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Research Article

Psychometric Characteristics For Learning Skills Test In The Light Of Twenty-First Century Skills In Science Education

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Abstract : This study aimed to identify the psychometric characteristics of testing learning skills in light of 21st century science skills. The descriptive analytical curriculum was used to achieve real results to reveal the psychometric characteristics of testing learning skills in the light of 21st century skills in science education, and in order to achieve real results, 1,070 students were selected as a sample of students from the eighth grade in the Directorate of Education in the Province of Authority from the public and private sectors. Where the researchers built the study tool, which was to test the skills of learning and teaching in the subject of general science after reference to literature and previous theoretical and scientific studies that were interested in detecting the skills of the twenty-first century in science education, and after the application of the test the results were analyzed and the results showed that the study tool that was built and applied to the individuals of the sample has appropriate psychological measurement characteristics, while the results of the study showed the absence of statistically significant differences in all demographic variables as a gender variable of the study, as well as the lack of Statistically significant differences in overall and sub-skills, with the exception of the standards (dimensions) of communication and cooperation as a result of the change in the education sector in favour of the public sector.

Keywords: 21st Century Skills, Communication and Cooperation Skills, Critical Thinking.

Introduction

Recently, the outburst of information and the growing technological advancement requires the training of individuals who are able to face the accelerating scientific and technical challenges, this in return urge teachers to make every effort to equip students with the necessary skills to keep pace with the steady global changes.

Zaitoun [8] points out that living in the twenty-first century and coexisting with its changes where challenges are embodied in the continuous progress of the scientific and technological approaches, require the use of science and technology in the appropriate way in various aspects of life. Stressing that positive interaction with the developments of science and technology helps to mend the scientific and technological gap between societies. The need for change and improvement in education in general and in science education, in particular, has become a global priority and the reason behind this is that science has the ability to interact with the most accurate rationale to cause a change in various societies. This is confirmed by the continuous projects to modify the education of science curricula since the beginning of the twentieth century until now.

One of the most important goals of science education reform projects, since the beginnings of scientific education, is preparing students and qualifying them to interact with the variables of their societies. This goal has crystallized in different ways to achieve it through the reform movements and the projects they produced. Project 2061 is one of the most important projects due to the alarming results in the report called “A Nation at Risk” where it revealed the underperformance of American students. It resulted in framing the basic outlines of vital

documents, such as Benchmarks For Science Literacy (BFSL) and National Science Education Standards (NSES) [3].

However, in the last century the pursuit of science education reform projects to equip the individual and enable him to keep pace with scientific and technological changes at the personal and societal levels, was not sufficient, as was illustrated by Bybee [13] in his book "Science Education from the Perspective of the Skills of the Twenty-First Century". He inferred from the previous specialized scientific and economic studies that science education curricula and programs do not fulfill the purpose of preparing students for life and work in the twenty-first century. Rather, students are preparing for jobs that are about to disappear if not they have already extinct from the global labor markets that are led by scientific and technological development, stressing the need to restructure science education to equip the individual with the required skills by rapid changes that are in line with the current and future developments.

Based on the above-mentioned facts, international academic, scientific, and technological institutions and bodies have submitted comprehensive proposals and frameworks through which they sought to agree to define the twenty-first century skills students are required to possess and relate them with educational programs and systems. The Partnership for 21st Century Skills (P21) was established in 2002 from several American and international educational, technological, scientific, and economic institutions, the most important of which are; US Department of Education and the National Education Association (NEA). This partnership, P21, provided an encouragement to build and integrate the twenty-first century skills necessary for individual success in life, enabling any individual to fulfill the requirements of scientific and technological progress through learning in schools and universities [21,28,30] Several institutions outside the Partnership for Twenty-First Century Skills (P21) have also sought to define frameworks and proposals of their own for twenty-first century skills. For example, the Organization for Economic Cooperation and Development (OECD), the North Central Regional Educational Laboratory (NCREL), the American Association of Colleges & Universities [19,23].

