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EFFECTS OF GENDER, TEST ANXIETY AND TEST ITEMS SCRAMBLING ON STUDENTS' PERFORMANCE IN MATHEMATICS: A QUASI-EXPERIMENTAL STUDY

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ABSTRACT

The relative contributions of gender, test anxiety and test items scrambling on performance in Mathematics has been widely assessed, although there is an inconclusive argument regarding the magnitude of such effects. This study was designed to contribute to this debate, while also being the first study to evaluate the interactive effects of the three dimensions of test anxiety (worry, emotion and total) on performance in Mathematics. A systematic random sample of 1,358 SS3 students participated in a quasi-experiment. Data were obtained using the Test Anxiety Scale (TAI) (Spielberger, 1980) and a Mathematics Achievement Test (MAT) developed by Etuk (2019). Findings indicated that there was no significant gender difference on performance; tests anxiety and items scrambling had significant effects on performance in Mathematics respectively; low students' performance in Mathematics was associated with high test anxiety and test items arrangement from complex to simple; there was a significant interaction of test anxiety worry, emotion and total on performance in Mathematics. It was concluded that gender does not play a significant role in the performance of students in mathematics. Test anxiety in terms of worry, emotion and total affect the performance of students in Mathematics. Based on the conclusions, relevant implications are discussed.

Contribution/Originality: This is the first Nigerian study to investigate the effect of test anxiety in terms of emotional, worry and total dimensions on performance in mathematics. Globally, this study is also the first to examine the interactive effect of TA-W, TA-E and TA-T on students' performance in Mathematics.

1. INTRODUCTION

Mathematics is a subject that is offered virtually at all levels of education and considered as the bedrock for all scientific and technological development of any nation (Etuk, 2019). Mathematics foster creative thinking and improves individuals' numeric and analytic skills. An individual can get on without having the ability to read and write, but would struggle with basic skills of counting, arithmetic and numeration (Anaduaka & Okafor, 2013). Irrespective of how rudimentary it might be, every man needs mathematics to survive. Mathematics equips an individual with knowledge and skills to handle daily life challenges with rationality, solve wide-range of difficult tasks and organize difficult problems into logical and simple forms (Etuk, 2019). The multifaceted use of mathematics in business, industries, homes, schools, offices and other innumerate dimensions make it an important subject for students to learn.

Despite the crucial role that the Mathematics play in the life of man, the performance of secondary school students in the subject has been reported to be discouraging (Adah & Anari, 2019; Ogunkola, 2016). Reports from different zones in Nigeria tend to create an impression that students' performance in the subject is appalling. For

instance, in Akwa Ibom and Cross River States of South-South Nigeria, reports from studies a few have indicated that students' performance in Mathematics has been abysmal (Joseph, 2014; Owan, 2019). In another instance, Unodiaku (2013) disclosed that performance in Mathematics of secondary school students is very poor in Enugu State in South-East Nigeria. In North Central Nigeria, Musa and Dauda (2014) presented a trend of students' performance in Mathematics in Nasarawa State from 2004 – 2013. The authors also used Auto-Regressive Distributed Lag (ARDL) parameters to predict students' future outcomes in Mathematics from 2014 to 2020. From the results, it was depicted that the performance of students is very dismal as there was not up to a 50% credit pass recorded between 2004 and 2013. Using the trends of the ten years, the researchers predicted that the highest mean percentage credit pass from 2014 to 2020 would be 37.7% in 2014, then decline to 35.34%, 33.81%, 32.82%, 32.18%, 31.77% and 31.50% in 2015, 2016, 2017, 2018, 2019, and 2020 respectively. Going by the evidence and predictions made, it is quite revealing that students' performance in Mathematics has been poor in North-central Nigeria and would continue to be poor (given the prediction) unless something urgent is done to improve it.

From the foregoing, it makes sense to state that the issue of students' poor performance in Mathematics seems to be a national problem. For instance, in a national result in summary of students' Mathematics performance in WAEC from 2009 – 2018 see Table 1, it is very glaring that students' performance is below expectations. In Nigeria, a credit pass is the minimum grade accepted for entry into higher education. Employers and scholarship providers also rely on grades at the credit passes level when giving considerations. Following this standard, it means that grades between A1 and C6 are usually taken seriously, while other grades (e.g. D7 – E8) are not considered for relevant for essential purposes, though they indicate a pass mark. A cursory look at Table 1 also reveals that WAEC candidates in Nigeria did not record up to an average of 50% credit pass in Mathematics from 2009 to 2018, suggesting a high extent of poor performance in Mathematics.

Table-1. Distribution of West African secondary school certificate examination (WASSCE) grades in mathematics in Nigeria from 2009 – 2018.

