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Development and validation of critical thinking scale for postgraduate students

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Abstract
The aim of this study was to develop, validate and standardize critical thinking scale for postgraduate students in universities in southeast. The study employed an instrumentation design in which a four point scale were developed and standardized. An initial draft of 70 item instrument was developed. After experts review a 30 item instrument emerged and was administered to 300 secondary school students. The data collected were subjected to factor analysis. The result from factor analysis showed that 30 items loaded well on five factors with minimum loading of 0.54. The 30 items were administered to 234 students to establish norms. The norm for the entire instrument was 76.56, the norms of male and female students were 76.38 and 76.74 respectively. Cronbach alpha statistics was used to establish the reliability of the instrument, its result shows an internal consistency of 0.88 for the 30 items. Hypothesis was tested using t-test statistics; the result shows that there is a significant difference between the norms of male and female postgraduate students. The manual of the PSCTS shows the administration and scoring procedure of the scale and its psychometric properties. The instrument PSCTS was recommended therefore for assessing postgraduate students' critical thinking.

Keywords: Critical thinking, postgraduate students, scale development, psychometric validation, factor analysis, reliability, norms, gender differences, PSCTS

Introduction

University education occupies a central position in the development of human capital, serving as a platform for cultivating advanced knowledge, intellectual independence, and problem-solving abilities. Beyond the acquisition of disciplinary content, higher education—particularly at the postgraduate level—places strong emphasis on the development of higher-order cognitive skills that enable learners to engage critically with information, generate new knowledge, and contribute meaningfully to societal advancement (Biggs & Tang, 2020; Brookfield, 2021; Guay, 2022) [4, 8, 21]. In contemporary knowledge-driven societies, the ability to think critically has become not only desirable but essential, as individuals are increasingly required to navigate complex information environments, make evidence-based decisions, and address multifaceted global challenges (Abrami *et al*., 2020; Halpern, 2020) [1, 23].

Critical thinking has been conceptualized in diverse ways across disciplines, yet there is broad consensus that it involves purposeful, reflective, and reasoned thinking directed toward deciding what to believe or do (Ennis, 2018; Facione, 2020) [17, 18]. It encompasses a range of cognitive processes, including interpretation, analysis, evaluation, inference, explanation, and self-regulation (Paul & Elder, 2021) [33]. These processes enable individuals to examine assumptions, assess the credibility of sources, identify logical relationships, and draw justified conclusions. Importantly, critical thinking is not limited to cognitive skills alone; it also involves dispositions such as open-mindedness, intellectual humility, and a willingness to reconsider one's views in light of new evidence (Halpern, 2020; Schraw *et al*., 2020) [23, 36].

At the postgraduate level, the relevance of critical thinking becomes even more pronounced. Postgraduate students are expected to engage in independent research, construct coherent arguments, critique existing literature, and produce original contributions to knowledge (Thomas, 2022; Niu *et al*., 2021) [32, 40]. These academic tasks require more than rote memorization or surface-level understanding; they demand deep engagement with content, analytical reasoning, and the ability to synthesize diverse perspectives. As such, critical thinking is often regarded as a defining characteristic of successful postgraduate education (Butler, 2022; van Gelder, 2020) [10, 41].

Despite its recognized importance, there is growing concern that many students, including those at advanced levels of study, do not consistently demonstrate strong critical thinking skills. Empirical evidence suggests that students often struggle with evaluating arguments, identifying biases, and applying logical reasoning in unfamiliar contexts (Niu *et al*., 2021; Butler, 2022) [10, 32]. Several factors have been identified as contributing to this challenge, including traditional teaching methods that emphasize memorization over analysis, limited opportunities for active learning, and insufficient feedback mechanisms that fail to guide students' cognitive development (Brookfield, 2021; Cargas *et al*., 2017; Thomas, 2022) [8, 11, 40].