On the other hand, the National Science Teacher Association (NSTA) and the National Research Council (NRC) have confirmed, as a result of a series of specialized studies, that the accurate description and organization of skills presented by the Partnership for Twenty-First-Century Skills (P21) is the most organized and applicable in the field of science than others. The Partnership for the Skills of the Twenty-first Century (P21) showed how to incorporate the skills that it developed in the context of education for various subjects in order to enable students to keep up with the developments of this era. These skills were classified into four axes; The first is the cognitive content, which requires mastery of the basics of the language, science and mathematics, and the provision of the necessary knowledge to understand the twenty-first century topics, namely; global awareness, civic culture, economic, health, and the environment [18,21,28].

While the second axis, which is the most important, is represented in learning and creativity skills that develop students' capabilities for personal and professional success through an interest in previous scientific knowledge, and skillfully employing it in real situations, focusing mainly on critical thinking and problem solving, communication and cooperation, creativity and innovation. The third axis included digital literacy skills, including information literacy skills, information and communication technology, media culture and multimedia, and the fourth axis expressed life and work skills that included initiative skills, self-direction, flexibility, adaptability, productivity and accountability, leadership, and assuming responsibility [13,28,30].

Similarly, the (NRC), (NSTA) and (P21) focused on the need to define common standards for learning, teaching and evaluating through coordination between the twenty-first century skills and the national standards for science education (NSES). Hence, it became a nucleus for formulating twenty-first century skills in science

education and identifying its accurate details, and perhaps this is confirmed by its taking on the basic principles in sketching special maps that show how to integrate the twenty-first century skills in science from kindergarten to twelfth grade (K-12) prepared in 2008 by (NSTA) and (P21) during the building of the products learn for each skill of the twenty-first century skills that students must achieve at the end of grade four, eight, and twelfth [18,21,28].

In this context, the collaboration between (P21) and (NSTA) have agreed that the twenty-first century skills maps for science education are very vital for students of the eighth-grade basic skills in science education according to its main standards. This study is concerned with the standards of learning and innovation, which was adopted in building the learning skills test, as its sub-skills were considered the most important of all skills; for its ability to distinguish students who possess the skills of the twenty-first century more than others as Trilling & Fidel [30] explained. This standard includes four sub-skills mainly related to learning:

First: Creativity and Innovation: The creativity and innovation skills of the twenty-first century include the ability to generate, expand, revise, analyze, evaluate, and validate a large number of valuable ideas. In order to prove their originality, the ability to communicate them to others, and transform them into useful practical products.

Second: Critical Thinking and Problem Solving: Kilbane and Milman [17] point out that students who possess the skill of critical thinking and problem-solving use different thinking styles. Inductive and deductive measures in line with the educational situation. They also can analyze the complex ideas they face, evaluate them, formulate hypotheses, examine them, and collect the necessary information after verifying their validity, in preparation for issuing judgments and establishing arguments. Moreover, these skills enable them to solve various problems in creative and unfamiliar ways, and they both represent together the basis of a proper scientific inquiry that provides students with real opportunities for planning, implementation, interpretation, analysis, and comparison of their results with the findings of scientists in the same context.

Third: Communication: Effective communication in the twenty-first century is the ability to express the use and interpretation of information contexts more broadly than verbal and writing. In fact, it includes diagrams, mathematical expressions, images, illustrations, and technology with their multiple media, so that the individual can understand and employ the information contained in all the contexts simultaneously. On this bases, communication is an important anchor of scientific research that depends on observation and interpretation. Scientists describe their research to others in such a way as to ensure that specialists can verify it and non-specialists (non-scientific) to understand and benefit from it, and this calls for students to employ different written, oral and technological contexts in effective scientific communication with others [16,25].

Within this framework, Trilling & Fidel [30] and Kilbane & Milman [17] assert that the twenty-first century accumulative scientific skill of students' creativity, critical thinking, and problem solving gives them the required ability that enables them to communicate in several ways to express what they reached it or what they seek to reach from knowledge.

