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DEVELOPMENT AND VALIDATION OF A 21ST-CENTURY SKILLS INSTRUMENT TOWARDS SUSTAINABLE EMPLOYABILITY OF GRADUATES OF TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING IN NIGERIA

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Abstract

The volatile global labour market and improvements in technology demand that teaching and assessment of Technical and Vocational Education and Training (TVET) institution programmes should focus on 21st-century skills (21CS) for the sustainable employability of the graduates. This implies that TVET institutions in Nigeria are expected to promote 21CS in their students. Traditionally, the teaching and assessment structures in the curricula of TVET institutions in Nigeria may not contain 21CS, which possibly accounts for the rising unemployment among the graduates. Since assessment plays a critical role in the actualisation of curriculum objectives, it is expected that both teachers and assessment practitioners should engage in assessment of 21CS. However, there is a lack of clarity regarding the specific 21CS that are being assessed in TVET programmes. This paper, therefore, identified 21st-century skills and developed an instrument for assessing the skills for sustainable employability. Four research questions were answered, and one hypothesis was tested. The study adopted an instrumentation research design. The population comprised all students of TVET institutions in Nigeria. Simple random sampling was used to select 2000 students of technical colleges in various trades. The Instrument for Assessing 21st Century Skills (IA21CS) was validated by four experts in measurement and evaluation and trial tested on 200 students with a Cronbach Alpha Coefficient of 0.87. Data were analysed using exploratory factor analysis and t-test statistics. Results showed that 60 out of the 100 items developed were retained in six of the fifteen factors with a high reliability coefficient of 0.95. Thus, it was recommended that the instrument be used to measure 21st-century skills of students in TVET institutions in Nigeria to promote sustainable employability of the graduates.

Keywords: Development, validation, 21st-century skills, sustainable employability, TVET.

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Introduction

An educational system is successful to the extent that it equips its students with the knowledge and skills that are required in the 21st century. Today, as never before, meeting the society's challenges demands educational excellence. Reviving the economy; achieving energy independence with alternative technologies; creating green jobs; and strengthening the healthcare system require a skilled populace that is ready for the critical challenges the society faces. The nature of work is undergoing rapid transformation from hard skills that involve technical abilities to modern skills that are more personality-related. These skills facilitate successful learning in the classroom and enhance sustainable employability.

Generally, there is a common definition of 21st Century Skills (21CS) across all the scholars. The term '21st-century skills' refers to a broad set of knowledge, skills, work habits and character traits that are believed by educators, employers and others to be critically important to success in today's world, particularly in academic programmes and workplaces. There are many terms used interchangeably to describe 21st-century skills, such as life skills, professional skills, workplace skills and soft skills. Scott (2015) defines the 21CS as the knowledge, skills and attitudes necessary to be competitive in the 21st-century workforce, participate appropriately in an increasingly diverse society, use new technologies and cope with rapidly changing workplaces. Voogt and Roblin (2012) explain it as an overarching concept for the knowledge, skills and dispositions that citizens need to be able to contribute to the knowledge society. According to Rich (2010), 21CS refers to certain core skills and competencies such as collaboration, problem-solving, digital literacy, knowledge and leadership skills students at the point of graduation need to succeed in work, life and citizenship.

Many researchers identified and grouped 21CS into four categories. Kennedy, Latham and Jacinto (2016) put the skills into four main categories: ways of thinking (creativity, critical thinking, problem-solving, decision-making and learning); ways of working (communication and collaboration); tools for working (information and communications technology and information literacy); and skills for living in the world (citizenship, life and career, and personal and social responsibility). Also, Binkley, Erstad, Herman, Raizen, Ripley, Miller-Ricci and Rumble (2012) categorise 21CS into four, namely, thinking (creativity and innovation, critical thinking, problem-solving, decision-making, and learning to learn); working with others (communication and collaboration/teamwork); facility with tools (information literacy and communications technology literacy); and general life skills (citizenship, life and career management, personal and social responsibility, and cultural awareness). Similarly, Partnership for 21st Century Skills (P21) grouped the skills into four main categories: digital age literacy, inventive thinking, effective communication and high productivity (Erdem, 2019).

The drive for holistic development as of today places a premium on 21st-century skills.

