



## Cognitive Load and Test-Taking Skills as Correlates of Academic Performance in Mathematics of Joint Universities Preliminary Examinations Board Science Students, University of Benin

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**Abstract.** This study was conducted to determine whether cognitive load and test-taking skills are correlates of academic performance in mathematics of Joint Universities Preliminary Examinations Board (JUPEB) Science students, University of Benin, Benin City. The study was hinged on Cognitive Load Theory (CLT) and Cognitive Social Learning Theory (CSLT). CLT was developed by Sweller (1988) while CSLT was developed by Bandura (1977, 1986). To guide this study, three research questions were raised which were also hypothesized and tested at 0.05 significant level. Survey design with correlational approach was adopted for the study. The population of the study consists of 82 JUPEB science students. The sample of the study was also 82 students as the population was small. Data was collected using an adapted instrument which was modified and titled “JUPEB Students’ Cognitive Load and Test-taking Skills Questionnaire (JSCLTSQ)”. The instrument was content-validated. Three experts from the Department of Educational Evaluation and Counselling Psychology made some corrections and suggestions which were incorporated into the final copy and thereafter certified valid for use for the study. The instrument was trial-tested on 20 students and the reliability was determined using the Cronbach Alpha statistics which yielded coefficients of 0.85 and 0.81 for the two subscales respectively. The three (3) hypotheses were tested using the Pearson Product Moment Correction Coefficient statistics. The findings revealed that cognitive load has a low inverse relationship with academic performance in mathematics while test-taking skills has a positive relationship with academic performance in mathematics. Cognitive load and test-taking skills are jointly correlated with academic performance in mathematics. Based on the findings, some recommendations were made. One of such recommendations is that tutors of JUPEB University of Benin need constant attendance in seminars and workshops funded by the government

and the school management on various cognitive load issues and effective test-taking strategies.

**Keywords:** Cognitive load, Test Taking Skills, Academic Performance

### 1. Introduction

Academic performance refers to the degree to which students, instructors, or institutions have met their short or long-term educational objectives. It assesses a student's proficiency across many academic topics (Briones et al, 2021). Good academic achievement among students throughout every stages of school is critical in the modern educational environment. Students' good performance in mathematics, for example, indicates a promising future in education, particularly in the sciences and engineering. Mathematics is regarded as one of the core disciplines in the educational curriculum. It constitutes the basis of scientific and technical knowledge, which contributes considerably to the socioeconomic advancement and growth of any country. However, poor academic performance in mathematics has been witnessed at different levels of education among students. This may not be unconnected with the perception, attitude and the approach that both teachers and learners adopt concerning the subject. Academic performance nowadays tends to be considered as an indication of a student's performance in response to school-based instructions and information acquired throughout the course of education (Igwe & Orluwene, 2019). Academic performance is the manifestation of information obtained by a learner throughout the course of schooling. This concept implies that academic achievement is a measure of pupils' comprehension of instructions. Students' academic achievement is measured using a variety of exams according to the rationale whereby the scores from the tests are utilised.

In today's world, mathematics is essential in many activities that we perform from day to day: when studying, working and while engaged in other daily activities. Mathematics is one of the core subjects offered at all levels of education. Irrespective of students' chosen area of specialization, mathematics is compulsory for students while enrolling into the Senior School Certificate Examination. Depending on students' chosen course of study, some students may not need much mathematics at the higher educational level. Nevertheless, it constitutes one of the conditions for entrance to a higher educational institution. Mathematics is a discipline that spans all human pursuits. Recognising the significance of math, the Nigerian government has proved its dedication to imparting knowledge about the subject, notably through the National Mathematics Centre's many developmental projects. Throughout the course of its history, NMC has implemented several Mathematics Improvement Projects (MIP) in an effort to enhance the instruction and learning of mathematics at both the primary and secondary education levels (Omeonu, 2014). These efforts involve organising teacher training/workshops, distributing educational resources to many different schools, and producing mathematics games; The national reward plan for learners in mathematics as well as teachers/institutions that have achieved a significant degree of effectiveness in mathematics education and instruction at all ranks.

Despite the efforts of the government and mathematics educators to provide quality mathematics education, educational institutions continue to face challenges that could undermine the quality of mathematics education provides (Omeonu, 2014). Effectiveness in the teaching-learning process is to a large extent determined by cognitive load factors as well as test-taking skills (Houichi & Sarnou, 2020). To increase students' academic achievement, instructors must grasp the research basis that supports learners practicing through design of lessons ideas, especially those connected to cognition. Mathematics being a key subject at different levels of education, is usually part of the subject combinations taken by some students who sit for the Joint Universities Preliminary Examinations Board (JUPEB) yearly.