Fourth: Collaboration: Collaboration requires students to have the ability to work effectively and respectfully, as well as to appreciate the value of sharing opinion and action. Given the cooperative nature of science that intertwines and interacts with other knowledge contexts, (P21) scientists, as a partnership for twenty-first century skills, presupposes that there are complementarily between different subjects and skills, taking into account that modern and future scientific careers which require precise specializations which are supposed to be an incentive for students to be able to have good scientific knowledge, work in a team spirit, adapt to different roles and responsibilities and participate in scientific discussions to benefit and assist others.

Trilling & Fadel (2012) summarize what they have elaborated on learning skills as the keys to the twenty-first century and the attributes of experts. Familiar, which makes the desired model for the student of the twenty-first century well-defined.

Based on the aforementioned, and based on the importance of students employing the twenty-first century skills in general and learning skills in particular, to ensure their survival in the global scientific and technological competitiveness system; It is necessary to pay attention to the reality of Jordanian students and to ask an unavoidable question related to what students possess of these skills and how they can diagnose and evaluate the presence or absence of them. The international and national tests whose questions are based on the twenty-first century skills emerge part of the foremost desire. The evaluation test results of (TIMSS) Trends In International Mathematics and Science Study showed that the level of Jordanian students in the field of science is lower than that of their peers in the world, as Jordan ranked (28) out of (50) countries in 2011, and unfortunately, in 2015 it is ranked the (32nd) out of (39) countries which are included in the study [20].

As for the national tests prepared by the Jordanian Ministry of Education in order to have indicators that assess students' possession of learning skills according to the economy of knowledge and to evaluate the outcomes of education programs in general. In 2016, the results showed that the average performance of eighth-grade students in the science subject was below the desired degree of proficiency, reaching (44) out of (100) with substantial differences between males and females in favor of females, and between the government and private sectors in favor of the private sector [7].

It should be noted that the current study has been limited to research and scrutiny in the science education of the twenty-first century skills in hope that the learning outcomes would be matching to the prepared maps by (P21) and (NSTA) has been achieved in this context for the eighth grade. Since it is one of the checkpoints and reviews to judge the quality of Educational programs in science education at the global level, Zaitoun (2010). Therefore, they were selected as a sample for the study, and it was limited to three sub-skills from the standards of learning and creativity: Critical thinking, problem solving, communication and cooperation. The skill of creativity and innovation is excluded from the measurement in the study tool because of the specificity of its components that require building an essay test to reveal it.

Studies and research have focused on the topic of twenty-first century skills and how to measure students' acquisition and level, given that it is an attractive element for research and investigation at a global level. However, some studies have focused on examining the psychometric properties of the tests and the objectives which are measured in multiple fields. Studies have linked this to tests or measures to twenty-first century skills in science education. In response to that, a study conducted by Amran, Perkasa, Satriawan, Jasin, and Irwansyah, (2019) sought to measure the degree of students' possession of the skills of the century and their environmental awareness in Indonesia where two measures were applied: The 21st Century Skills Scale includes four standards: critical thinking, collaboration, communication, and creative thinking and the Self-Assessment Scale for Environmental Awareness. The study followed the descriptive approach, as its sample consisted of (184) students in the secondary stage. The results showed that the students have a low level of twenty-first century skills. The skills are ranked in descendent order creative thinking, critical thinking, cooperation, and communication.

Ref [5] focused on building a scale for scientific research skills and identifying the indications of validity and its stability parameters among graduate students at the College of Education at Umm Al-Qura University. The study sample consisted of (496) male and female students, and the study adopted the descriptive approach. In order to achieve its goals between the scale of scientific research skills, the results showed that the scale has good psychometric properties based on the indications of validity using internal consistency, discriminatory validity,

exploratory and affirmative global validity, in addition to the constancy of the stability coefficients using the Spearman-Brown equation and the Alpha Cronbach coefficient, which confirmed the stability of the scale.