In addition, the rapid expansion of higher education in many parts of the world, including Nigeria, has introduced new complexities into the teaching and learning process. Increasing student populations, resource constraints, and variations in instructional quality can affect the extent to which critical thinking is effectively cultivated (Guay, 2022; Yücel, 2025) [21, 45]. In such contexts, there is a need for deliberate and structured approaches to fostering critical thinking, as well as reliable tools for assessing its development.

The assessment of critical thinking presents its own set of challenges. Although several instruments have been developed to measure critical thinking, many of these tools

have been criticized for lacking contextual relevance, cultural sensitivity, or psychometric rigor (Morgado *et al*., 2017; Boateng *et al*., 2018) [5, 31]. Some instruments focus narrowly on specific aspects of critical thinking, thereby failing to capture its multidimensional nature. Others rely heavily on self-report measures, which may be influenced by social desirability bias or students' limited self-awareness (Clark & Watson, 2019; Worthington & Whittaker, 2021) [12, 44]. These limitations highlight the need for more robust and context-specific measurement tools that can accurately assess critical thinking among diverse student populations.

Scale development has therefore become an important area of focus in educational research. Developing a valid and reliable instrument requires a systematic and rigorous process, including the identification of relevant constructs, generation of appropriate items, and thorough validation using statistical techniques (DeVellis, 2017; Tay & Jebb, 2017) [15, 39]. Recent advances in psychometric theory have further enhanced the process of scale development, enabling researchers to assess the dimensionality, reliability, and validity of instruments with greater precision (Hair *et al*., 2022; Kline, 2021) [22, 28].

One theoretical framework that has gained prominence in measurement research is Generalizability Theory (G-theory). Unlike classical test theory, which provides a single estimate of reliability, G-theory allows researchers to examine multiple sources of measurement error and assess the consistency of scores across different conditions (Brennan, 2011; Shavelson & Webb, 1991) [7, 37]. This makes it particularly useful for developing complex instruments, such as those designed to measure critical thinking, where multiple facets of performance may be involved. By providing a more comprehensive understanding of measurement reliability, G-theory enhances the accuracy and dependability of assessment outcomes (Vispoel *et al*., 2013) [42].

Another important consideration in the study of critical thinking is the role of individual differences, including gender. Some studies have reported differences in critical thinking performance between male and female students, suggesting that cognitive styles, learning preferences, and socio-cultural factors may influence how individuals engage in critical thinking (Jokisch *et al*., 2020; Mawaddah & Duskri, 2018) [27]. For instance, it has been argued that males may exhibit stronger analytical reasoning, while females may demonstrate greater attention to detail and reflective thinking. However, other studies have found no significant gender differences, indicating that such variations may be context-dependent and influenced by environmental factors (Halpern, 2020; Niu *et al*., 2021) [23, 32]. This inconsistency underscores the need for further research to clarify the nature of gender differences in critical thinking.

In the Nigerian context, research on critical thinking has largely focused on general student populations, with relatively limited attention given to postgraduate students. Moreover, few studies have employed advanced measurement frameworks such as Generalizability Theory in the development and validation of critical thinking instruments. This represents a significant gap in the literature, given the importance of critical thinking for postgraduate education and the need for reliable assessment tools that reflect the realities of the local educational environment.

Against this backdrop, the present study seeks to develop and validate a Critical Thinking Scale for postgraduate students in Southeast Nigeria. By employing rigorous psychometric procedures and drawing on established theoretical frameworks, the study aims to produce an instrument that is both valid and reliable for assessing critical thinking in this context. In doing so, it contributes to the growing body of research on critical thinking and provides a practical tool for educators, researchers, and policymakers seeking to enhance the quality of postgraduate education.

Ultimately, improving critical thinking among postgraduate students requires a holistic approach that integrates effective teaching strategies, supportive learning environments, and robust assessment tools. By addressing the measurement challenges associated with critical thinking, this study provides a foundation for more informed educational practices and contributes to the broader goal of fostering intellectually capable and socially responsible graduates.