The Joint Universities Preliminary Examination Board (JUPEB) is a nationwide examinations organisation that was recognised by the Federal Government of Nigeria in 2013. It was officially founded in 2014 by a consortium of ten (10) member universities, led by the University of Lagos. JUPEB was established to standardise the admission procedure for partner universities through their individual preparatory courses. To be qualified to take the test that leads to the award of JUPEB's Direct Entry Certificates, applicants must have

completed a rigorous programme of academic study related to their intended university subject. Each prospective student has to apply, take tests, along with satisfying the Board in three disciplines and a general studies course related to the course of study suggested at any of the institutions. Each topic is often divided into four courses, two of which the candidate must complete each semester. After completing the curriculum, students get certificates indicating their level of achievement, typically bear letter grades A, B, C, D, E, or F in each of the aforementioned subjects including the General Studies Paper.

Over the last decade, there seems to be a considerable interest in the areas of intellect, test-taking abilities, and schooling. Cognitive science appears to have advanced our understanding of the mental procedures that occur while comprehending instructional content to the point where it is clear that conventional teaching and learning approaches are no longer adequate. New teaching approaches based on the concept of cognitive load and abilities to take tests have become available (Chandler & Sweller, 1991, quoted in Houichi & Sarnou, 2020). Test is a collection of questions to which the respondents are expected to answer (Afemikhe, 2014). The collection of questions could be seen as a task which is presented to a person calling for a kind of behaviour; the performance indicates whether the individual possesses the behaviour called for by the task. Tests are meant to assess a sample's quality, aptitude, skill, or knowledge in comparison to a predetermined expected, so which is typically regarded appropriate or not. Not all examinations ask questions, but the subject matter of the test suggests the presence of a series of questions. Test-taking skills are the cognitive talents needed to manage every testing setting appropriately and know what to do throughout exams. It is pertinent to note that many crucial decisions that could have effect on the life of individuals are based on specific tests. The place tests occupy in the future of students necessitates that it be given serious attention that it rightly deserves in the teaching-learning process.

Cognitive load refers to the quantity of data that the brain's working memory can handle at once. In the discipline of cognitive psychology, cognitive load is defined as the quantity of working memory processes utilised. According to Rao (2021), the cognitive workload is a type of intellectual power required to assimilate learning information in a certain environment. Working memory must be considered short-term and finite, but memory that is long-lasting can be viewed as endless. The goal is supposed to be to shift knowledge to long-term mental storage since once a student is introduced to new material, they may call on their existing

expertise so the cognitive burden is lessened. Nevertheless, if the topic information is insufficient, the learner is unable to rely on long-term memory, and the working memory gets overloaded, resulting in functioning memory failures. According to Osa-Edoh (2016), memory used for computation possesses a very restricted capacity as well as can only handle around seven objects at once. Certain learners perform badly on tests due to a lack of abilities to take tests or the usage of ineffective ones. These abilities have a direct and indirect impact on pupils' results. These tactics directly assist students improve their test scores by optimising their time, effort, and exam circumstances. Indirectly, utilising suitable test-taking tactics influences other related but essential issues, such as lowering test anxiety and enhancing students' attitudes towards tests. Testing skills assist students in applying their learning environment information to real-world situations. Students who have learned test-taking methods or skills will improve their testing proficiency and, consequently, their academic success. According to studies, kids who use test-taking tactics have (1) better attitudes towards tests, (2) lower levels of test anxiety, and (3) higher academic performance. Even those learners who are conversant with the material may perform badly on examinations due to an absence of test-taking abilities (Sweetnam, 2003).

Examinees can effectively cope with test anxiety by improving their test-taking abilities and avoiding cognitive overload. Test anxiety may be defined as a state of tension and anxiety that interferes with one's capacity to convey what one understands in a test setting. Anxiety about tests is a pretty prevalent issue among students, particularly at the higher educational level. Although an appropriate amount of test anxiety can help stimulate students to perform better on tests, a severe case of test nervousness can interfere with the manner in which students excel, negatively affecting concentration, idea and thought organisation, question comprehension, and keyword retrieval. Highly nervous pupils typically have poor test-taking skills. They, for instance, might devote a greater amount of time on irrelevant ideas than on duties, and they typically have bad study habits. Furthermore, they may struggle with writing assignments along with take-home assessments, as well as multiple-choice verbal things. Tests are often meant to examine pupils' understanding of certain topic or items. When other variables influence pupils' how they perform, scores from tests are no longer reliable indicators of their knowledge or aptitude levels. Test-taking practices can increase the general reliability of test scores, ensuring that they correctly represent what students actually know.