Modern workplaces need personnel who can solve non-routine problems, perform complex communication, and have social skills. According to Erdem (2019), the changes evident in the 21st century require new skills and should be possessed by individuals who will be engaged in the world of work. The 21CS is not an alternative to specific subject knowledge and technical skills; rather, it enhances these areas, allowing all employees to make use of their specific knowledge and technical skills (Kalauz, Goran & Kivinic, 2015). Nationally, the need to teach 21CS in order to prepare for the workforce has increased as the number of jobs that require such skills continues to grow (Hirsch, 2017). More jobs require interactions among multiple individuals or departments to complete tasks, and a changing economy has made specific technical skills less valuable (Mitchell, Skinner & White, 2010). Most available job vacancies today remain unfilled because job-seekers may not have the needed skills to fit into the jobs. Also, many businesses find it difficult to grow because of the inability to get the workforce needed to increase their productivity. The skill gap remains, and it is preventing economies from developing.

Workers in the digital age should know how to effectively convey and receive messages in person as well as via phone, email and social media. However, in Nigeria, the quest for technological breakthroughs, industrialisation and economic development is slow and unimpressive, as evidenced by the increasing rates of unemployment. For instance, in the first quarter of 2021, a report published by the National Bureau of Statistics (NBS, 2022) notes that Nigeria's unemployment rate has risen from 27.1 percent in the second quarter of 2020 to 33 percent in the fourth quarter. The analysis of the report further shows that the unemployment rate for youth aged 15 to 24 stood at 53.4 percent in the fourth quarter and at 37.2 percent for people aged 25 to 34. The jobless rate for women was 35.2 percent compared with 31.8 percent for men. The increasing rate of unemployment is a pointer to the fact that most Nigerian youths may not have the skill to start and operate a business and become self-reliant. This means that the country at large suffers economically, lacking the skilled manpower for job creation and sustainable development.

In any organisation, there are a variety of skills needed to effectively carry everyone along. These include communication, organisation, teamwork, creativity, critical thinking, and adaptability and social intelligence, as well as other factors that keep people going. These are key factors that control the relationship between people. They are important skills which individuals, especially leaders, are expected to possess. For instance, Doyle (2019) states that the ability to communicate effectively with superiors, colleagues, and staff is essential, no matter what industry you are working in. Thus, these skills are often not explicitly taught as part of school curricula. While content knowledge is a necessary requirement for students' education, successful academic achievement is not sufficient for professional accomplishment. Much has

been written about the importance of 21st-century skills, yet today there remains a gap between the skills college graduates enter the workforce prepared with and the skills needed in the places of work. Jobs in the 21st century require the use of high-tech equipment, as society depends on the ability of individuals to communicate, negotiate, compete and collaborate both locally and globally. In view of this, Ezenwafor and Okoli (2014) observe that the realities of globalisation and technological advancement call for schools to turn out skilled workers, who can acquire, apply and transfer their knowledge to varying technological conditions and societal changes.

Technical and Vocational Education and Training (TVET) is an integral part of secondary and post-secondary education that is designed to educate individuals about, through and for careers (Rojewski, Asunda & Kim, 2008). It is aimed at developing human resources and facilitates the transition of a nation to a more sustainable economy. TVET provides youths and adults with the technical skills, knowledge and training necessary to succeed in specific occupations and careers. The United Nations Educational, Scientific and Cultural Organization (UNESCO) – United Nations Vocational Education (UNEVOC) (UNESCO-UNEVOC, 2012) notes in its report that TVET has great prospects for tackling poverty, enhancing employability through skill acquisition and boosting sustainable development in different continents. Many people, both in developed and developing countries, recognized the important role that TVET plays in equipping individuals with requisite skills, thus enabling them to effectively participate in social, economic and technological innovation processes (Netherlands Organization for International Cooperation in Higher Education, 2010). The UNESCO (2010) estimates that about 80% of occupations around the world are based on the applications of TVET skills in the world of work. This implies that the future success of any country, individual, enterprise and community increasingly depends on the possession of TVET skills.

TVET institutions in Nigeria carry out teaching based on a curriculum, which is a document that explains how content standards should be organised and sequenced for a particular subject and at various grade levels. However, due to the rapid change in technology and information dissemination, the qualities and skills employers and colleges demand in the 21st century have changed. TVET needs to properly prepare their students to live and work in the 21st century. This preparation includes providing students with important skills needed in the 21st century. Thus, it is important to make the 21st-century skills an integral part of TVET curricula to enhance the employability of their graduates. This can be achieved with an effective measuring instrument. In education, identification of special traits and basic skills in humans has always relied on appropriate test instruments or rating scales.