Afandi, Sajidan, Akhyar & Suryani, [11] conducted a study which aimed at building a proposed framework for the integration between environmental science courses and twenty-first century skills standards in science education in Indonesia, using the Delphi method and applying specialized questionnaires through which opinions and suggestions were elicited by (15) experts and educators from various scientific backgrounds in the field of science and the results showed that the experts agreed on four dimensions of the 21st-century skills standards for science education. Featured in information and communication technology, thinking skills, character building skills, and spiritual values. The study of Kana'n [15] aimed to determine the relationship between students' skills in the twenty-first century and academic achievement in science in Jordan. The research sample consisted of (96) students from four urban schools and four city schools in Irbid randomly. The researcher developed the Malaysian 21st Century Skills Tool, which is based on the 21st century skills framework of Metiri and NCREL. The results indicated the existence of statistically significant differences attributable to academic achievement in favor of students with higher achievement, and the existence of differences attributed to gender in favor of female students in the city's schools.

While Siddiq, Gochyyev & Wilson [29] study sought to evaluate students' twenty-first century skills in learning through interaction with networks, information and communication technology, cooperation, communication, and problem-solving in Malaysia, where the study sample consisted of (144) students from Ninth grade. The information and communication technology test was applied to assess the level of students' ability to communicate and cooperate with each other through chat programs or search engine documents and their documents during a specific period of time and deal with digital data and solve problems through it. The results showed that there are no significant differences due to the gender variable. And the existence of differences attributed to academic motivation and socio-economic background.

While Fraihat and Bani Yassin [6] conducted a study aimed at identifying the psychometric properties of a reference spoken chemistry test according to the modern theory of educational and psychological measurement. The study sample consisted of 390 male and female students from the second scientific secondary class in the Irbid Education Directorate in Jordan. The test consisted of 57 multiple-choice items. The results showed that the test reliability coefficient reached 0.97 and the individuals' stability coefficient reached 0.89. The test has high validity and provides the largest amount of information on students' performance ability level was average.

As for Danielle, Salloum, Khishfe & BouJaoude [14], they used in their study the prepared framework by the Partnership for Twenty-First Century Skills (P21) to build a tool for analyzing science curriculum standards and determining their suitability for twenty-first century skills; the knowledge of science books, skills, and additional components of the curriculum, were applied to samples of science books in Ohio, New York, Qatar, and Lebanon. The study concluded that the implication of the skills of the twenty-first century was not at the required level.

While Al-Daham [1] sought to extract the psychometric characteristics of the behavioral characteristics scale for the detection of gifted students. The study sample consisted of (289) elementary grades in the regions of Jeddah, Abha, and Al-Ahsa in Saudi Arabia. The validity of the scale was verified through arbitration and internal consistency, as the values of the item correlation coefficients differed. In the total range between (0.35-0.96), and the factor analysis, the stability was verified by the Cronbach Alpha method, and its coefficients were between (0.81-0.90) and the half-segmentation and its coefficients ranged between (0.91-0.96) and its repetition, and the values of the stability coefficients ranged (0.81-0.87).

Through the presentation of previous studies, it is possible to conclude their diversity in their objectives, tools and procedures, and this is a clear evidence of the importance of twenty-first century skills as a modern global educational trend. Empty research - within the limits of researchers' knowledge - related to determining the psychometric properties of a learning skills test in particular, and thus this study is considered the first study that investigated this aspect.

Statement of Problem and its questions

The researchers drew on the study problem from the reality of their experience in the educational field and as a result of reviewing a number of literature and studies concerned with topics related to the study. In Jordan, the students' evaluation of the curricula in general and of the science curricula in particular in is still done in the traditional way through tests that often measure students' possession of basic scientific knowledge, without paying the same attention to determining the to which extent students possess the skills they need to enable them to keep pace with the rapid developments in science and technology in the current century. The researchers believe that there is a big gap between the skills that students learn in schools that they need in life and work. Perhaps the evidence is shown in the low results of the international test TIMSS and the national tests based on the economy of knowledge skills, including skills for critical thinking and problem solving, from the low-performance level of the elementary eighth-grade students and the Ministry of Education [20,24].