According to Alshammari et al. (2017), organisational factors that impact the academic achievement of learners include insufficient libraries, insufficient research facilities, an absence of university lodgings, curriculum-related variables, an insufficient number of lecturers, and university-enforced academic guidelines. Universities in Africa, particularly in Nigeria, confront an imminent danger of anomie. This can be evident in the presence or lack of norms. To be more exact, Nigerian colleges are experiencing a core values crisis. The degree of psychological strain has a significant impact on student acquisition of knowledge and academic achievement. Students' test-taking abilities are seen as a critical aspect that might influence academic success, particularly in quantitative courses such as mathematics (Igwe & Orluwene, 2019). The value of students' suitable test-taking strategies is clear because it minimises anxiety during exams and leads to higher exam scores (Dodeen et al., 2014). Sweetnam (2003), as referenced in Dodeen (2015), said that learning test-taking methods or skills will improve students' testing proficiency thus contributing to their academic success. Studies show that pupils who understand taking assessments strategies: (i) have improved studies towards test (ii) have lower levels of test anxiety (iii) achieve better in academic-related tasks. Even learners who are conversant with the material may perform badly on tests due to their shortage of test-taking abilities (Sweetnam, 2003). According to Almalki (2023), competence plays an important role in the deployment of certain test-wiseness tactics. In addition, their findings indicated that sex had no significant impact on the choosing of test-wiseness techniques. Igwe and Orluwene (2019) looked at test-taking techniques as determinants of pupils' maths success in Rivers State secondary schools. The results of this research revealed that test-taking tactics had a strong predictive effect on students' academic outcomes in mathematics.

### **1.1 Statement of the Problem**

Mathematics is an important topic, especially for engineering and scientific students. Nevertheless, many students see it as a difficult nut to crack. This might imply that many of the pupils lack the necessary abilities for taking exams while writing mathematics assessments or examinations. So numerous learners believe that no matter how hard they work to prepare for mathematics exams, they will never pass. In the words of Eklof (2010), achievement on exams is dependent not just on understanding of the topics or subject matter, but also on the development of certain skills, among them test-taking abilities. Test-taking abilities are those that are concerned with how they respond and react when attempting a test rather than the topic

content. As a result, it can assist to lessen test anxiety and/or dread, allowing pupils to write the exam with a calm mind and therefore enhance their performance. To that aim, regardless of whether all of the criteria influencing students' test performance are positive, it is still required to have particular preparation in the ways of answering to questions from the exam and to employ relevant skills while on the examination itself in order to be productive. Bond and Herman (2013), as reported in Bicak (2013), claimed that ability, a successful outcome, and Grade Point Average (GPA) are all characteristics that overlap owing to distinct test-taking abilities.

To improve exam efficiency, the primary focus should be on abilities to take tests rather than testing experience. Meeaad et al. (2022) and Houichi and Sarnou (2020) found that metacognitive features of test-taking experience, such as selecting skills, time frame, difficulty prediction, including monitoring, are critical to exam achievement. The same may be stated for cognitive burden. Where irrelevant distractions, such as intellectual overload, can be prevented, the ramifications for exam achievement can be extremely striking. In fact, a student's academic achievement in Mathematics may be influenced by his or her test-taking abilities along with the lack of cognitive overabundance rather than just by mastering the subject content.

The literature reviewed found a gap in that most previous research addressed characteristics such as mental workload as well as test-taking abilities separately as potential predictors of students' academic achievement in mathematics. As a result, there is a need to do research on the combined impact of cognitive load along with test-taking abilities on JUPEB students' academic achievement in mathematics in Nigerian higher education institutions. It is also worth noting that there is limited study on mental workload and test-taking abilities as predictors of academic achievement in mathematics among Joint Universities Preliminary Examination Board science students at the University of Benin. It is based on the above premise that the researcher was motivated to carry out a study on Cognitive Load and Test-taking Skills as Correlate of Academic Performance in Mathematics of JUPEB Science Students, University of Benin.

### 1.2 Research Questions

To guide the study, the following research questions were raised:

- Is there a relationship between cognitive load and academic performance in mathematics of JUPEB science students, University of Benin?

- Is there a relationship between test-taking skills and academic performance in Mathematics of JUPEB science students, University of Benin?
- Do cognitive load and test-taking skills jointly correlate academic performance in mathematics of JUPEB science students, University of Benin?

### 1.3 Hypotheses

The following hypotheses were formulated and will be tested at 0.05 level of significance:

- There is no significant relationship between cognitive load and academic performance in mathematics of JUPEB science students, University of Benin.
- There is no significant relationship between test-taking skills and academic performance in mathematics of JUPEB science students, University of Benin. Cognitive load and test-taking skills do not significantly correlate academic performance in mathematics of JUPEB science students, University of Benin.

