results of this study depended on the validity and reliability of the study instrument.

3.7. Statistical Analyses

To answer the study question, the following statistical tests were used:

1. To answer the first question: SPSS v29 was used to conduct the factor analysis, construct validity, and the scree plot.
2. To answer the second question: The reliability indicators were extracted using SPSS and Exametrika V55 software.

To answer the third question, the software Exametrika V55 was used to extract the item-fitting indicators for the GRE model, including reliability, the item characteristic curve, and the item information function curve.

4. Findings and Discussions

Q1) What are the validity indicators of the student attitudes scale towards online learning?

To answer this question, the following indicators were used:

First: The construct validity: The validity indicators were verified by finding the correlation of the items with the overall scale, as shown in Table 2:

Table 2. Item correlation coefficient values with the overall scale.

Item number	Correlation coefficient	Item number	Correlation coefficient	Item number	Correlation coefficient
1	0.52**	18	0.48**	33	0.12
2	0.51**	19	0.57**		
3	0.61**	20	0.39**		
4	0.45**	21	0.61**		
5	0.50**	22	0.46**		
6	0.49**	23	0.56**		
7	0.52**	24	0.49**		
8	0.46**	25	0.63**		
9	0.45**	26	0.61**		
10	0.62**	27	0.57**		
11	0.43**	28	0.63**		
12	0.42**	29	0.40**		
13	0.49**	28	0.47**		
14	0.60**	29	0.56**		
15	0.52**	30	0.54**		
16	0.18	31	0.13		
17	0.37*	32	0.65**		

Note: ** $\alpha = (0.01)$ * $\alpha = (0.05)$

The findings of Table 2 revealed that the values of the correlation coefficient were all positive and greater than 0.30, and statistically significant at the level ($\alpha = 0.01$), except for three items (16, 31, 33), which were deleted from the final copy of the scale.

Second: The factor analysis: By using the principal component method to conduct an exploratory factor analysis of the highest degree over the entire sample for the responses of individuals to the test items, the validity of the overall scale was confirmed. The Varimax rotation was employed, and the results showed that the eigenvalues were greater than 1. Eigenvalues and variance explanation were computed for each factor, as shown in Table 3.

Table 3. The component, eigenvalues, the percentage of explained variance, and the cumulative variation of the factors that make up the attitudes towards e-learning scale.

Component	Initial Eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	18.820	62.734	62.734	18.820	62.734	62.734	11.464	38.214	38.214
2	1.626	5.418	68.153	1.626	5.418	68.153	7.928	26.426	64.640
3	1.245	4.152	72.304	1.245	4.152	72.304	2.299	7.665	72.304
4	1.122	3.739	76.044						
5	1.021	3.404	79.448						

Extraction Method: Principal Component Analysis.

It is clear from Table 3 results indicate that five factors have Eigenvalues exceeding 1. The highest factor reached 18.820, accounting for 62.734% of the explained variance. The second factor reached 1.626, with an explained variance of 5.418%. Moreover, the ratio of the first Eigenvalue to the second Eigenvalue is greater than two, which suggests the presence of a one-dimensional structure for the attribute measured by the scale (Hattie, 1985).

Figure 1 shows the graphical representation (Scree Plot) of the values of the eigenvalues.

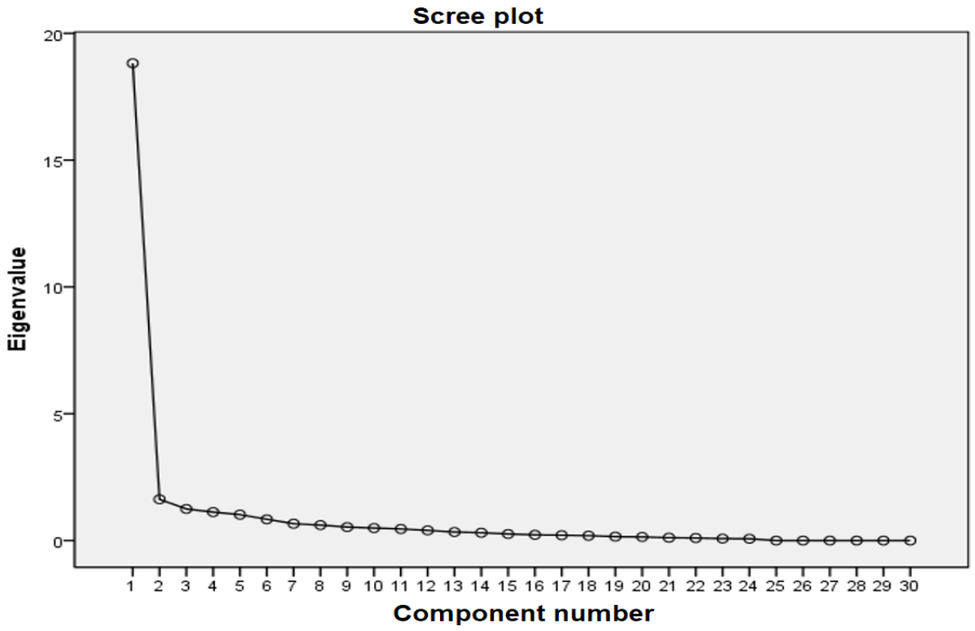

Figure 1. Graphical representation of the component Eigenvalues of the students' attitude towards online learning.

