Validity and reliability of eight-grade digital culture test in light of item response theory

Moen Salman Alnasraween [a] *, Amman Arab University, Faculty of Education and Psychology, P.O Box 2234 Amman, Jordan, https://orcid.org/0000-0002-1905-6253

Ayat Mohammad Al -mughrabi [b], Middle East University,Faculty of Educational Sciences , P.O Box 11610 Amman, Jordan https://orcid.org/0000-0003-1777-6553

Raeda Mofid Ammari [c], Amman Arab University, Faculty of Art and Science, P.O Box 2234 Amman, Jordan https://orcid.org/0000-0003-1173-4395

Mohammad Saleh Alkaramneh [d,] Ministry of Education, P.O Box 2234 Amman, Jordan https://orcid.org/0000-0002-0175-2197

Abstract

The purpose of this study is to construct a digital culture test in light of the Item Response Theory and to investigate its psychometric properties. The study sample consisted of six hundred fifty (650) male and female students in the eighth grade from the Directorate of Education and Teaching of Salt District. To obtain the results, the descriptive approach was used. The results showed that the items have acceptable indicators of discrimination and extend on the continuum of difficulty adequately. The validity and reliability of the test were verified by using several methods, including content validity and internal consistency. The study findings showed that most of the test items fit the assumptions of the two-parameter logistic model. The results also displayed statistically significant differences in the arithmetic means of the digital culture test due to gender in favor of female students. Moreover, the outcomes presented statistically significant differences attributed to the education sector variable favoring the private sector.

Keywords: Digital Culture Test, IRT, Psychometric Properties, Teaching.

* ADDRESS FOR CORRESPONDENCE: Mo'en Salman Alnasraween, Amman Arab University, Faculty of Education and Psychology, P.O Box 2234 Amman, Jordan,
Email Address: mueen@aau.edu.jo

1. Introduction

The phenomenal growth of scientific and technological development has undoubtedly led to the modern advancement of civilized mankind and naturally enhanced the fundamental level of ultimate challenges facing it. The twenty-first century has witnessed an increasing diversity in innovative technology, which has caused radical changes in the way to access, employ and benefit from the vast available knowledge.

Among the most prominent of these challenges is the gap between someone who possesses knowledge by his information and abilities, dealing with contemporary technology effectively, and unable to do so. Therefore, typically employing technology is more than simply acquiring necessary information or printing a scientific text in the third millennium. In line with the essential need for effective change according to continuous developments, by inspiring individuals with the intellectual ability to succeed in the twenty-first century, various international associations and institutions are interested in enabling students to manage the content of knowledge and the fundamental skills necessary for societal success. They have sought partnership and cooperation to present proposals through which the 21st-century skills that students are supposed to possess, precisely explained, and the extent of their relevance to educational systems, programs, fields, and academic contexts(Sternberg and Grigorenko, 2002)

In the same context, the partnership for 21st-Century Skills (henceforth P21) was established in 2002 through the US Department of Education, the National Education Association (NEA), by some US and international educational, technical, scientific, and economic associations and institutions. As this partnership, P21 was designed to be a catalyst for integrating the P21 skills necessary to form an individual who can adapt to the present. The future through his scientific ability represented in a combination of interconnected and integrated skills simultaneously according to the requirements of scientific and technological progress taught at schools and universities to reduce the gap that separates the school from the outside world (Trilling& Fadel, 2012; National Science Teachers Association, 2011).

Theoretical background of the study

The partnership for 21st (P21) Century Skills includes the identification of the skills necessary for learners in the twenty-first century, as well as the mechanisms for including such skills in the educational contexts of all subjects to enable students to adapt and keep up with the evolutions of this era. These skills were classified into four axes; The knowledge content formed the first axis; Where this axis requires the student to master the basics in language, mathematics, science and provides the minimum sufficient to understand the topics related to the twenty-first century in particular, namely; Global awareness, economic, civic, health, and environment culture (Sadiku, Tembely & Musa, 2017).

As for the second axis, it was represented in learning and creativity skills which focuses primarily on considerable ingenuity, modern innovation, critical thinking, problem-solving, effective communication, and cooperation. These undoubtedly possess essential qualities, which are the fundamental criterion for reliably distinguishing between gifted students who are prepared for typically encountering practical life from those who aren't ready (Bybee, 2010; Shunn, 2008).

The third axis is the Digital literacy skills which generally consist of informational culture skills, media culture and multimedia, valuable information, and modern communication technology.

The fourth axis comprises intellectual life and work skills, which included flexibility and resilience skills, enhanced productivity, mutual accountability, collaborative initiative, self-direction, leadership, assuming responsibility, and social skills (Trilling & Fadel, 2012).

Sergis, Samson & Giannakos (2017) defined digital culture with its informational culture, media, and technological culture as having mastery of the extensive use of electronic devices, access to correct and sufficient information through them. As for Lever-Duffy & McDonald (2017), they carefully described the skills of digital culture to obtain the remarkable ability to use digital resources ideally and benefit from them through critical thinking, communication, cooperation, and innovation. This way guarantees the individual adaptation to face the changing society. This axis prominently includes three necessary sub-skills that fall within its comprehensive framework as follows:

First: Information Literacy: the genuine interest is the emergence of the data society major indicator, which forms the nucleus of the digital knowledge society in the current century. It naturally forms the essential basis for building the scientific explanations, formulating arguments, logical evidence adopted in critical thinking to solve individual and societal problems correctly. Hence, earnest students must distinguish between reliable scientific information from its references, opinions, and issues found in different sources, as well as pay attention to the accuracy of the adopted accessing methods (Lever-Duffy & McDonald, 2017).