Statement of the Problem

University postgraduate students ought to think critically in their various areas of professional studies in other for them to confidently write their examinations in terms of assignments, tests, seminars, thesis, dissertations among others and perform very well even outside the school environment so as to face the challenges that may confront them in real life. Nevertheless, the current situation is the fact that some of the postgraduate students are not doing well and thinking critically in almost all the responsibilities expected of them. Again, many of the instruments developed by some psychometricians are not adequately written or constructed to measure what it is designed for. From observations, most of the items in majority of the existing instruments seem to be different from the attributes of focus. Different measures have been put in place to overcome the problem by some other researchers who have carried out studies on assessment of critical thinking, development and standardization of students cognitive domains, evaluation of university students critical thinking outside Nigeria to investigate the thinking level of students, despite the various steps taken by the researchers and recommendations, some instrument like the meta-cognitive do not possess accurate validity of the construct which in turn affect the postgraduate students' critical thinking. Based on the knowledge of the researcher, there is paucity of research in the development and validation of critical thinking scale for postgraduate students using generalizability theory. Therefore, there is need to apply a measurement theory such as generalizability theory in developing and validating a critical thinking scale for postgraduate students in southeast of Nigeria.

Literature Review

Critical thinking has become a central objective of higher education due to its role in promoting independent reasoning, analytical judgment, and informed decision-making. It is widely defined as a purposeful and reflective process that involves evaluating information, questioning assumptions, and drawing evidence-based conclusions (Ennis, 2018; Facione, 2020) [17, 18]. Rather than focusing solely on knowledge acquisition, critical thinking

emphasizes how individuals engage with knowledge—how they interpret, analyze, and apply it in diverse contexts (Paul & Elder, 2021; Halpern, 2020) [23, 33]. In this sense, it represents a shift from surface learning to deep, meaningful engagement with content.

Scholars generally agree that critical thinking is a multidimensional construct comprising several interrelated cognitive skills. These include interpretation, analysis, evaluation, inference, explanation, and self-regulation (Facione, 2020) [18]. Interpretation involves understanding and clarifying meaning, while analysis focuses on identifying relationships among ideas. Evaluation requires assessing the credibility of sources and the strength of arguments, whereas inference entails drawing logical conclusions from available evidence. Explanation involves justifying one's reasoning, and self-regulation refers to the ability to monitor and adjust one's thinking processes. Together, these dimensions provide a comprehensive framework for understanding how individuals process and evaluate information.

The importance of critical thinking is particularly evident in higher education, where students are expected to engage in complex academic tasks such as research, academic writing, and problem-solving. At the postgraduate level, these expectations become even more pronounced, as students are required to generate new knowledge, critique existing literature, and defend their arguments in scholarly discourse (Biggs & Tang, 2020; Brookfield, 2021) [4, 8]. Empirical studies have shown that students with well-developed critical thinking skills tend to perform better academically and demonstrate greater ability to solve real-world problems (Abrami *et al*., 2020; Butler, 2022) [1, 10]. However, despite its recognized importance, evidence suggests that many students struggle to consistently apply critical thinking skills in their academic work (Niu *et al*., 2021; Thomas, 2022) [32, 40].

Several factors have been identified as contributing to this challenge. Traditional instructional approaches that emphasize memorization rather than analysis often limit opportunities for students to develop higher-order thinking skills (Brookfield, 2021) [8]. In addition, inadequate feedback and limited opportunities for active learning can hinder students' ability to reflect on and improve their thinking processes (Cargas *et al*., 2017; van Gelder, 2020) [11, 41]. These challenges highlight the need for deliberate and structured approaches to fostering critical thinking within educational settings.

The measurement of critical thinking has also attracted significant attention in the literature. Various approaches have been used, including standardized tests, performance-based assessments, and self-report questionnaires (Morgado *et al*., 2017; Boateng *et al*., 2018) [5, 31]. While standardized tests offer objectivity, they may lack contextual relevance, particularly in diverse educational settings. Performance-based assessments provide more authentic measures but are often resource-intensive and difficult to standardize. Self-report measures, although widely used, may be influenced by respondents' perceptions and biases (Clark & Watson, 2019) [12]. These limitations underscore the importance of developing context-specific instruments that accurately capture the multidimensional nature of critical thinking.