This created a problem for the researchers, which is summarized in the necessity of having tests that suit the Jordanian environment where students' acquisition of the learning skills is necessary for their success in the twenty-first century is clearly and accurately measured. This is following the Ministry of Education's endeavor to prepare students to be active and productive individuals in society, who possess the skills that enable them to interact with the developments of the scientific and technological changes.

Hence, the study problem is summarized in determining the psychometric characteristics of a learning skills test in light of the twenty-first century skills in science education, and the study tried to find the answer of the following questions:

- What are the implications of the validity of the learning skills test in light of the twenty-first century skills in science education?
- What are the implications of the stability of the learning skills test in light of the twenty-first century skills in science education?
- Are there differences in testing learning skills in light of the twenty-first century skills in science education attributable to the variables of gender and the education sector?

Study Approach:

The study followed the Descriptive Research method in achieving the study objectives and answering its questions, as the quantitative method was adopted in collecting data, and the psychometric method was used to reveal the characteristics of the study tool.

Study population and sample:

The study population consisted of all students of the eighth grade in the Directorate of Education of the Salt region who are enrolled in male and female schools in the government and private sectors for the academic year 2018/2019, as shown in Table (1).

Table (1)

Distribution of the study population according to

the study variables, gender and the education sector

Education sector	Gender		Total
	Female	Male	
Government	1392	933	2325
Private	275	513	788
Total	1667	1446	3113

As for the study sample, it was chosen by the random cluster method, by choosing the school (and the division) as the Cluster Sample unit, as shown in Table (2).

Table (2)

Distribution and sample of the study population according to the number of schools and the number of students

	The whole sample	Sample of the study	Percentage%
Number of schools	70	35	%50
Number of students	3113	1070	34.37%

Table (3) shows the distribution of the study sample according to the two variables of the study: gender and the education sector.

Table (3)

Distribution of the study sample according to the study variables, gender and the education sector

Education Sector	Gender		Total
	Female	Male	
Government	445	299	744
Private	152	174	326
	597	473	Total

Study Tool: Test of Learning Skills

In order to collect data and answer the study questions, this test was prepared by reviewing relevant previous educational literature and using maps of academic science content. The test included in its final form (25) multiple-choice items, each of which was followed by four alternatives. The test targeted the skills of critical thinking, problem-solving, communication and cooperation only from the focus of learning and creativity skills, and excluded the skill of creativity and innovation for its specificity.

The validity of the study tool was verified by extracting the following indicators:

- Validate the content:

The test was presented in its initial form, which included (30) items, to be reviewed by (12) science curricula and teaching methods specialists in order to assess the range of its comprehensiveness in the areas of science education learning skills in light of the twenty-first century skills and its scientific and linguistic validity to measure what was prepared for it. Taking into consideration the referees 'notes, some items have been modified and others deleted so that the number of test items in the final form is (28) items.

The items correlation coefficients were extracted with the total score and the dimension to which it belongs, as seen in Table (4) below.

Table (4):

Items correlation coefficients with the total degree

Item	correlation coefficients with the total degree	correlation coefficients with distance
1	**0.54	**0.56
2	**0.49	**0.45
3	**0.64	*0.34
4	**0.53	**0.55
5	**0.48	**0.49
6	0.04	0.15
7	**0.63	**0.62
8	**0.65	**0.45
9	**0.68	**0.47
10	**0.70	**0.63
11	**0.72	**0.45
12	**0.74	**0.49
13	**0.76	*0.43
14	*0.38	**0.58
15	**0.77	**0.41
16	**0.52	*0.40
17	**0.62	*0.39
18	**0.51	*0.62
19	**0.63	**0.44
20	*0.45	**0.50
21	**0.50	**0.46
22	0.09	0.06
23	**0.47	**0.45
24	**0.63	**0.62
25	**0.45	**0.50
26	**0.44	**0.63
27	*0.43	*0.43
28	0.11	0.10

** when ($\alpha = 0.01$) * when ($\alpha = 0.05$).

It is noticed from Table (4) results that the values of the correlation coefficients were all positive and statistically function except for paragraphs (28, 22, 6) and thus they were omitted from the test, and the test in its final form consisted of (25) items.