### 1.4 Research Methodology

Design for the study is survey using correlational approach. The adoption of this design was to enable the researchers collect and analyze quantifiable information that can be used to make generalization from the sampled population to the entire population of the study. Thus, information was collected from 2022/2023 JUPEB students and analyzed and the findings were generalized to the entire population of JUPEB science mathematics students of University of Benin. The population of this study consists of all University of Benin JUPEB science students for the 2022/2023 examination year totaling 82 students. The sample of this study consists of 82 JUPEB science students in 2022/2023 session, University of Benin. The sampling technique used was the census as the population size is small. In the census sampling, all the 82 JUPEB science students were selected as part of the sample. The instrument that was used for data collection is the questionnaire titled: "JUPEB Students' Cognitive Load and Test-taking Skills Questionnaire (JSCLATSQ)". The questionnaire is subdivided into two (2) sections. Section A elicits Likert scale responses on Cognitive Load, A four-point Likert scale was used, and scoring ranges from Strongly Agree = 4, Agree = 3, Disagree = 2, Strongly Disagree = 1. Section B elicits Likert scale responses on Test-taking skills. A four-point Likert scale was used, and scoring ranges from Strongly Agree = 4, Agree = 3, Disagree = 2, Strongly Disagree = 1. Sections A and B consist of sixteen (16) items each. The questionnaire consists

of a total of thirty-two (32) items. The items in section A of the instrument were adapted from Houichi and Sarnou (2020) Cognitive Load Scale while the items in section B were adapted from Almalki (2019) Test-Taking Scale. The instruments were validated by 3 experts. To determine the reliability of the instruments, the researchers administered twenty (20) copies of the instruments to 2022/2023 JUPEB students in another University with the same characteristics but not part of the sample. The data collected were analyzed using Cronbach's Alpha statistical method to estimate the

internal consistency of the instruments. The values 0.85, and 0.81 were obtained as the reliability coefficients for Cognitive Load and Test-taking Skills sub-scales respectively. The high reliability coefficients obtained indicate that the instrument is reliable and fit for use for the study. The final instruments were administered to the respondents by the researchers. Hypotheses 1, 2 and 3 were tested using Pearson Product Moment Correlation Coefficient (PPMCC) statistics. All hypotheses were tested at 0.05 level of significance.

**2. Presentation of Results and Discussion of Findings**

**Hypothesis 1:** There is no significant relationship between cognitive load and academic performance in mathematics of JUPEB science students, University of Benin.

**Table 1:** Pearson Correlation Showing Relationship between Cognitive Load and Academic Performance in Mathematics of JUPEB Science Students

Variables	N	Mean	Std.	df Dev.	r-Cal	Alpha	Value	Sig. (2-tailed)	Decision
Cognitive Load	82	48.55	9.70	80	-0.11	0.05		0.346	Not Significant
Academic Performance in Mathematics	82	23.95	12.62						

P < 0.05

Table 1 has shown an inverse association involving cognitive load and academic achievement in mathematics among JUPEB Science Students at the University of Benin in Benin City. The value of the coefficient of correlation (r) was -0.11, indicating a minimal negative link between cognitive load and academic performance of JUPEB students in mathematics. It returned a p-value of 0.346, meaning it is more than the alpha value of 0.05. As a result, the finding is not statistically significant. The null hypothesis was so preserved. This means that there is no significant link between mental workload and academic achievement in mathematics among JUPEB Science students at the University of Benin in Benin City.

**Hypothesis 2:** There is no significant relationship between test-taking skills and academic performance in mathematics of JUPEB science students, University of Benin.

**Table 2:** Pearson Correlation Showing Relationship between Test-taking Skills and Academic Performance in Mathematics of JUPEB Science Students

Variables	N	Mean	Std.	df Dev.	r-Cal	Alpha	Value	Sig. (2-tailed)	Decision
Cognitive Load	82	21.62	5.77	80	0.70	0.05		0.000	Significant
Academic Performance in Mathematics	82	23.95	12.62						

P < 0.05

Table 2 shows a link between test-taking skills overall successful academic achievement in mathematics among JUPEB Science Students at the University of Benin in Benin City. The coefficient of correlation (r) found was 0.70, indicating a strong positive association between test-taking abilities and academic success in mathematics among JUPEB science students. It returned a P-value of 0.000, which is smaller than the alpha value of 0.05. Consequently, the outcome is noteworthy. The null hypothesis was thus rejected in favour of the alternative. This shows that there is a substantial association connecting test-taking abilities as well as academic success in mathematics among JUPEB students studying science at the University of Benin in Benin City.