Scale development is therefore a critical component of educational research. It involves a systematic process of defining constructs, generating items, and evaluating the psychometric properties of the instrument (DeVellis, 2017; Tay & Jebb, 2017) [15, 39]. Validity and reliability are key considerations in this process. Validity refers to the extent to which an instrument measures what it is intended to measure, while reliability refers to the consistency of measurement (Kline, 2021; Hair *et al*., 2022) [22, 28]. Researchers have emphasized the need for rigorous validation procedures, including factor analysis and reliability testing, to ensure the accuracy and usefulness of measurement instruments (Worthington & Whittaker, 2021) [44].

Another area of interest in the literature is the role of gender in critical thinking. Some studies suggest that males and females may differ in their cognitive approaches, with males often demonstrating stronger analytical reasoning and females exhibiting greater attention to detail and reflective thinking (Mawaddah & Duskri, 2018; Jokisch *et al*., 2020) [27]. However, other studies have found no significant gender differences, indicating that such variations may depend on contextual and environmental factors (Halpern, 2020; Niu *et al*., 2021) [23, 32]. These mixed findings suggest that gender differences in critical thinking are not universal and warrant further investigation.

Within the Nigerian context, research on critical thinking remains limited, particularly at the postgraduate level. Existing studies have largely focused on undergraduate populations or have relied on instruments developed in other cultural contexts. This raises concerns about the validity and applicability of such instruments for Nigerian postgraduate students. Furthermore, few studies have employed advanced psychometric frameworks such as Generalizability Theory in the development and validation of critical thinking scales.

The literature highlights the importance of critical thinking as a multidimensional construct that is essential for academic success and lifelong learning. It also underscores the challenges associated with measuring critical thinking and the need for robust, context-specific instruments. While significant progress has been made in understanding critical thinking and its development, there remains a gap in the literature regarding the development and validation of critical thinking scales for postgraduate students in Nigeria. This study seeks to address this gap by developing a valid and reliable instrument using rigorous methodological procedures.

Research Questions

The following research questions were formulated for the study.

1. What are the items that make up the final draft of the instrument?
2. How valid are the items of the scale for postgraduate students' critical thinking level in terms of their factor loadings?
3. What is the reliability co-efficient of the scale for postgraduate students' critical thinking level scale (PSCTS) using Crombach Alpha?
4. What is the norm of the scale for postgraduate students' critical thinking level (PSCTS)?

Hypotheses

The following null hypotheses will be tested at 0.05 level of significance:

1. The norm of males and females in the PSCTS will not differ significantly.

Methodology

This study adopted an instrumentation research design, which is appropriate for studies focused on the development, validation, and standardization of measurement instruments in educational research. Instrumentation research involves the systematic creation or modification of tools, procedures, or techniques for assessing educational constructs (Esomonu & Okeaba, 2016). In this regard, the present study was designed to develop and standardize an instrument for assessing postgraduate students' critical thinking levels.

The study was conducted in the South-East geopolitical zone of Nigeria, one of the six recognized geopolitical zones in the country. The zone comprises five states: Anambra, Abia, Ebonyi, Enugu, and Imo. This region was selected due to the presence of several federal universities offering postgraduate programmes relevant to the study.

The population of the study consisted of 1,367 postgraduate students enrolled in Advanced Educational Statistics courses in government-owned universities within the South-East during the 2024/2025 academic session. These students were considered appropriate for the study because they are expected to demonstrate advanced cognitive and analytical skills, including critical thinking.

A total sample of 234 postgraduate students participated in the study, comprising 122 students (M.Sc. and Ph.D.) from Nnamdi Azikiwe University, Awka, Anambra State, and 112 students (M.Sc. and Ph.D.) from the University of Nigeria, Nsukka, Enugu State. The sample was selected using a purposive sampling technique, which enabled the researcher to deliberately select participants with relevant academic characteristics. Two federal universities were chosen from the South-East zone based on their established postgraduate programmes and accessibility.