To verify the reliability of the test, it was applied to an exploratory sample from outside the study sample consisting of (60) male and female students, and after two weeks the application was re-applied to the members of the sample themselves (stability of repetition). Internal consistency through Cronbach's Alpha equation and Table (5) shows these values.

Table (5)

Evaluate the stability coefficients with the return method and internal consistency by the method of the Cronbach-Alpha sub-skills equation The overall score for the learning skills test

Test skills	Pearson Correlation Coefficient (reliability coefficients)	Internal consistency (Cronbach-Alpha)
Critical thinking	0.81	0.85
Problem -solving	0.82	0.80
Communication and collaboration	0.84	0.88
Total	0.86	0.90

Study implementation procedures

- After defining the study problem, the educational scientific literature and previous studies related to the subject of the study were reviewed, and then the study population was identified, the sample, the specially built tool, verification of its psychometric characteristics, and the test applied to students (the study sample), with the help of some teachers and supervisors in the Directorate of Education of Salt.
- Correcting the test, extracting students' marks, collecting and unpacking data, analyzing it statistically (descriptive and inferential) and classifying the statistical data of the study sample in light of its variables; They are: gender (male, female), the education sector (governmental and private), analyzing and interpreting results, reaching conclusions and formulating recommendations in light of the reached results.

Study variables

The study included independent and dependent variables as follows:

First: the independent variables; Which:

- Gender, and it has two levels: male (student) and female (student).
- The education sector, which has two levels: governmental and private.

Second: the dependent variable; it is a test of learning skills in light of the twenty-first century skills in science education.

Results, Discussion, Conclusions, Recommendation

First: The results related to the answer to the first study question, "What is the significance of the validity of the learning skills test in light of the twenty-first century skills in science education" ?

To answer this question, the validity factor was extracted through:

Validity:

Where the normal distribution of students' responses to the learning skills test was verified using the One-Sample Kolmogorov-Smirnov Test (KS), with a value of (1.679) and it is not statistically significant at the level ($\alpha = 0.05$), which indicates the normal distribution property, which allowed the factor analysis procedures to be completed. Where the validity of the factor test was verified by employing the first-class Exploratory Factor Analysis on the sample as a whole using the Principal Component Analysis method for the responses of individuals to the test items, and the rotation process was performed using Varimax Rotation. For factors whose latent root values were greater than (1), the values of latent roots (Eigen Values) and the Explained Variance ratio were calculated for each of the factors, as Table (6) shows these results.

Table (6):

Summary of the results of the factor analysis using the main components method and the orthogonal rotation of the performance on a learning skills test

Factors	Latent Root	Explained variance	Cumulative explained variance %
1	4.053	16.213	16.213
2	1.654	6.617	22.830
3	1.231	4.925	27.755
4	1.203	4.813	32.568
5	1.157	4.628	37.196
6	1.106	4.423	41.618
7	1.063	4.254	45.872
8	1.003	4.013	49.885

Results of Table (6) reveals that there are six factors whose latent root values are greater than the correct one, as the value of the latent root of the first factor reached (4.053) and the explained variance of this factor was (16,213%), and that the second factor had a value of (1.654). Explain variance is (6.617%) , and since the result of dividing the first factor by the second factor exceeds (2), this is an indication of the achievement of a one-dimensional characteristic in the interpretation of performance of this test, which means that it measures learning skills only. The graphic representation shows the latent roots values of these factors resulting from the factor analysis of the learning skills test.