The eigenvalues of the components that explain performance on the e-learning attitude scale are displayed in Figure 1. A one-dimensional performance property on this scale might therefore be assumed to be available.

These results can be explained by the soundness of the procedures that were followed, starting with building the items of the scale in terms of clarity and appropriateness of the length of the scale as a whole. Moreover, the soundness of the scale application process procedures, the results of this question align with the results of Depaoli et al. (2018) and Yavuzalp and Bahcivan (2020), each of which showed that the scale had adequate factorial validity.

Third: Local independence: As long as the one-dimensionality was assured, then local independence as an assumption of the IRT was fulfilled.

Fourth: Item Characteristics Curve: Assumption of the item characteristics curve: To verify this assumption, an item characteristics curve was drawn for all items of the scale, and Figure 2 shows the item 8 characteristics curve.

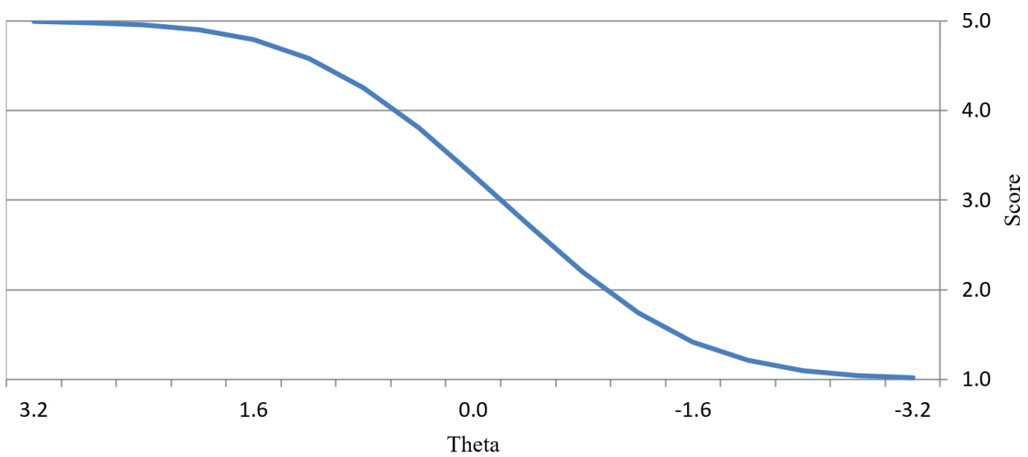

Figure 2. Item characteristics curve for item 8.

Figure 2 shows that there is a relationship between the difficulty levels of the item and the probability of answering it, and that the answer probability increases as the ability level increases.