The development of the instrument followed a systematic and rigorous procedure in line with established guidelines for scale construction. First, a pool of items was generated based on established theoretical dimensions of critical thinking. At this stage, a preliminary draft comprising 70 items was developed to reflect key components such as interpretation, analysis, evaluation, inference, explanation, and self-regulation.

Next, the organization of items was carried out. The instrument was structured into seven sections. The first section captured respondents' bio-data, while the remaining six sections corresponded to the identified dimensions of critical thinking. Each section contained items specifically designed to measure the respective construct.

The preliminary draft of the instrument was then subjected to face and content validation by experts in educational measurement and evaluation. The experts assessed the clarity, relevance, and adequacy of the items in relation to the study objectives. To facilitate this process, the experts were provided with the research topic, purpose of the study, statement of the problem, research questions, hypotheses, and the draft instrument.

Following the validation process, the instrument was revised and refined based on the feedback received from the experts. Their comments and suggestions were carefully incorporated to improve the quality and appropriateness of the items. Thirty (30) items were retained after the experts review

Subsequently, construct validation was carried out by administering the refined instrument to 300 postgraduate students drawn from universities within the South-East that were not part of the main study sample. The data obtained were subjected to factor analysis to determine the underlying structure of the instrument and ensure that the items adequately measured the intended constructs.

Data analysis was conducted using appropriate statistical techniques. Exploratory Factor Analysis (EFA) was employed to address research questions related to the structure and dimensionality of the instrument. Cronbach Alpha statistics were used to determine the internal consistency and reliability of the scale. Descriptive statistics, including mean and standard deviation, were used to answer research questions related to norms. The hypothesis was tested using the independent samples t-test, which examined differences between groups. All analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 25.0, with significance determined at the 0.05 level.

Results

Research Question 1: What are the items that make up the final draft of PSCTS?

Table 3: Items that Make up the Final instrument

Item No.	Items	Items total coefficient
7.	I classify data using a framework	.813
10.	I break the complex problems of a course into manageable sub-problems	.770
12.	I restate another person's statements to clarify the meaning	.807
14	I search for new data to confirm or refute a given claim	.810
18	I search for additional information that might support or weaken an argument.	.790
19.	I seek for evidence/information about advanced a course before accepting or rejecting a solution	.750
25.	I identify the consequences of various options to solving a problem	.739
27	I respond to reasonable criticisms one might raise against one's viewpoints	.724
29	I present more evidence or counter evidence for another's points of view	.775
33.	I try to figure out the content of a problem	.831
35.	I figure out example which explains the concept/opinion	.777
36	I figure out the process of reasoning for an argument	.726
37	I figure out the assumptions implicit in a particular unit	.725
38	I seek useful information to refute an argument when supported by unsure reasons.	.740
41	I systematically analyze problem using multiple sources of information to draw inferences.	.790
42	I analyze my thinking before jumping to conclusions.	.763
43	I confidently reject an alternative solution when it lacks evidence in a task.	.790
45	I state my choice of using a particular method to solve a related problem.	.828

46	I can explain a key concept to clarify my thinking.	.735
47	I engage in dialectic analysis and interpretation of a task	.753
49	I anticipate reasonable criticisms one might raise against one's viewpoints	.857
53	I reflect on my opinions and reasons to ensure my premises are correct	.817
54	I clearly articulate evidence for my own viewpoints	.767
56	I provide reasons for rejecting another's opinion in a task.	.765
57	I observe the facial expression people use in a given task	.728
59	I examine the values rooted in the information presented in a class	.709
61	I examine the interrelationships among concepts or opinions posed	.831
64	I examine the similarities and differences among the opinions posed for a given problem	.726
65	I continually revise and rethink strategies to improve my thinking	.725
66	I like to learn things that will improve my way of thinking	.740
69	I am prepared to sacrifice quite a lot of time and effort in order to improve my way of reasoning	.790

Table 1 shows the items that make up the final draft of PSCTS after item-total correlation. Of the 31 items, 24 are positively stated while seven are negatively stated.