Specialized studies in this framework specify precisely that the information of life cycle does not exceed a maximum of seven years in the scientific, digital, and economic fields. Hence, what a student learns in his first year at the university, for example, will not be feasible shortly after graduation. This change powerfully reinforces the apparent necessity of typically possessing new knowledge continuously, which promptly makes it compulsory for modern schools to progressively develop scientific and technological curricula periodically and frequently (Coteli, 2019).

In addition, Kilbane and Milman (2014) confirm that students who possess information literacy skills are the most capable of quickly dealing with the changes of the current era than others, given the extraordinary abundance of information sources and their variation in the degree of originality and reliability.

Second: Media Literacy: The tremendous leap in considerable information and modern communication technology has naturally led to the potential emergence of a global culture that is about to wipe out local cultures. This development requires contemporary media to adequately consider the accuracy in choosing its topics and scrutinizing their consistency with people's values and traditions, and their importance to satisfy future needs. At the same time, social media messages should be carefully composed to make it easy for the target groups to understand and respond favorably to them. Because it is one of the influencing factors in bringing about both positive and negative change in individuals, societies, and media culture in terms of importance as the impact is similar to the third parent after family and school (Sheta, 2006; Laar, Deursen, Dijk and Haan, 2017).

Since complex scientific topics and observed phenomena are not accurately expressed in the media, students' awareness of scientific knowledge and the development of critical analysis skills are essential to determine the degree of data consistency that the media may present with technical knowledge. The media interpretation of scientific information may differ remarkably from the possible interpretation formulated by the specialized scientific community of that information. As a result of what the journalists broadcast according to their prevailing opinions rather than scientific facts, believing that they meet the social needs (Sheta, 2006; Murad, 2014).

Third: Information and Communications Technology Literacy (ICT): the ability to interact and analyze positively and objectively the vast flow of scientific knowledge and create new tools to employ and benefit tremendously from it, require the possession of broad capabilities provided by information and communication technology, which makes it urgent for students to realize the function of technology, in its different tools, in achieving the goals of science (P21, 2008; NSTA, 2013; Laar et al., 2017).

 Perhaps the importance of digital literacy skills is embodied in its successful investment to solve the societies' problems. The most important of which are: the time gap between the leading industry and the use of technology in the developed countries where their excessive consumption imposes the necessity for a change in the education system to the digital age rendering the twenty-first- century skills. Modern technology is no longer an extra option but an essential part that complements the structure of education that would be deficient without it. This situation necessitates preparing students for digital culture and engaging them in collaborative technological experiences using critical thinking to solve the problems they face (Lever-Duffy & McDonald, 2017; Laar et al., 2017; Kilbane Milman, 2014).

Besides those mentioned above, the sub-domains of the digital culture axis skills include specific skills. An integrative and interdependent nature traditionally characterizes them. Moreover, they are distinguished by being acquired by learning and practice. It is typically transmitted from one individual to another by transferring knowledge from one society to another through competition or acculturation. These skills are accumulative and renewable since they are transmitted through the generations. It helps new patterns and ideas emerge, so each generation starts from where its predecessors stopped (NSTA, 2013; P21,2008; Laar et al., 2017).

Murad (2014) emphasized that Arab countries, in general, suffer from an apparent decline in the production, consumption of digital culture, and lack proper handling of its tools. Consequently, they are content with teaching students to use technology without correctly understanding how it is produced and developed only to meet their needs. The insufficient knowledge powerfully reinforces a digital gap associated with understanding the cultural changes resulting from technology and the cognitive ability and skills to employ it in an era where information sources and objectives are numerous. The degree of potential benefit from it varied tremendously at the global, Arab, and local levels.

The Item Response Theory of measurement establishes a framework for the automatic and future direction by carefully selecting the items, regarding the set of defects and criticisms of the classical theory, which deals with many educational and psychological issues more effectively than the classical theory of measurement. This theory assumes that the performance of individuals can be predicted or interpreted in a psychological or educational test in the light of a distinctive feature of this performance called the 'traits.' These traits are complex to observe accurately, so they must be estimated or inferred from the individual performance. Researchers can detect a group of scale items and that's why it is called the 'latent features'. This theory is based on fundamental assumptions: the assumption of one-dimensional, local independence, the distinctive aspect of the unique item, and the absence of guesswork. This theory obtains a set of advanced models that have been developed and known as *latent trait models*. It principally aims to exactly determine the relationship between the performance of the individual in the test where this characteristic lies behind it and its interpretation, including the one-parameter logistic model, the two-parameter logistic model, and the three-parameter logistic model(Demars,2010; Yen & Fitzpatrick, 2006; Holland and Hoskens, 2002).

These models can be classified into three distinct types; the first type is related to dichotomous responses, in which the subject's response is either a correct answer and takes a score (1), or an incorrect answer which takes the score (zero). The second type is related to multiple responses

(polytomous) where the individual response is graded, and the third type can comprise a mixture of the first and second classes. The following represents a brief description of the most dominant logistical models used in the framework of Item Response Theory (Reeve, 2004; DeAyala, 2009).