In developing an instrument, validity and reliability are key indicators of its quality and usefulness. An instrument is considered valid when it measures what it is intended to measure (Muijs, 2011). The major types of validity include face, criterion, content and construct validity.

Reliability, on the other hand, refers to the extent to which test scores are free from measurement error, reflecting the instrument's stability or internal consistency. According to Hakan and Seval (2011), reliability may take various forms depending on administration frequency and respondents involved, such as test-retest, alternate forms, alternate forms and test-retest, internal consistency, and inter-rater reliability. Although an instrument can be reliable without being valid, it cannot be valid unless it is reliable (Muijs, 2011). Thus, a well-developed instrument should consistently and accurately measure the intended variables, yielding dependable results. A validated instrument embodies these qualities (Ogbebor & Uba, 2014).

In this study, there are fifteen skills identified in the development of the Instrument for Assessing 21st Century Skills (IA21CS). The elements of IA21CS are leadership, communication, teamwork, digital literacy, career, work ethics, collaboration, problem-solving, social responsibilities, critical thinking, creative thinking, analysis, flexibility, and interpersonal and professional attitude. The importance of these skills in personal development for effective performance of one's tasks necessitated the development and validation of the instrument for measuring students' 21st-century skills. A 21st-century skills survey could provide researchers with baseline data on these skills prior to an educational intervention. The instrument could be administered as a pre-test post-test assessment. This type of instrument could assess overall students' growth over a period of time.

The 21st-century skills have increasingly become the subject of various educational studies. For instance, Uwah and Orluwene (2022) develop and standardise the Soft Skill Scale (SSS) for educational and industrial use in Nigeria. The findings show that 69 items loaded into five factors (communication, organisation, teamwork, creativity and adaptability) with split-half reliability of 0.87. Validity through hypothesis testing evidence demonstrated significant differences in tribal scores, age and educational level. However, there were insignificant differences in the mean scores of respondents by gender. Also, Todd, Geoff, Jung & Euisuk (2019) develop a 21st-century skills instrument for high school students. The final exploratory factor analysis yielded a total of 30 items loaded across four subscales (communication, collaboration, critical thinking and creativity) with strong internal consistency within the constructs. In terms of gender differences in 21st-century skills, Sümen and Çalışıcı, (2017) reveal that females are significantly higher than those of male students. Similarly, Karakaş (2015) states that females have higher averages than male students in the cognitive, affective and socio-cultural dimensions of 21CS.

Twenty-first-century skills have been identified to be important to learners, trainers, employees and employers. Graduates entering the workplace are expected to possess adequate content knowledge and proficiency in 21CS. Much has been written about the importance of 21st-century skills, yet today there remains a gap between the skills possessed by college

graduates and the ones needed in places of work. The lack of such skills may be responsible for rising graduate unemployment, poor productivity and work delivery in organisations. Could it be that 21CS are not clearly identified and assessed in schools? Therefore, this study sets out to identify 21st-century skills and develop and validate an instrument for assessing the skills.

The objectives of the study are to:

1. Determine the factors of the instrument for assessing 21st century skills after rotation.
2. Examine the factor loadings of each principal component after rotation of the instrument for assessing 21st century skills.
3. Determine the convergent validity indices of the identified factors of the instrument for assessing 21st century skills.
4. Establish the internal consistency of the instrument for assessing 21st century skills.

Research Questions

The following research questions guided the study:

1. What are the factors of the instrument for assessing 21st-century skills after rotation?
2. What are the factor loadings for each principal component after rotation of the instrument for assessing 21st-century skills?
3. What are the convergent validity indices of the identified factors of the instrument for assessing 21st-century skills?
4. What is the internal consistency of the instrument for assessing 21st-century skills?

Hypothesis

1. There is no significant difference between the mean scores of male and female respondents in the instrument for assessing the 21st-century skills.

Methodology

The study employed instrumentation research design. The population comprised all students of both federal and state technical colleges across the six (6) geopolitical zones of Nigeria. Multi-stage sampling was employed in selecting the sample. Firstly, the simple random sampling technique was used to select 17 states out of the 36 states and Federal Capital Territory (FCT) across the six geopolitical zones in Nigeria. Secondly, out of 177 technical colleges, simple random sampling was also used to select 40, which comprised six (6) Federal Technical Colleges (one from each geopolitical zone) and thirty-four state technical colleges (two from each state). Thirdly, a simple random sampling technique was further used to select fifty students from each school, making a total of two thousand students.