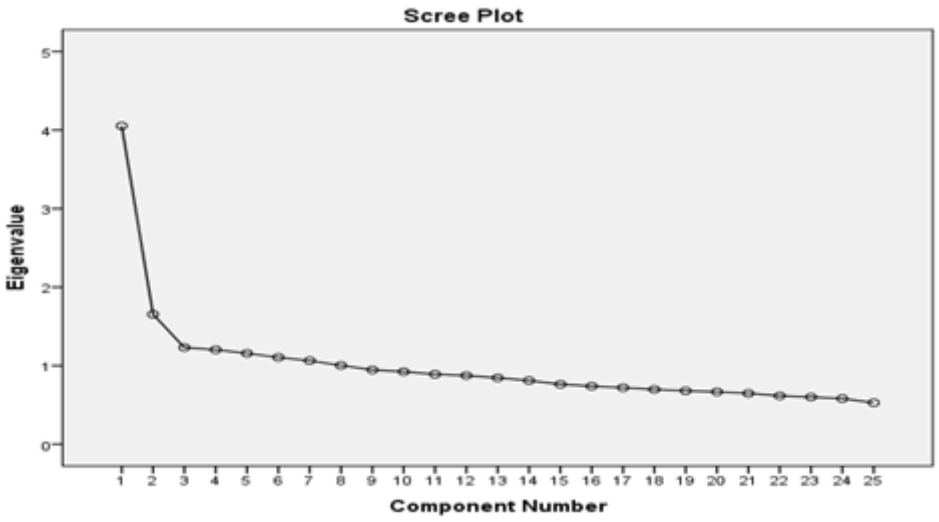

Figure (1)

Graphical representation of the values of the underlying roots of the factors that explain performance on a learning skills test.

It is noticed from Figure (1) that the amount of slope between the first factor and the second factor was very large when compared to the slope between the second and third factor, and then the slope remained close between the remaining factors, which confirms the fulfillment of the one-dimensional assumption in the interpretation of performance on this test. The results showed that the learning skills test has appropriate validity indications when applied to the eighth-grade students in Jordan. It is signified by the quantitative indicators obtained from the application of validity that showed the test measures learning skills only. This result can be explained by looking at the careful review of educational literature and previous studies and research related to learning skills based on

the skills of the twenty-first century and extracting ideas that reliably achieve the purpose of this test. And taking into account the scientific foundations for writing the multiple-choice items.

Second: The results related to the answer to the second question : "What are the implications of the stability of the learning skills test in light of the twenty-first century skills in science education"?

The reliability of the learning skills test was verified by the following methods:

- By relying on internal consistency using the Cronbach Alpha equation: where it was extracted on the main sample of the research and its value was (0.82), which is a high value suitable for the purposes of the current study.
- Stability using half-segmentation: its value is (0.87), which is considered an appropriate value for the purposes of the current study.
- Standard error of measurement: The standard error of measurement was found for each of the total degrees, where the standard error is used as an indicator of stability, and its value reached (0.007), which indicates a high and appropriate stability coefficient.
- Extracting the stability using the Hoyt equation: This equation is an indicator of the internal homogeneity of the paragraphs through the use of the error variance and the variance between individuals, as its value reached (0.86).

In the diagnosis, evaluation, and classification, this was evidenced by calculating the reliability coefficients that are reached by The Cronbach-Alpha equation, the half-segmentation, the standard error of measurement, the Hoyt equation, and, accordingly, the high values of the stability coefficients are inferred by the low percentage of measurement errors that may occur upon application and the high value of the reliability coefficient through the Cronbach Alpha equation. It is inferred by the consistency of the test structure, while the increase in its value by the half-segmentation method indicates the clear internal consistency between the parts of the test, and the researchers attribute this result to the integrity and clarity of the procedures that were applied, taking into account the accuracy in implementing each of them, the clarity of the methodology used and their scientific sequence.

Third: The results related to the answer to the third question: "Are there differences in the learning skills test in light of the twenty-first century skills in science education attributable to the variables of gender and the education sector"?

To answer this question, arithmetic averages and standard deviations were extracted to test learning skills in light of the twenty-first century skills in science education in different gender shown in Table (7), and with different education sectors in Table (8).