1. One parameter Logistic Model:

This model assumes that the performance on the test is determined and affected by the item difficulty. In this model, the difficulty parameters are estimated while the discrimination indices are imputed as known constants. It is also presumed that academic subjects do not resort to guessing when they answer the test items promptly. Hence, these items differ sufficiently in terms of the level of academic difficulty (Emberston and Reise, 2000).

The mathematical formula for this model has the following form:

whereas:

$P_i(\theta)$: the probability of the respondent having the ability (θ), who was randomly selected to represents a correct answer on item (i).

D: constant value equal (1.7), bi: difficulty parameter of the item (i).

a_i: Discernment parameter of the item (i), e: natural logarithmic base equal to (2.718)

(Ostini and Nering, 2006, p70)

2. Two Parameter Logistic Model:

This model had been suggested by Birnbaum in 1968, where he considered the performance on the test is decided based on item parameter's difficulty and discrimination. It is presumed that there is no guessing, but the items vary in the level of difficulty and the level of discrimination.

The equation of the two-parameter logistic model takes the following form:

$$p_i(\theta) = \frac{e^{Da_i(\theta - \mathbf{bi})}}{1 + e^{Da_i(\theta - \mathbf{bi})}}$$

Where: (Linden & Hambleton, 1997, p10)

$P_i(\theta)$: The probability that the subject is having the ability (θ) who was chosen randomly to answer item (i) correctly.

D: constant value equal to(1.7)

b_i: the difficulty parameter for the item (i).

(e): the natural logarithmic base equals.(2.718)

a_i: Discernment parameter of the item (i).

Three Parameter Logistic Model:

The Item Response Theory developed several approaches to overcome the problem of guessing, the three-parameter logistic model, which assumes that the items vary in terms of the level of difficulty, discrimination, Moreover this model assumes the performance on the test is constrained by a third parameter called the guessing parameter(Lord, 1980).

The equation for this model takes the following form :

$$p_i(\theta) = Ci + (1 - Ci)\frac{e^{Dai(\theta - bi)}}{1 + e^{Dai(\theta - bi)}}$$

(Lord, 1983, p. 425)

Whereas:

$P_i(\theta)$: The probability that the subject is having the ability(θ) who was chosen randomly to answer item (i) correctly.

D: a constant value equal to (1.7) .

b_i: The difficulty parameter for the item (i).

e. The natural logarithmic base equals (2.718).

C_i: The guessing parameter for the item (i).

Item and test information function:

The information function I(θ) is a fundamental concept in Item Response Theory (IRT) whether the item is dichotomous or not, where the item information function is seen as a function between the subject's ability and the information provided by the item. Moreover, I(θ) is designed to evaluate how well an assessment differentiates between examinees performance on a given test, and at what ranges of ability.

This function represents the amount of data that the test items can provide at a specific ability level. In addition to the possibility of determining the point on the continuous latent with the maximum information at a given ability level (θ).

Hambleton, Swaminathan, and Rogers (1991) indicate that the item information function is a means of describing each of the items and the test. The most significant applications that the information function contributes to are: Constructing various tests, selecting test items based on the amount of information provided by each item that fits with the nature and purpose of the test, evaluating the accuracy of measuring tools, comparing tests, comparing the correction methods used, and what distinguishes the information function is that it can be defined at each level of the ability parameter (θ) on the characteristic continuum and that the information for any item is not affected by the information provided by the other items composing the test (Lord, 1980).

The following equation shows the item information function:

$$I_i(\theta) = \frac{P'(\theta)^2}{Pi(\theta)Qi(\theta)}$$

Whereas:

$I_i(\theta)$: The information function of the item (i).

$P'_i(\theta)$ ´: The first derivative of the probability of a correct answer to the item (i).

$P_i(\theta)$: Represents the probability of the response of the subject having the ability (θ), chosen randomly on item (i), to answer it correctly.

$Q_i(\theta)$: The probability of answering item (i) wrongly.

(Yen, and Fitzpatrick, 2006, P 126)

From this logic, the need to construct and develop a test for digital culture in light of item response theory has increased, the theory allows constructing test items whose parameters are not changing regardless of the changes in the study sample properties. The choice of items depends on the amount of information that the item contributes to the total amount of the test information function, as the test information function is characterized by constructing highly accurate tests.

The Problem of the Study

Developing capabilities and skills in dealing with the massive electronic flow of information is one of the most critical challenges of its expansion in the twenty-first century. Access to the vast and constantly growing amount of data is no longer a goal that is benefiting from this information, and employing it has become an essential element to enable students to manage their future. Besides, solving the problems that hindered their career. This study sought to determine the level of students and their ability to deal with all these variables and the extent of their appropriate skills possession that enables them to interact with scientific, social, and economic developments. The researchers believe that it is necessary to investigate the level of digital culture among Jordanian students in light of the 21st- century skills in science education.

Specifically, this study aimed to build a test for digital culture in considering Item Response Theory according to the two-parameter logistic model, as one of the models of the item response theory. Therefore, the problem of the study is the urgent need to develop an objective and accurate tool to measure the digital culture skill among eighth-grade students. The Item Response Theory has not received much attention, especially in Arab studies, when constructing scales in general, despite its advantages in preparing various tests and scales.