**Hypothesis 3:** Cognitive load and Test-taking Skills do not significantly correlate Academic Performance in Mathematics of JUPEB Science Students, University of Benin.

**Table 3:** Pearson Multiple Correlation Showing Relationship between Cognitive Load, Test-taking Skills and Academic Performance in Mathematics of JUPEB Science Students

Variables	N	Mean	Std.	df	r-Cal	Alpha	Sig. (2-tailed)	Decision
Cognitive Load/Test-Taking Skills	82	23.948	8.79	80	0.70	0.05	0.000	Significant
Academic Performance in Mathematics	82	23.951	12.62					

P < 0.05

Table 3 shows a link between Cognitive Load, Test-taking Skills, and Academic Performance in Mathematics among JUPEB Science Students at the University of Benin in Benin City. The correlation value, *r*, was 0.70, indicating a strong positive association between cognitive workload, test-taking competencies, and students' academic achievement in mathematics. It returned a P-value of 0.000, which is smaller than the alpha value of 0.05. Thus, the outcome is noteworthy. The null hypothesis was thus rejected. This shows that cognitive load and test-taking abilities have a substantial correlation with learning outcomes in mathematics among JUPEB Science students at the University of Benin in Benin City.

### 3. Discussion of Findings

The findings showed that there is an inverse link between cognitive workload and academic achievement among JUPEB science students at the University of Benin. This association is not noteworthy. This suggests that cognitive stress may affect academic performance in mathematics, but not considerably. The findings agree with Houichi and Sarnou (2020) and Chandler and Sweller (1991) who reported that the level of cognitive load has effect on students' learning and academic performance. Sweller et al. (1998) also stressed that split attention occurs commonly in instructional contexts and has a negative effect on learning and students' academic achievement. He emphasized that cognitive overload should be eliminated wherever possible. According to Alshammari et al. (2017), institutional factors that affect the educational achievement of learners include not sufficient libraries, insufficient research facilities, a lack of university lodging, curriculum-related variables, an insufficient number of lecturers, and university-enforced educational policies. It is possible that JUPEB science students, University of Benin are occupied with how to resolve the challenges of inadequate libraries, lack of accommodation, inadequate number of lecturers,

curriculum related factors amongst others and are therefore distracted from their studies. Hence their low academic performance in Mathematics.

The results of this study also demonstrate a favourable link between test-taking abilities and academic success in mathematics among JUPEB science students at the University of Benin in Benin City. The association is substantial. This implies that test-taking abilities may impact academic success in mathematics. This conclusion is consistent with Slim et al. (2013), who found that students' success in low-stakes examinations was reliant on test-taking effort factors such as the total quantity of items, the proportion of tries to solve, along with the amount of time dedicated to completing an item. It also aligns with Dodeen et al. (2014), who found a favourable relationship between students' proficiency in taking tests especially their enthusiasm for studying mathematics, beliefs regarding mathematics, and their mindsets towards testing. Sweetnam (2003) noted that even students who are conversant with the subject matter may perform badly on tests due to a lack of test-taking skills.

The findings also indicate a substantial link between cognitive load, test-taking abilities (jointly), and academic success in mathematics. The findings are consistent with Igwe and Orluwene's (2019) conclusion that test-taking techniques and cognitive load concurrently influence students' academic achievement. In context with this, Hattie (2009) stated that the instructor decides to establish the learning and achievement criteria and makes them transparent to the students, models them, evaluates if they understand what they have been advised by inspecting for comprehension, as well as recounting them what they ought to have had been advised by weaving it in entirety with closure.

#### 4. Conclusion

The research came to the conclusion that cognitive load possesses a negative linear connection with scholastic achievement in mathematics, the ability to take tests has a beneficial linear connection with educational achievement in mathematics, as well as intellectual load along with test-taking competencies have a significant positive connection with academic accomplishment in Mathematics, making them in the best predictors for educational achievement in mathematics. Reducing cognitive load while improving good aptitude for taking tests will enhance pupils' academic achievement.

#### 5. Recommendations

On the basis of the findings of the study, the following recommendations were made that:

- Deliberate effort should be made by the school management of JUPEB to ensure that appropriate level of cognitive load is maintained during instruction.
- Concerted effort should be made to teach test-taking skills to JUPEB science students in order to enhance their performance in mathematics.
- Tutors of JUPEB University of Benin need constant attendance in seminars and workshops funded by the government and the school management on various cognitive load issues and effective test-taking strategies.

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