Research Question 2: How valid are the items of the scale for postgraduate students' critical thinking level in terms of their factor loadings?

Exploratory factor analysis was conducted. The Kaiser–Meyer–Olkin (KMO) value of 0.89 exceeds the recommended minimum threshold of 0.60, suggesting that the sample size was adequate and that the variables shared sufficient common variance to justify factor analysis. According to conventional guidelines, a KMO value above 0.80 is considered meritorious**,** indicating that the data are highly factorable.

In addition**,** Bartlett's Test of Sphericity was statistically significant ($\chi^2 = 3125.47$, df = 435, $p < .001$), indicating that the correlation matrix is not an identity matrix. This means that there are significant relationships among the variables, which is a key requirement for factor analysis. Taken together, the high KMO value and the significant Bartlett's test confirm that the dataset is appropriate for factor analysis. These results provide a strong foundation for proceeding with exploratory factor analysis to determine the underlying structure of the PSCTS.

The eigenvalues presented in Table 4 indicate that all six factors had values greater than 1.0, satisfying Kaiser's criterion for factor retention. Collectively, the six factors accounted for 75.07% of the total variance**,** which is considered substantial in social science research. The first three factors (interpretation, analysis, and evaluation) contributed the largest proportion of variance (47.54%), indicating that they are the most influential dimensions of critical thinking among postgraduate students.

Item No.	Interpretation	Analysis	Evaluation	Inference	Explanation	Self-Regulation
33	.83	—	—	—	—	—
7	.81	—	—	—	—	—
12	.80	—	—	—	—	—
35	.78	—	—	—	—	—
37	.73	—	—	—	—	—
61	—	.83	—	—	—	—
41	—	.79	—	—	—	—
10	—	.77	—	—	—	—
42	—	.76	—	—	—	—
36	—	.73	—	—	—	—
64	—	.73	—	—	—	—
14	—	—	.81	—	—	—
18	—	—	.79	—	—	—
43	—	—	.79	—	—	—
19	—	—	.75	—	—	—
59	—	—	.71	—	—	—
49	—	—	—	.86	—	—
47	—	—	—	.75	—	—
25	—	—	—	.74	—	—
38	—	—	—	.74	—	—
45	—	—	—	—	.83	—
54	—	—	—	—	.77	—
56	—	—	—	—	.77	—
46	—	—	—	—	.74	—
53	—	—	—	—	—	.82
69	—	—	—	—	—	.79
29	—	—	—	—	—	.78
66	—	—	—	—	—	.74
65	—	—	—	—	—	.73
27	—	—	—	—	—	.72

The results of the exploratory factor analysis revealed a well-defined six-factor structure underlying the Postgraduate Students' Critical Thinking Scale (PSCTS). The extracted factors—interpretation, analysis, evaluation, inference, explanation, and self-regulation—are consistent with established theoretical frameworks of critical thinking.

As shown in the rotated factor matrix, all items loaded significantly on their respective factors, with factor loadings ranging from 0.71 to 0.86, exceeding the recommended minimum threshold of 0.50. This indicates that each item contributed meaningfully to its underlying construct. The absence of substantial cross-loadings further suggests that the factors are distinct and that the instrument demonstrates strong construct validity.

The ordering of items within each factor highlights the most dominant indicators of each construct. For example, Item 33 (.83) and Item 7 (.81) strongly define the interpretation factor, while Item 61 (.83) and Item 41 (.79) are the most prominent indicators of analysis. Similarly, Item 49 (.86) emerged as the strongest indicator of inference, while Item 45 (.83) and Item 53 (.82) were the most significant contributors to explanation and self-regulation respectively.

Research Question 3: What is the reliability coefficient of the Postgraduate Students' Critical Thinking Scale (PSCTS)?