Research Question:

The first question: *To what extent have the assumptions of item response theory fulfilled?*

The second question: *What is the appropriate logistic model for testing digital culture?*

The third question: *What are the estimates of the parameters for each test item of digital culture and the information function according to the 2- Parameter Logistic model?*

The fourth question: *Are there statistically significant differences at ($\alpha = 0.05$) in the digital culture level due to gender and the education sector?*

Study terms and procedural definitions:

Digital culture: Ali (2018) defined it as the ability to use digital devices and access information through them, and Lever-Duffy & McDonald (2017) described it as the ability to use digital resources perfectly and benefit from them through critical thinking, cooperation, communication, and innovation in a manner that guarantees the individual adaptation to meet the changing society.

Eighth-grade students: Students between the ages of 13-14 years.

The Significance of the study

The theoretical importance of the academic study is that it represents a response pattern to global trends in science education. Given the technological revolution, the study is expected to provide qualitative literature based on scientific-educational literature in this field. It will likely constitute a

gateway to other studies that examine various axes of twenty-first-century skills. The practical importance is scientifically proved by its cognitive ability to offer field information framed in a scientific and research for the level of students' acquisition of digital literacy, focusing on 21st-century skills. This would enhance the possibility of directing the training of science teachers in line with the 21st-century skills and may contribute to the development of training programs. Students in the elementary stage play a role in developing their digital literacy skills. This study may help diagnose the level of digital culture among the studied sample, primarily as it constitutes a review and inspection point to examine the effectiveness of education on a global level.

Previous studies

Al-Rashed (2017) conducted a study to investigate how Jordanian university students possess digital citizenship skills. For that purpose, a (45) item questionnaire was developed. A sample consisted of (5200) students were randomly selected from (6) universities. The results showed that the degree of possessing digital skills was high. Whereas maintaining the digital safety and digital responsibility skills were moderate. Moreover, it indicated no statistically significant differences between the arithmetic means digital citizenship according to the study variables (gender, faculty, and school year). At the same time, it pointed out that there are differences according to variable difference (University) between the University of Jordan and Mut'ah University in favor of the University of Jordan.

Mahdi's study (2018) sought to investigate strategic effectiveness in innovative learning that relies on project knowledge and Google services in providing students and teachers in Palestine with some 21st-century skills, namely, learning and creativity skills, digital technology skills, and life skills. These three measures of 21st-century skills were implemented and applied to (45) male and female students. The study results demonstrated a statistically significant impact of the intelligent learning proposed strategy in providing students with 21st-century skills in the three areas.

Al-Zoubi and Salameh (2017) conducted a study to build a test of critical reasoning skills using the Item Response Theory. The study sample consisted of (444) male and female students in the higher primary stage (610) in the secondary stage and (120) at the university level. The study revealed that the three-parameter model was the most appropriate for the data because the estimated capacity is more accurate than the other models. The features of the items and the parameter of ability were characterized by stability.

While Siddiq, Gochyyev, and Wilson (2017) pursued to assess Malaysian Students' students' 21st- century skills in learning through interaction with networks, information, communication technology, cooperation, communication, and problem-solving. The ICT test was applied to a sample consisting of (144) students from the ninth grade. The test focused on assessing the extent of students' ability to communicate and cooperate through chat programs or search engine documents, deal with digital data and solve problems through it during a specific period. The results displayed no significant differences attributed to a variable of gender and the existence of disagreements attributed to academic motivation and socio-economic background.

The study of Al-Rusasi (2017) aimed to investigate science teachers' competencies in Jordan's information and communication technology field. The descriptive and analytical approach was employed. A scale for the competencies of the science teacher was developed which includes four key areas: Information and communication technology culture, information and communication technology skills, employing information and communication technology, and ethics in using information technology. The study sample consisted of (163) male and female students who were graduates of the College of Science at Al-Hussein Bin Talal University. The results showed that the

students' estimates of possessing ICT competencies were low in both the overall scores and ICT culture and employment, while their grades were moderate in ICT used skills and ethics.

Laar, Deursen, Dijk, & Haan (2017) performed a study aimed at identifying the relationship between 21st- century skills and digital skills and providing a reference framework for digital skills in the twenty-first century with conceptual domains and practical applications. In the Netherlands, a systematic literature review was conducted. Educational articles related to digital skills in the twenty-first century included (1592) academic articles concerned with these skills. The results highlighted that 21st- century skills are more comprehensive than digital skills. Moreover, the study showed that educational literature agreed on seven basic 21st- century skills; problem-solving, creativity, critical thinking, collaboration, technology, informatics, and communication.

Melhem's study (2017) aimed to determine the degree of availability of 21st- century skills in the technology course for the higher basic stage in Palestine and the degree to which Tulkarm students possess those skills from their point of view. A questionnaire was used as a study tool for the study. The study sample consisted of (328) male and female students. The results displayed that students' possession of 21st- century skills was high, and digital culture skills came first, then life and work skills, followed by learning and creativity skills. The results also showed statistically significant differences in the degree to which students possess 21st-century skills due to gender in favor of males and related differences. The significance attributed to the place of study favored villages, while there was no statistically significant difference attributable to the academic rate. The outcomes also revealed that the technology course's most available skills in the twenty-first century were life and work skills, then learning and creativity skills. In contrast, information technology skills were ranked last.

The study of Al-Haroun(2016) pursued to identify the most important basic competencies of media culture that should be included in the science curricula in the preparatory stage in Egypt and their effectiveness in developing the twenty-first-century skills. The study sample consisted of (68) eighth-grade students was based on the quasi-experimental approach and the use of the 21st- century skills scale. The findings showed that the media literacy competencies that should be included in science curricula involved awareness of media messages, comprehension, analysis, evaluation, and how to develop them. The results also revealed that there were statistically significant differences between the mean scores of the students who were in favor of the experimental group on the scale of 21st- century skills.