The cross-sectional method was used to identify fifteen 21st-century skills for technical college students. Through an extensive literature review, current reports on workforce trends, nationally recognised skill sets, students' focused group discussions, input from educators, and experts in measurement and evaluation, the constructs that best represent what students need to

learn and acquire through their college in the 21st century were developed (Instrument for the Assessment of the 21st Century Skills). The instrument was a 100-item structured questionnaire developed by the researchers from literature reviewed. The questionnaire consisted of two sections (A and B). Section A contained information on students' Bio-Data consisting of five items, while Section B contained one hundred items that addressed some skills related to the activities carried out by students. Students were required to tick the level of engagement with the activities on a four-point Likert scale of Always (A), Sometimes (S), Rarely (R) and Never (N).

One hundred and seventy-two (172) items were thoroughly critiqued by experts; their comments regarding the appropriateness of each item and ability of students to understand and respond to them were sought. The experts' suggestion to rewrite 13 items and delete 27 was considered. After addressing the recommendations of the experts, only 145 items survived. Therefore, the 145-item instrument was trial tested on 200 students, and their responses were subjected to Cronbach's alpha reliability statistics. This helped in the decision for the removal of redundant 45 items due to negative average covariance among the items; thus, only 100 items were retained for the final instrument.

The researchers administered and retrieved the instrument in all the selected technical colleges. However, out of the 2000 copies of the instrument administered, 1901 were retrieved and used for the data analysis. Data was analysed using Exploratory Factor Analysis (EFA) and t-test statistics. The data analysis was in two (2) phases: (i) Preliminary analysis to check out the fitness of the data for factor analysis; (ii) the factor analysis.

The Main Analysis

- The method of factor extraction was principal component analysis
- There was a check for eigenvalues, communality, component matrix and scree plot.
- The axis was rotated using oblique rotation.
- The test items that loaded on each factor were identified. Only test items with factor loading exceeding 0.4 were retained for each factor.
- The factors were named. 124
- The item-total correlation matrix of the items in each of the sub-scales of the final scale was done to determine the new communality mean and the reliability coefficient of the factors if an item were deleted.
- Inter-factor correlation was also done to find out if they correlate (i.e., the correlation coefficient should be moderate).
- Finally, the internal consistency reliability coefficient of the final instrument was determined.

Result

Table 1
KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.967
Bartlett's Test of Sphericity	Approx. Chi-Square	62840.785
	df	3486
	Sig.	.000

Table 1 shows the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity, which are prerequisites to conducting factor analysis. The Bartlett's Test of Sphericity must be statistically significant. The KMO was 0.967, and Bartlett's Test of Sphericity (62840.785, $p < .0005$) confirmed the appropriateness of the data for proceeding with factor analysis.

Research Question One:

What are the factors of the instrument for assessing 21st-century skills after rotation?

Table 2
Total Variance Explained

Factor	Initial Eigenvalues				Extraction Sums of Squared Loadings									
	Rotation Sums of Squared Loadings				Total % of Cumulative Variance %				Total %					
Variance	Total	% of	Cumulative %	Total	% of	Cumulative Variance %	Total	%	Cumulative Variance %	Total	%	Cumulative Variance %	Total	%
1	21.756	25.900	25.900	21.161	25.192	25.192	7.552	8.991	8.991	2	3.508	4.176	30.077	2.946
	3.507	28.699	7.336	8.733	17.724									
3	2.523	3.003	33.080		1.974	2.350	31.049			4.323	5.147	22.870		
4	2.127	2.532	35.611	1.523	1.813	32.863		3.600	4.286	27.156				
5	1.925	2.292	37.903		1.218	1.450	34.312		2.478	2.950	30.106			
6	1.594	1.898	39.801		1.188	1.414	35.727		1.736	2.067	32.173			
7	1.478	1.759	41.560											
8	1.450	1.726	43.287											
9	1.302	1.550	44.837											
10	1.272	1.515	46.352											
11	1.193	1.421	47.772											
12	1.160	1.381	49.154	13	.967	1.151	55.256						
.	.	.	.											
.	.	.	.											
84	.270	.322	100.000											