Table (7):

Arithmetic means and standard deviations for testing learning skills in light of the twenty-first century skills in science education with different gender

Field	Gender	Standard deviation	Means	Number
Critical thinking	Male	2.34	4.99	473
	Female	2.30	4.88	597
	Total	**2.32**	**4.93**	**1070**
Problem Solving	Male	1.56	3.34	473
	Female	1.53	3.37	597
	Total	**1.54**	**3.36**	**1070**
Communication and collaboration	Male	1.75	3.28	473
	Female	1.80	3.36	597
	Total	**1.78**	**3.33**	**1070**
Total mark	Male	4.48	11.60	473
	Female	4.45	11.61	597
	Total	**4.46**	**11.61**	**1070**

Results of Table (7) points out that there are apparent differences between the arithmetic means of testing learning skills in light of the twenty-first century skills in science education with gender difference, and to find out whether these differences are statistically significant, the results of the multiple analysis of variance (MANOVA) as extracted from Table (8)

Table (8)

Arithmetic means and standard deviations for testing learning skills in light of the twenty-first century skills in

science education in different education sectors

Skill	education sector	No.	Mean	St. deviation
Critical thinking	Public	744	4.94	2.32
	Private	326	4.90	2.31
	Total	1070	4.93	2.32
Problem solving	Public	744	3.39	1.53
	Private	326	3.27	1.56
	Total	1070	3.36	1.54
Communication and cooperation	Public	744	3.40	1.78
	Private	326	3.15	1.76
	Total	1070	3.33	1.78
Total degree	Public	744	11.73	4.47
	Private	326	11.32	4.43
	Total	1070	11.61	4.46

It is noted from the results of Table (8) that there are apparent differences between the arithmetic averages for testing learning skills in light of the twenty-first century skills in science education in the different education sectors (government and private). MANOVA, Table (9) shows this.

Table (9):

The results of the Multiple Variation Analysis (MANOVA) to examine the significance of the differences between the arithmetic means for testing learning skills in light of the twenty-first century skills in science education with different gender and education sector

variance source	skill	Sum of square	Df	Mean square	f	sig
Education sector	Critical thinking	.456	1	.456	.085	.771
	Problem solving	3.451	1	3.451	1.455	.228
	Communication and cooperation	13.383	1	13.383	4.258	.039
	Total	38.334	1	38.334	1.927	.165
Gender	Critical thinking	3.199	1	3.199	.594	.441
	Problem solving	.103	1	.103	.044	.835
	Communication and cooperation	.682	1	.682	.217	.641
	Total	.411	1	.411	.021	.886
Error	Critical thinking	5741.757	1067	5.381		
	Problem solving	2531.290	1067	2.372		
	Communication and cooperation	3353.790	1067	3.143		
	Total	21223.007	1067	19.890		
Total	Critical thinking	31711.000	1070			
	Problem solving	14580.000	1070			
	Communication and cooperation	15200.000	1070			
	Total	165403.000	1070			

From the results of Table (9), it could be inferred that there are no statistically significant differences in the overall score and dimensions of the learning skills test with different gender if the significance values of “P” values are greater than (0.05) for each case. The researchers attribute this result to the similarity of the nature of school environments in general. Students study the same scientific curricula, with similar teaching methods and

strategies, as a result of male and female teachers submitting the same training courses on the one hand, and facing the same challenges related to teaching on the other hand, such as lack of time and curriculum momentum.

With regard to the education sector variable, the results showed that there are no differences attributable to the education sector variable on the total degree and on all dimensions except for the dimension of "communication", as the value of "q" reached (4.258), which is statistically significant at the level of significance ($\alpha = 0.05$) in favor of the government sector. This result can be explained by looking at the commonalities between the schools and the similarity of the science curricula appointed by the Ministry of Education to which the two parties follow, despite the presence of some additional scientific curricula in schools affiliated with the private sector. As for the existence of a statistically significant difference in the skill of communication and cooperation attributable to the education sector in favor of public education, the result can be attributed to the social and cultural background to which students belong in public schools, which encourages cooperation and engagement in group activities as a result of several factors, the economic dimension being one of them.

Recommendations:

Taking into consideration the results of the study, it recommends the following:

- Using researchers interested in the field of twenty-first century skills in science education to test learning skills because of its appropriate psychometric properties.
- Conducting other psychometric studies on the test by applying one of the paragraph response theory models such as the Rush model.

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