Whereas, the study of Pheeraphan (2013) sought to determine the effect of integration in ICT in classrooms in Thailand in enhancing the 21st- century learning skills of collaboration, communication, information culture, media culture, and ICT culture. The sample of the study consisted of (69) undergraduate students and (22) postgraduate students in two different 4-month courses during which the integrated lessons in information and communication technology were applied in their classrooms, and then the students were evaluated through the assessment tool for learning skills in the twenty-first century which they were prepared for it. The results showed that the integration of ICT in the classroom greatly enhances learning skills in the twenty-first century for both undergraduate and postgraduate levels.

Research Methodology

The descriptive and analytical approach was used in this study.

Study population:

The study population consisted of all the eighth-grade basic stage students (males and females) at the Directorate of Education of the Salt Region both government and private sectors for the academic year (2020/2021). The number of students reached (3113). The government sector included (933) students, while the private sector reached (513) students. The total number of females was (167); in the government sector (1392) female students and (275) female students in the private sector. The number of schools which included the eighth grade is (70) schools, of which (54) are government schools and (20) schools for males, (34) schools for females, and (16) schools for males and females.

Study sample:

The study sample was chosen randomly from students of the basic eighth grade, which reached (650) students. The distribution of study individuals according to gender and education sector is shown in Table (1) as follows:

Table 1. Distribution of study individuals according to gender and education sector

Class	Gender		Teaching sector	
	Male	Female	Public	Private
Eight Grade	257	393	483	167
Total	650		650	

Digital Culture Test

This test was prepared to determine the level of digital literacy skills for students of the eighth grade in light of the 21st-century skills plan in science education. The initial form of the test consisted of (38) multiple-choice items; each item was followed by four alternatives. The tested targeted areas of digital culture skills: media culture, information culture, valuable information, and modern communication technology. To construct the test, previous academic literature related to it was reviewed in light of the 21st-century skills maps. In addition, the researchers employed the Academic science maps content to identify the areas of digital literacy skills and their main elements that have been focused on, then decide the main axes of the skills to be included in the test. Later, the items, the estimated time for the test and the Answer key for its correction were all prepared. A preliminary test has been designed with a number of (38) items for the eighth grade. To achieve the target of the test, the items covered all the main skill axes, where the test was presented to (15) arbitrators who are specialized in science curricula, teaching methods, and educational technology. The arbitrators commented on the test items in terms of clarity, scientific information and linguistic formation, suitability for the target group, and its precise measurement for digital literacy skills. After their accurate observations, some items were deleted, so the number of the test items in their final form was (35). Hence, the test items sufficiently covered all specific areas of digital literacy skills.

Validity of Digital Culture Skills Test

The validity of the test content was carefully extracted by presenting it to a group of (25) academic experts in science curricula, teaching methods, and educational technology with experience and competence. The tests objectively assessed the areas of digital literacy skills comprehensiveness, and its scientific and linguistic validity was to measure what it was prepared for. Some items were

modified and others were deleted after sufficiently taking into account the valuable comments of the arbitrator so that the number of test items in the final form was (35) items.

The researchers also calculated the leading indicators of construct validity by finding the correlation coefficients of the items with the total score, which ranged between (0.38 - 0.77), and all of them were positive.

Reliability of Digital Culture Test

To verify the stability of the test, the researchers applied an exploratory sample which was excluded from the primary study sample consisting of (60) male and female students. The stability of internal consistency was extracted through Cronbach's Alpha equation. It reached a total score of (0.91), which was suitable for the present study purposes.

The Primary Applying of the Test

The test was applied in its initial form of (35) items on an exploratory sample outside the study sample, where the number of students reached (60) students from the basic eighth grade. The purpose of the application was limited to determining the time needed for students to answer the test items and identify the level of the items' difficulty, their discriminatory ability, and the clarity of the linguistic wording of the items. The values of the difficulty coefficients for the items ranged (0.32-0.62), the discrimination coefficients ranged (0.32-0.70) and the item correlation coefficients ranged from the total score (0.38-0.77). Accordingly, all the items were preserved, and depending on the initial application of the test, the appropriate time for the test was determined in (45) minutes. The test reliability coefficient was also extracted by the Cronbach's Alpha method for sub-skills. As for the overall degree, the reliability coefficient for sub-skills, information culture, media culture, and information and communication technology culture were (0.81, 0.83, 0.08), respectively, and the overall reliability coefficient was (0.91).

Validity of the Test

Content validity was verified by presenting the test to a group of (10) experienced and competent arbitrators the necessary adjustments were made to the test items according to the suggestions of the referees. The experimental empirical stability was estimated in its final form according to the two-parameter logistic model using the MGBilog3 program, where the stability reached(0.77) .

Results and Discussion

The first question: To what extent are the assumptions of the Item Response Theory fulfilled?

1. Unidimensional assumption

The Unidimensional hypothetically of the test was verified through the SPSS package by utilizing the factor analysis through Principal Components with the orthogonal rotation of the Varimax axes for the data obtained. The adequacy of the sample size was examined using Kaiser-Mayer-Olkin index (KMO index) where its value reached (0.78), according to Kaiser (1974), the index of the adequacy of the sample size must be (0.50) at least, to be acceptable.