Extraction Method: Minimum Likelihood

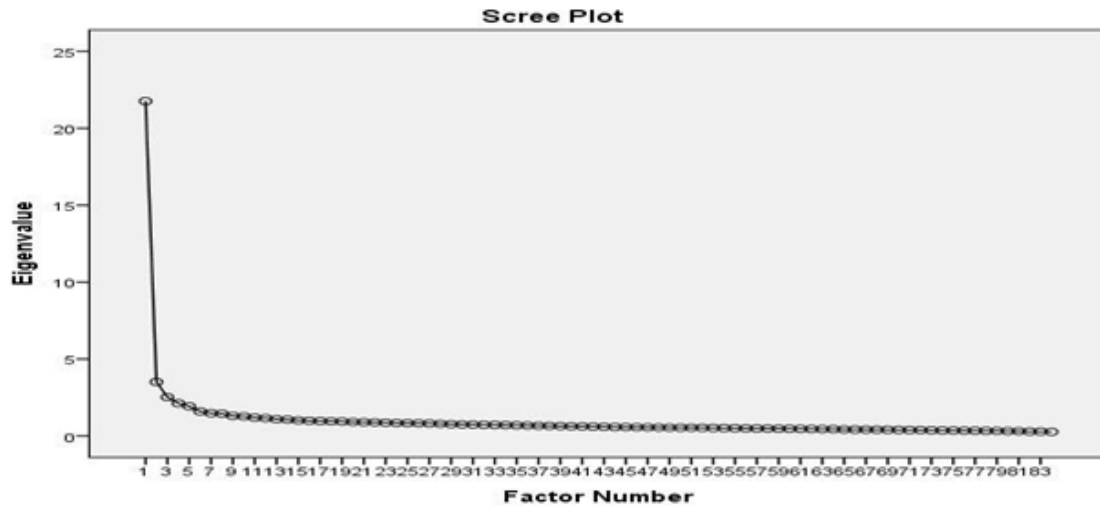


Figure 1: Scree Plot of Eigenvalues

Table 2 and Figure 1 show the investigation of different factors of the instrument for assessing 21st-century skills. Six underlying factors were extracted based on the scree plot and eigenvalue greater than 1 criterion. The six extracted factors had an extracted sum of squared loadings cumulative percentage of 35.727. Factors 1 to 6 had initial eigenvalues of 21.756, 3.508, 2.523, 2.127, 1.925 and 1.594, respectively. Total extracted sum of square loadings that respectively accounted for 25.192, 3.507, 2.350, 1.813, 1.450 and 1.414 percent of the total variance explained before the Varimax with Kaiser normalisation rotation. The rotation sum of squared loading total and % of variance explained for factors 1 to 6 were 7.552 and 8.991; 7.336 and 8.733; 4.323 and 5.147; 3.600 and 4.286; 2.478 and 2.950; and 1.736 and 2.067, respectively. Which amounted to 32.173 cumulative % of total variance explained by the six rotated factors.

Research Question Two

What are the factor loadings of each factor after rotation of the instrument for assessing 21st-century skills?

Table 3
Factor loadings after rotation

SN	Items	Factors					
		1	2	3	4	5	6
1	82	.563					
2	86	.553					
3	84	.545					
4	79	.539					
5	80	.523					
6	85	.516					
7	89	.503					
8	91	.502					
9	81	.489					
10	92	.480					
11	90	.480					
12	78	.479					
13	87	.464					
14	88	.453					
15	72	.448					
16	75	.445					
17	71	.418					
18	74	.412					
19	83	.408					
20	59		.576				
21	55		.576				
22	56		.539				
23	51		.529				
24	58		.513				
25	52		.511				
26	49		.487				
27	60		.484				
28	61		.477				
29	47		.475				
30	48		.469				
31	57		.461				
32	39		.439				
33	46		.438				
34	42		.429				
35	40		.421				
36	43		.407				
37	97			.690			
38	96			.654			
39	98			.636			
40	94			.569			

41	99	.556	
42	95	.555	
43	100	.511	
44	93	.422	
45	18	.535	
46	7	.480	
47	6	.476	
48	19	.432	
49	10	.420	
50	12	.413	
51	16	.402	
52	29	.655	
53	27	.653	
54	28	.653	
55	26	.627	
56	30	.477	
57	68	.531	
58	67	.471	
59	66	.457	
60	69	.456	

Table 3 shows the rotated factor matrix; factor loadings less than 0.4 were not displayed. Thus, only six factors emerged after the Oblimin rotation. Items that did not load on any of the factors were discarded. Therefore, the final scale has 60 items. The factors retained the name adopted from the original scale along with the items that loaded on each factor, though the order in terms of arrangements was rearranged in-line with the factor loadings.