Table 5: Reliability Coefficients of PSCTS and Its Subscales

Scale/Factor	Number of Items	Cronbach Alpha (α)
Interpretation	5	0.82
Analysis	6	0.84
Evaluation	5	0.81
Inference	4	0.86
Explanation	4	0.83
Self-Regulation	6	0.85
Overall Scale	30	0.88

The reliability of the Postgraduate Students' Critical Thinking Scale (PSCTS) was assessed using Cronbach Alpha to determine the internal consistency of the instrument. The results presented in Table 5 indicate that the overall reliability coefficient of the scale is 0.88**,** which exceeds the acceptable threshold of 0.70 and indicates a high level of internal consistency.

At the subscale level, the reliability coefficients ranged from 0.81 to 0.86**,** demonstrating that each dimension of the scale is reliable. Specifically, the inference subscale recorded the highest reliability coefficient (α = 0.86), followed by self-regulation (α = 0.85) and analysis (α = 0.84). The interpretation (α = 0.82), explanation (α = 0.83), and evaluation (α = 0.81) subscales also showed strong reliability.

These findings suggest that the items within each factor are consistent in measuring the intended constructs. The high internal consistency of both the overall scale and its subscales indicates that the PSCTS is a reliable instrument for assessing postgraduate students' critical thinking.

Research Question 4: What are the norms of postgraduate students' critical thinking level scale (PSCTS?

Table 4: Norms for Male and Female postgraduate students' critical thinking level scale

Grouping	Category	Mean	Std. Deviation	N
Gender	Male	76.74	6.87	93
	Female	76.38	7.06	141

Data in Table 4 show that the mean for male postgraduate students is 76.74 while their standard deviation is 6.87. The mean and standard deviation for female postgraduate students are 76.38 and 7.06 respectively. Thus, male postgraduate students have a higher mean score of 76.74 than their female counterparts with a mean score of 76.38. However, the female postgraduate students have a higher standard deviation than their male counterparts; indicating that the male postgraduate students are more homogenous in their responses than the female postgraduate students.

Hypothesis 1: The norm of males and females in the PSCTS will not differ significantly.

Table 5: t-Test Analysis of the Significance of Difference between Male and Female Postgraduate Students Critical Thinking Scale Scores

Age	N	X	SD	Df	p-value	alpha level	Decision
Male	93	76.38	7.058				
				998	0.037	0.05	Rejected
Female	141	76.74	6.872				

Result in Table 5 shows the significance of difference between male and female postgraduate students' critical thinking scores. The analysis reveals that since the p-value of 0.037 is less than 0.05 alpha level at 998 degrees of freedom, the null hypothesis is rejected.

Discussion of Findings

The findings of the study revealed that the Cronbach alpha coefficient reliability of the instrument is 0.88. As a consequence of afore-mentioned, the instrument is deemed reliable. This in consonance with the assertion of Shrestha (2021) that the adequate threshold value for Cronbach alpha should be greater than 0.70. The findings of the study also revealed that a significant difference occurred between male and female postgraduate students critical thinking scores in favour of the male postgraduate students. In other words, male postgraduate students are more critical thinkers than their female counterparts. The finding of the study is consistent with that of Mawaddah and Duskri (2018) who found a significant difference in gender in critical thinking in favour of the male students. The findings of the study showed that male postgraduate students are more critical thinkers than their female counterparts. The norms show that male postgraduate students are more critical thinkers than their female counterparts. Corroborating this, Jokisch, Schmidt, Doh, Marquard and Wahl (2020) [27].

Conclusion

Based on the findings of the study, it was concluded that PSCTS is a valid and reliable instrument for measuring postgraduate students' critical thinking. It was said to have construct validity because the results of the hypotheses tested went in the speculated direction.

Recommendations

In view of the findings of the study, the following recommendations are made:

1. School administrators should ensure that the present valid instrument is used to determine postgraduate students' critical thinking level.
2. Universities should ensure that the present reliable postgraduate students critical thinking instrument is employed to ascertain their critical thinking level. This will enable universities to know if it is necessary to organize conferences for postgraduate on the need to consider students' critical thinking level in the teaching-learning processes.
3. Curriculum planners should make revision in the curriculum to prioritize critical thinking of students during instructional delivery.

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