The factors, Eigenvalue, the explained variance percentage, and the cumulative variance have been conducted for the factors composing the digital culture test, as Table (2) demonstrates.

Table2. The values of the Eigenvalue, explained variance, and the cumulative variance of the factors composing the digital culture test

Factor	Eigenvalue	Explained Variance Percentage	Cumulative Explained Variance Percentage
1	3.930	11.228	11.228
2	1.838	5.252	16.480
3	1.415	4.042	20.522
4	1.379	3.939	24.461
5	1.306	3.732	28.193
6	1.230	3.513	31.706
7	1.197	3.421	35.127
8	1.151	3.288	38.415
9	1.089	3.111	41.526
10	1.047	2.990	44.516
11	1.040	2.971	47.488
12	1.018	2.908	50.396

Table (2) results highlighted that there are only twelve factors, whose Eigenvalue value was greater than (1). The overall variance (50.396%) in performance on the digital culture test was explained where the Eigenvalue of the first factor was (3.930). Furthermore, an amount (11.228%) of the variance in performance was justified on the digital culture test. The Eigenvalue of the second factor was (1.838) with an amount of (5.252%) explained variance. Table (2) shows that the ratio of the Eigenvalue of the first factor on the Eigenvalue of the second factor is (2.138) which is greater than (2), indicating a one-dimensional trait measured by the digital culture test.

Figure (1) describes a graphical representation (Scree Plot) of the Eigenvalues of the factors composing the digital culture test.
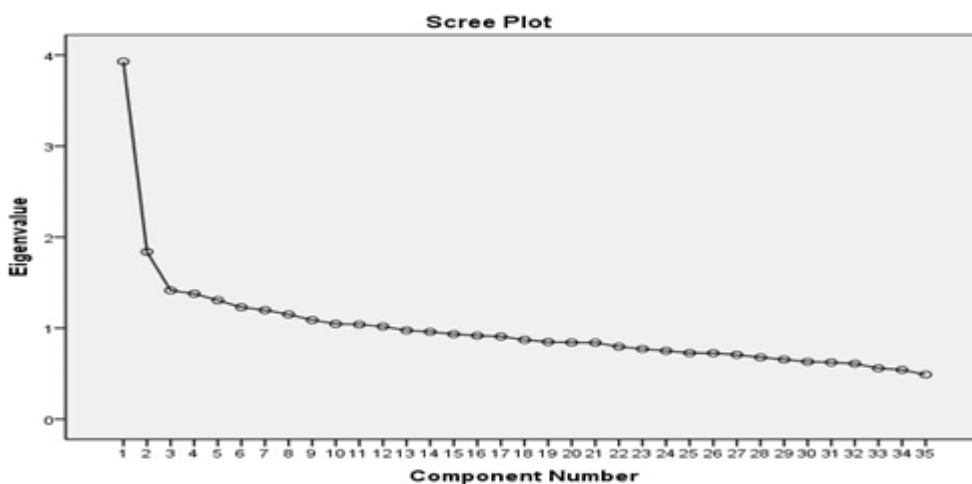
Figure (1) Graphic representation of factors composing the

Eigenvalues of the digital culture test

Figure (1) demonstrates the factors with Eigenvalue that explain the variation in the digital culture test scores. It is noticed that the Eigenvalue of the first factor is immense compared to the second factor. There is a tendency for the third factor to shift while remaining close to the rest of the factors. It also suggests the presence of a dominant trait in the digital culture test.

2.Local Independence:

Since the one-dimensional assumption has been fulfilled, this guarantees the fulfillment of the local independence assumption as indicated by Hambleton and Swaminathan (1985) .

3. Equality of Discrimination:

Equality of Discrimination was ascertained by calculating the coefficients of correlation of the item with the total score on the test; that is, the double correlation coefficient, where the unequal discrimination indices were verified using a software (Bilog-MG- 3) through the first stage output, where the results indicated that the discriminant indices were not equal for all items, and this is evidence of the unsuitability of the single model for the data.

4. Speediness:

It was confirmed that the individuals did not answer the test items due to their inability and not to the speed factor effect. Which means that enough time was given to a student during the performance on the test.

The second question: What is the appropriate logistic model for testing digital culture？

By fitting each of the Item Response Theory models with the items of the digital culture test, the researchers analyzed the data obtained from the test application using the BILOG-MG3 software three times and independently to determine the minimum number of items that do not fit IRT models. These models are the one-parameter logistic model, the two-parameter logistic model, the three-parameter logistic model. The researchers found that the logistic model that fits the data is the two-parameter logistic model. Hence, by using Chi-Square Statistics to judge the fitting of the items for the model, where the number of excluded items from the one-parameter (24) items, the two-parameter (8), and the three-parameter logistic (12) items. Thus, the number of items for the digital culture test according to the two-parameter logistic reached (27) items.

The third question: What are the estimates of the parameters for each test item of digital culture and the information function according to the 2- Parameter Logistic model?