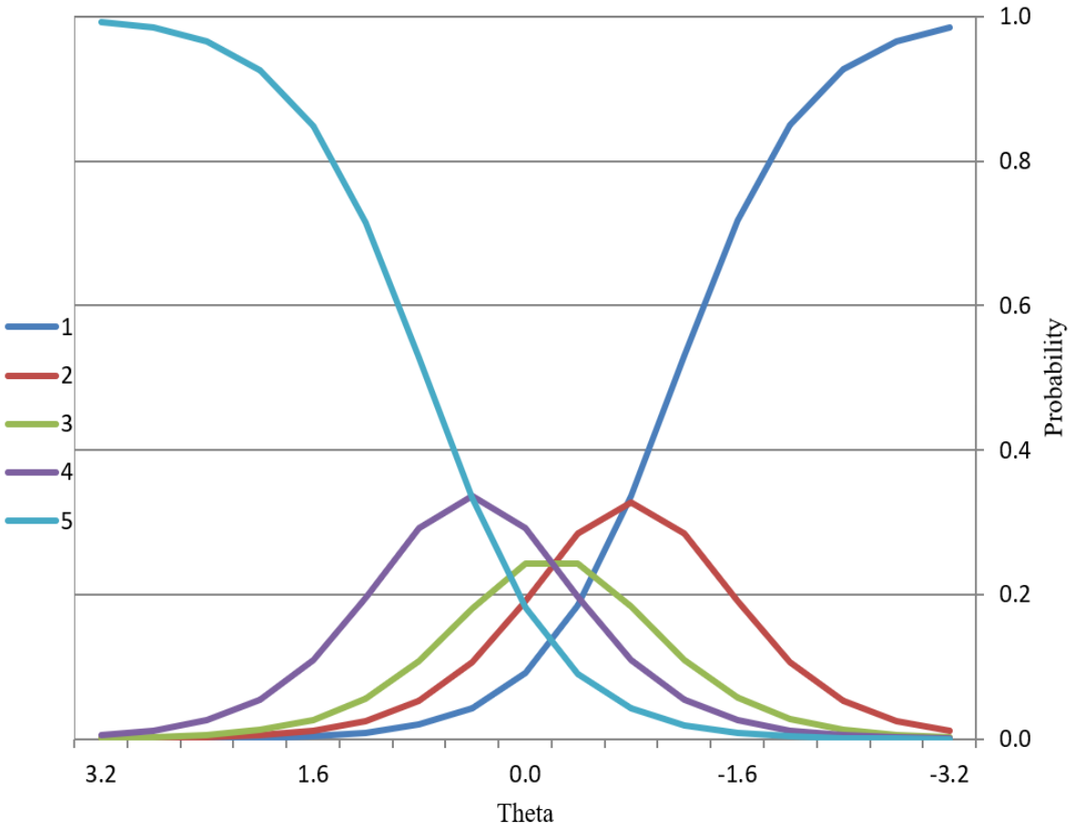

Figure 3. The relationship between the difficulty levels of the scale alternatives.

It is noticed from Figure 3 that the alternatives are gradual in difficulty and that the best alternative is 5, thus the assumption of the item characteristic curve is fulfilled.

Fifth: Speediness: This assumption indicates that the scale measures ability, not time, and this was verified by calculating the percentage of students who completed the answer on the scale, as well as the percentage of items answered by the sample members.

If the percentage of individuals who complete the answer on the scale within the specified time is 75%, and the percentage of answered scale items is 80%, then the assumption of freedom from speed is considered fulfilled. The percentage of individuals who completed the answer on the scale was 100%, as well as the percentage of items answered, which was also 100%, indicating that the scale measures ability and does not measure speed. Therefore, the speediness assumption has been achieved.

Q2) What are the reliability indicators of the student attitude scale towards distance learning?

First: To achieve internal consistency, the Cronbach's Alpha equation was used. It was calculated on the main sample N = 596, and its value reached 0.87, which is considered high and suitable for the purpose of the current study.

Second: The standard measurement error SME was discovered; as the standard error is a reliable indicator, its value of 0.005 denotes a high and suitable stability factor. These factors demonstrated the authenticity of the online learning attitude scale results. The researchers' appropriate approach and the accuracy measure they took when creating the items and examining the scale's psychometric qualities in this study can be utilized to explain this outcome.

Reliability in the framework of the IRT is achieved by verifying the independence of the measurement from the sample to which the scale is applied, and its independence from the items of the scale applied to the sample. Reliability for individuals was calculated, and it reached 0.842, which is a high value indicating the adequacy of the study sample. Additionally, the reliability coefficient related to the test items was calculated, and its value was 0.852, which is considered a high value indicating the adequacy of the scale items to distinguish between individuals on the trait that the scale is measuring.

These results can be explained by the soundness of the procedures that were followed, starting with preparing the items of the scale in terms of clarity and length appropriateness, as well as the scale administration procedures being conducted properly and adhering to standard psychometric guidelines. The results of this question align with the findings of Auné et al. (2019), and each of these studies demonstrated that the scale had adequate reliability indicators.

Q3) To what extent do the items of the students' attitudes scale towards e-learning fit the GRM?

To answer this question, the software Exametrika V55 was used to extract the items fitting indicators to the GRM, the reliability, the item characteristic curve, and the item information function curve, as the following tables display.

Table 4. The results of items fitting indicators of the study scale to the Graded Response Model.