Research Question Three

What are the convergent validity indices of the identified factors of the instrument for assessing 21st-century skills?

Table 4
Correlation Matrix of the Factors

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Factor 1	1					
Factor 2	.666**	1				
Factor 3	.715**	.517**	1			
Factor 4	.500**	.522**	.376**	1		
Factor 5	.321**	.244**	.325**	.264**	1	
Factor 6	.656**	.567**	.529**	.400**	.289**	1

**Correlation is significant at 0.05 level (2-tailed).

Table 4 shows that the correlation between the six factors was significant at 0.005 level of significance (2-tailed). This table contains the Pearson correlation coefficient between all pairs of factors. This correlation matrix was used to check the pattern of relationships between the factors. The correlation between the factors ranges between 0.244 and 0.715, meaning that the factors correlate well, which also implies that there exists a significant relationship among the factors.

Research Question Four

What is the internal consistency of the instrument for assessing 21st-century skills?

Table 5
Cronbach Alpha Coefficient of the Factors

Factors	No. of items	Mean	S.D.	Cronbach Alpha
Interpersonal Skill	19	63.67	10.325	0.915
Collaboration Skill	17	57.39	8.821	0.894
Professional Attitude Skill	8	27.65	5.190	0.881
Leadership Skill	7	23.32	3.695	0.706
Digital Literacy Skill	5	15.54	3.600	0.776
Critical Thinking Skill	4	13.62	2.447	0.770
Overall IA21CS	60	201.16	26.925	0.953

Table 5 shows that only 60 items of instruments for assessing 21st-century skills were retained, and the reliability coefficients of the factors range between 0.706 and 0.915. The reliability coefficient for the overall instrument (IA21CS) was 0.953, which was high. Although only 60 items were retained, the instrument is reliable and dependable for measuring 21st-century skills of technical college students. Therefore, we can conclude that the 60 items that constitute IA21CS and its factors are highly reliable.

Hypothesis

There is no significant difference between the mean scores of male and female respondents in the instrument for assessing 21st-century skills.

Table 6
Independent T-Test Of Male And Female Responses On 21st-century Skills

Grouping variable	N	Mean	Std Deviation	t-value	Sig.
Male	1365	333.87	37.38	4.478	.000*
Female	536	324.65	47.16		

*P < 0.05 level of significance; df = 1899.

Table 6 shows that the calculated t-value was 4.478, $df = 1899$, and $p < 0.05$. There was a significant difference between the mean scores of male and female respondents in the instrument for assessing 21st-century skills. Hence, the null hypothesis was rejected

Discussion

The study developed and validated an instrument for assessing 21st-century skills towards sustainable employability of graduates of TVET colleges in Nigeria. The 60 items in the instrument successfully measured the technical college students' 21st-century skills in six factors: interpersonal, collaboration, professional attitude, leadership, digital literacy and critical thinking skills. The identified factors in this study cover ways of thinking (critical thinking), ways of working (collaboration), tools for working (digital literacy), and skills for living in the world (interpersonal). The finding is supported by Kennedy, Latham and Jacinto (2016), who categorised skills into four: ways of thinking (creativity, critical thinking, problem-solving, decision-making and learning); ways of working (communication and collaboration); tools for working (information and communications technology and information literacy); and skills for living in the world (citizenship, life and career, and personal and social responsibility). Also, Binkley, Erstad, Herman, Raizen, Ripley, Miller-Ricci and Rumble (2012) corroborated the finding.

In terms of gender differences in the possession of 21st Century Skills, the result revealed a significant difference in favour of male students. This study is not in agreement with the studies of Sümen & Çalişici (2017) and Karakaş (2015) which revealed that female students have higher averages than male students in the cognitive, affective and socio-cultural dimensions of 21st Century Skills.

Conclusion and Recommendation

Based on the findings, it was concluded that the instrument for assessing 21st Century Skills is reliable and can be used for assessing interpersonal, collaboration, professional attitude, leadership, digital literacy and critical thinking skills of students in TVET institutions in Nigeria for sustainable gainful employment.

Therefore, it is recommended that TVET institutions, curriculum developers, and policymakers adopt and integrate the validated 21st Century Skills assessment instrument into their evaluation processes to regularly measure and enhance students' interpersonal, collaborative, professional, leadership, digital literacy, and critical thinking skills, thereby improving their readiness for sustainable employment in the modern workforce.

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