To answer this question, the researchers extracted the features of each item of the digital culture test and information function through the Bilog-MG3 program after deleting the items and individuals that do not fit the two-parameter logistic model. Table (3) displays the features of each of the digital culture test items, and the information function according to the two-parameter logistic model**.**

Table 3. the values of the difficulty parameters (b), discrimination (a), standard error (SE), and the information function of the digital culture test according to the two-parameter logistic model

Item	(a)	SE(a)	(b)	SE(b)	Item Information Function(IIF)
1	0.634	0.106	1.342	0.260	0.1005
2	0.361	0.081	0.791	0.285	0.0325
3	0.679	0.113	0.032	0.124	0.1152
4	0.620	0.105	-0.005	0.133	0.0961
5	0.632	0.109	-0.388	0.140	0.0999
6	0.292	0.076	5.331	1.402	0.0213
7	0.965	0.137	0.353	0.109	0.2330
8	0.991	0.142	0.330	0.100	0.2458
9	0.523	0.097	0.683	0.205	0.0684
10	0.710	0.110	1.836	0.292	0.1262
11	0.915	0.132	0.753	0.143	0.2095
12	1.137	0.156	0.856	0.127	0.3235
13	0.951	0.141	0.606	0.126	0.2261
14	1.067	0.146	0.932	0.146	0.2844
15	0.709	0.114	1.010	0.195	0.1258
16	0.785	0.114	0.049	0.109	0.1540
17	0.608	0.105	0.685	0.181	0.0925
18	0.617	0.104	1.140	0.232	0.0953
19	0.621	0.101	0.957	0.195	0.0965
20	0.831	0.115	0.509	0.123	0.1726
21	0.458	0.091	1.784	0.392	0.0524
22	0.725	0.177	0.506	0.148	0.1312
23	0.458	0.093	3.011	0.605	0.0524

24	0.873	0.131	1.505	0.231	0.1904
25	0.918	0.133	0.289	0.104	0.2107
26	0.711	0.112	0.901	0.184	0.1264
27	0.556	0.100	1.252	0.260	0.0773

Also, the lowest and highest values, the arithmetic means, and the standard deviation of the difficulty and discrimination parameters for the items were calculated according to the Item Response Theory as shown in Table(4) .

Table 4.The lowest , highest values, arithmetic means, and standard deviation of the test difficulty and discrimination parameters

Parameter	High Score	Lowest Value	Mean	Standard Deviation
Difficulty	5.331	-0.388	1.002	1.104
Discrimination	1.137	0.292	0.717	0.213

Table (4) shows that the value of the difficulty parameter ranged between (- 0.388 - 5.331) with an arithmetic means (1.002), and that the value of the discrimination parameter ranged between (0.292 - 1.137) with an arithmetic means (0.717).

The data function was also extracted for the test, to draw the relationship between the values of the item information function and the standard error of the scale items estimation according to the two-parameter logistics model, as Figure (2) shows.

Figure(2)
Test information Function and standard error of estimation according to the two-parameter logistic model
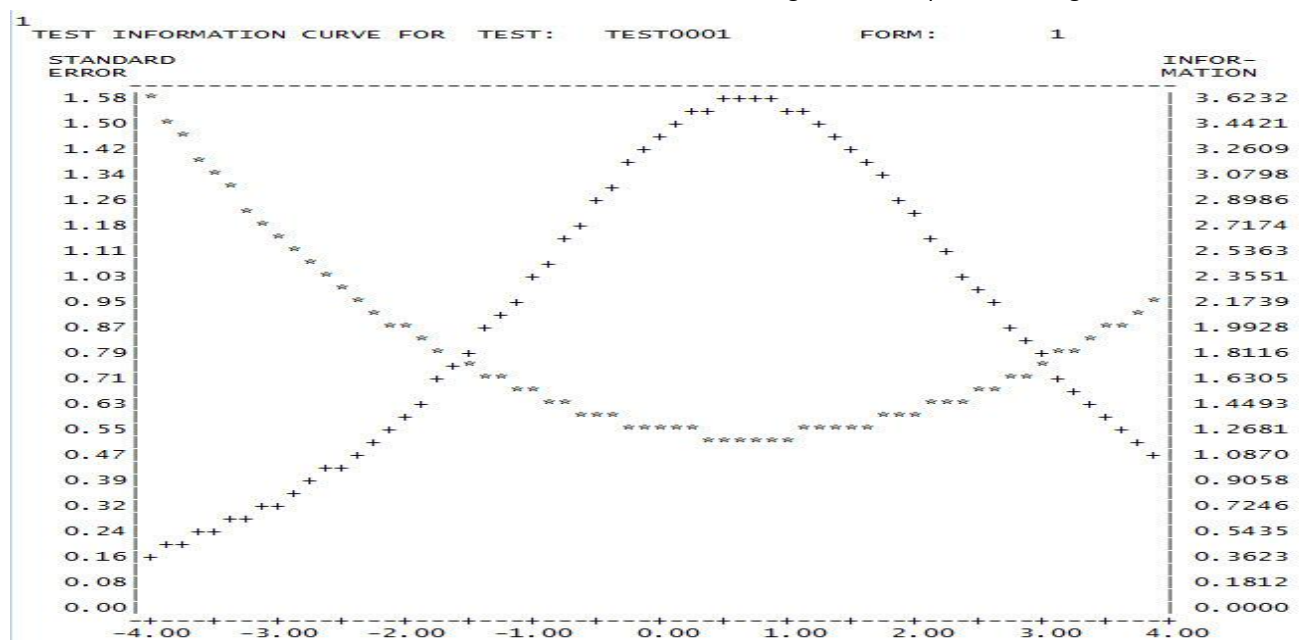
Figure (2) shows that the most considerable amount of information provided by the test as a whole is at moderate ability, as the value of the test information function reached (3.62) at an ability level(0.75), and that the least amount of information was at the high and low ability levels. The figure also illustrates that the value of the information function increases with the decrease in the values of the Standard Error of Estimation, which fits the model's expectations.