Item	Indicators								
	NFI	RFI	IFI	TLI	CFI	RMSEA	AIC	CAIC	BIC
Item 1	0.642	0.624	0.717	0.700	0.715	0.064	109.525	-300.133	-224.133
Item 12	0.766	0.754	0.856	0.847	0.855	0.045	17.317	-392.342	-316.342
Item 19	0.648	0.630	0.741	0.725	0.739	0.055	61.554	-348.104	-272.104
Item 17	0.280	0.242	0.332	0.290	0.325	0.078	249.088	-262.985	-167.985
Item 20	0.722	0.708	0.821	0.810	0.820	0.047	23.645	-386.014	-310.014
Item 4	0.726	0.712	0.819	0.808	0.818	0.049	31.078	-378.581	-302.581
Item 22	0.712	0.697	0.786	0.774	0.785	0.059	80.238	-329.420	-253.420
Item 26	0.723	0.709	0.793	0.781	0.792	0.060	87.867	-321.791	-245.791
Item 18	0.671	0.654	0.745	0.730	0.744	0.062	99.271	-310.388	-234.388
Item 10	0.549	0.525	0.640	0.617	0.637	0.060	111.303	-400.770	-305.770
Item 6	0.678	0.661	0.744	0.729	0.743	0.066	122.927	-286.731	-210.731
Item 2	0.717	0.702	0.823	0.812	0.822	0.045	15.184	-394.474	-318.474
Item 30	0.696	0.680	0.754	0.740	0.753	0.070	146.201	-263.457	-187.457
Item 15	0.664	0.646	0.742	0.727	0.741	0.061	90.148	-319.510	-243.510
Item 5	0.727	0.712	0.808	0.796	0.806	0.054	55.100	-354.558	-278.558
Item 23	0.532	0.507	0.602	0.578	0.599	0.071	192.614	-319.459	-224.459
Item 27	0.000	0.000	0.000	0.000	0.000	0.199	1713.934	1304.275	1380.275
Item 14	0.654	0.636	0.756	0.741	0.754	0.051	42.620	-367.039	-291.039
Item 24	0.710	0.695	0.821	0.810	0.820	0.044	10.950	-398.708	-322.708
Item 16	0.480	0.453	0.559	0.532	0.555	0.067	160.519	-351.554	-256.554
Item 29	0.658	0.640	0.717	0.701	0.716	0.072	160.236	-249.423	-173.423
Item 7	0.687	0.670	0.767	0.753	0.766	0.058	75.389	-334.269	-258.269
Item 3	0.177	0.133	0.218	0.166	0.208	0.075	225.979	-286.094	-191.094
Item 8	0.699	0.683	0.777	0.764	0.776	0.058	74.221	-335.437	-259.437
Item 13	0.658	0.640	0.717	0.701	0.716	0.072	160.236	-249.423	-173.423
Item 11	0.687	0.670	0.767	0.753	0.766	0.058	75.389	-334.269	-258.269
Item 21	0.177	0.133	0.218	0.166	0.208	0.075	225.979	-286.094	-191.094
Item 25	0.658	0.640	0.717	0.701	0.716	0.072	160.236	-249.423	-173.423
Item 28	0.532	0.507	0.602	0.578	0.599	0.071	192.614	-319.459	-224.459
Item 9	0.766	0.754	0.856	0.847	0.855	0.045	17.317	-392.342	-316.342
Total degree	0.930	0.981	0.974	0.956	0.972	0.065	0.987	0.987	0.987
Accepted value	≥0.90	≥0.90	≥0.90	≥0.90	≥0.90	≥0.08	≥0.90	≥0.90	≥0.90

The results of Table 4 showed that the items of the study scale match the model, except item 27, where the RMSEA value is 0.199, which exceeds the accepted limit of 0.08. Therefore, this item was omitted from the scale.

Moreover, Table 4 displays the values of the fitting indicators for the total degree. These indicators show that they are within the accepted range, especially the RMSEA, which reached 0.08.

The researchers attribute this result to the integrity of the scale-constructing procedures, starting with the preparation of items and the seriousness of the sample in responding to the scale. The results of the answer to this question agreed with the results of the studies of Auné et al. (2019) and Depaoli et al. (2018), which both used the GRM model and showed the fitting of the items to this model.

5. Conclusion

This study aimed to explore the psychometric efficiency of students' attitudes towards online learning using Item Response Theory. A scale was constructed, consisting of a pool of items. The exploratory factor analysis revealed that one trait underlies performance on this scale. Both content and construct validity were established. The reliability indicators' values were acceptable. Moreover, the results demonstrated good fit indices for the scale items with the Graded Response Model (GRM). This study may succeed in proposing a scale with strong psychometric properties that researchers can utilize in future studies.

6. Limitations of the Study

The current study had several limitations, including a small sample size, a limited number of variables, and a narrow research focus. Future research could be extended to other impoverished and developing nations where financial and resource constraints are common.

7. Recommendations

Based on the study findings, the researchers recommend that future studies explore additional variables and consider applying different Item Response Theory (IRT) models. They also suggest that researchers use this scale, given its strong psychometric properties, and employ multiple software programs to examine item parameters and model fit. Moreover, IRT software should be utilized to investigate the differential functioning of scale items more comprehensively.

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