The fourth question: Are there statistically significant differences at (α = 0.05) in the level of digital culture test due to gender and the education sector?

To answer this question, the arithmetic means and standard deviations of the level of digital culture skills were extracted according to the variables: gender and education sector, as Table (5) shows.

Table 5.The arithmetic means and standard deviations of the level of digital culture test according to gender and the education sector

Variable	Level		Informational Culture	Media Culture	Information and Communication Technology	Total Degree
Gender	Male	Mean	5.15	3.18	2.85	11.18
		Standard Deviation	2.51	1.75	1.59	4.33
	Female	Mean	6.02	4.25	4.30	14.58
		Standard Deviation	2.48	2.13	2.01	5.48
Education sector	Public	Mean	5.41	3.51	3.49	12.42
		Standard Deviation	2.37	1.79	1.91	4.68
	Private	Mean	6.43	4.74	4.41	15.59
		Standard Deviation	2.78	2.47	2.05	6.29

It is noticed from Table (5) that there are apparent differences between the arithmetic means of the level of digital culture according to the different variables of gender and the education sector, and to figure out if these differences are statistically significant, MNAOVA test was extracted as table (6) display .

Table 6.The results of the multivariate analysis of variance (MANOVA) for testing the significant differences between the arithmetic means of digital culture test according to gender and education sector.

Variables	Variance Source	Sum of Square	df	Mean Square	F	Sig.
Gender	Informational Culture	214.418	1	214.418	36.586	0.000
	Media Culture	203.966	1	203.966	55.744	0.000
	Information and Communication Technology	350.485	1	350.485	107.664	0.000
	Total	2270.132	1	2270.132	98.682	0.000
Education	Informational Culture	75.385	1	75.385	12.863	0.000

sector	Media Culture	147.263	1	147.263	40.247	0.000
	Information and Communication Technology	72.904	1	72.904	22.395	0.000
	Total	861.776	1	861.776	37.461	0.000
	Informational Culture	3786.028	646	5.861		
	Media Culture	2363.703	646	3.659		
Error	Information and Communication Technology	2102.968	646	3.255		
	Total	14860.873	646	23.004		
	Informational Culture	4145.440	649			
	Media Culture	2760.045	649			
Total	Information and Communication Technology	2570.345	649			
	Total	18384.038	649			

It could be noticed from Table(6) results the existence of statistically significant differences between the arithmetic means of the digital culture test in all domains and the total score according to the gender variable were F reached(98.682), p-value=0.000<α=0.05 and in favor of the females for total score and the domains. Table(6) also shows that there are statistically significant differences between the arithmetic means of digital culture test in total score and all domains according to the education sector variable as F reached (37.461), p-value=0.000<α=0.05 and in favor of the private sector for the total score and the domains.

This result may be attributed to a number of social and cultural factors; Parents assume that males are more gifted than females in achievement, which prompts them to encourage females to study more, leading to their superiority. The methods and ways of family education and upbringing that females undergo differ from males as females are treated more thoughtfully and caring. The different educational achievement styles of males and females play a role in females' superiority, who usually strive to focus on understanding the subject. In contrast, males seek to focus on attaining the final results of their studies. Females are more academically superior than male students, and females are more disciplined, good at listening, and adhere to instructions. Females are also able to pay attention and complete duties than males.

The findings of the answer to this question differed from the results of Melhem's study (2017), which showed statistically significant differences between the arithmetic means of the degree of the twenty-first-century skills of availability in the technology course for the higher basic stage in favor of males. The results of the answer to this question differed from the results of Siddiq's study. And Siddiq, Gochyyev &Wilson (2017), showed no statistically significant differences between the arithmetic means in assessing students' twenty-first-century skills in learning through interaction with networks, information, communication technology, and cooperation across the gender variable.

The existed outcome of differences between the arithmetic means in favor of the private sector can be explained by the interest of private schools in developing a digital culture for students. These

schools' curricula consider students' acquisition of various knowledge and skills, as digital culture expresses information awareness, knowledge, and abilities emanating from it that guarantee the individual the ability to keep up with the developments of vibrant life positively and continuously.

Conclusion:

The result of the statistical analysis proved that the logistic model that fits the data is the two-parameter logistic model, Moreover Judging by the number of results of initial and filtered searches, we find that digital culture is an essential issue in today's life for students to possess the skills needed to deal with academic success and be prepared later for the job market.

Also, the result of data analysis demonstrated that the digital culture test has suitable psychometric properties in light of the Item Response Theory. Furthermore, the findings showed that the arithmetic means of digital culture test were affected by gender in favor of the females students , and the education sector in favor of the private sector, these findings could be attributed to the fact that females are more academically superior than males students, and females are more disciplined, good at listening and adhere to instructions. Females, by nature, pay attention and carry out their duties and accomplish tasks more than males do, Furthermore, as for the private schools in Jordan, they consider and integrate in their curricula students' acquisition of various knowledge and skills.

Recommendation

The authors suggest using the digital culture test of this study by researchers in the field of education, a further suggestion for the researchers to conduct more studies on digital culture skills using other logistic models of Item Response Theory, next researchers should consider investigating other variables expected to affect student digital culture skills.

Conflict of interests

The authors declare that they have no conflict of interest.

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