Year	No. of candidates	Credit Pass {A1 – C6 (%)}	Pass {D7 - E8 (%)}	Fail {F9 (%)}
2009	1265090	171546 (13.56)	459860 (36.35)	633684 (50.09)
2010	1280256	560974 (42.93)	363900 (27.85)	355382 (27.20)
2011	1540250	587630 (38.15)	412358 (26.77)	540262 (35.07)
2012	1672224	649156 (38.81)	586321 (35.06)	436747 (26.11)
2013	1689188	639760 (38.30)	498521 (29.51)	550904 (32.61)
2014	1605613	529425 (30.32)	502315 (31.28)	573873 (35.74)
2015	1605248	616370 (38.68)	407123 (25.36)	581755 (36.24)
2016	1544234	376485 (24.38)	548203 (35.50)	619546 (40.12)
2017	1243722	249864 (20.09)	389906 (31.35)	603952 (48.56)
2018	1572396	481626 (30.63)	504424 (32.08)	586346 (37.29)

Students' abysmal performance in mathematics has been attributed to enormous factors ranging from personality, political, economic, school environment, home and psycho-social factors (Adeyemi & Adeyemi, 2014; Iroegbu, 2013; Owan, 2019). Other researchers have pointed accusing fingers to several other factors including students' phobic attitude, teachers' teaching style, students' interest in the subject, poor teacher-student interpersonal relationship, lack of teachers' supervision of students' work, poor attitude to assessment procedures, inadequate classroom management skills (Adeyemi & Adeyemi, 2014; Umoinyang, 1999) problems of school management, quality assurance practices, students' personality, political, economic, home and psycho-social factors (Bassey, Owan, & Agunwa, 2019; Owan, Nwannunu, & Madukwe, 2018) school-community relationship and students' perception of teachers' effectiveness (Owan & Agunwa, 2019; Robert & Owan, 2019). Although these factors have been outlined in the literature, the present study is contending that gender, test anxiety, and test-item scrambling could also impact on the performance of students in mathematics. These factors were considered in this study since they have been assessed widely in the foreign literature and to a relatively low extent in the Nigerian context. A review of existing literature on the effect of gender, test anxiety, and test item scrambling on performance in Mathematics becomes necessary at this point.

1.1. Gender and Performance in Mathematics

Gender is seen as the biological characteristics of being either a male or female. Education practitioners, psychometricians, academic and policymakers have created a lot of concern about gender as a variable that has gained wide attention in performance variability. For instance, it is a widely known fact that in the middle- and high-income economies, female students are at a disadvantaged position in terms of their performance in mathematics tests vis-à-vis their male counterpart (Fryer & Levitt, 2010; Guiso, Monte, Sapienza, & Zingales, 2008; Hedges & Nowell, 1995). The reasons for explaining these underlying differences is still debatable (Dickerson, McIntosh, & Valente, 2013). Gender has been shown by various studies to have a significant influence on performance variability among students (Salikutluk & Heyne, 2017; Unodiaku, 2013). A study found in general that, boys were significantly readier than girls in mathematics test and that gender and ability level influenced the mathematics readiness of male students (Unodiaku, 2013).

Similarly, the results of another study indicate that boys outperformed girls in Mathematics and the difference is statistically significant (Salikutluk & Heyne, 2017). It was also found that the performance of girls was worse, particularly in classrooms characterized by the presence of traditional masculine norms (Salikutluk & Heyne, 2017). However, in classrooms where such norms of masculinity are absent, it was reported that gender differences in Mathematics performance were not significantly apparent (Salikutluk & Heyne, 2017). Using microdata from 19 African countries, Dickerson et al. (2013) examined differences in the gender scores of primary school pupils in Mathematics. A significant difference was found in favour of males based on scores in a mathematics test (Dickerson et al., 2013). The authors did not attribute this gender disparity in the performance to factors such as home environment, school quality nor gender discrimination in accessing school inputs within the school; but maintained that personal or home-related factors may be responsible for the observed difference (Dickerson et al., 2013). With an effect size of d = 0.15, a meta-analysis carried out by Hyde, Fennema, and Lamon (1990) showed that male students scored higher than females in Mathematics in the sample of observation. In contrast, it was reported that females outperformed males in the general population but by a negligible difference (d = -0.05) (Hyde et al., 1990).

On the contrary, some studies discovered that gender is not a significant factor that affects the performance of students in mathematics (Adeleke, 2007; Khadijatu, 2017; Lindberg, Hyde, Petersen, & Linn, 2010; Owan, 2019). For instance, Owan and Agunwa (2019) argued that the main effect of gender is not statistically significant on the performance of students in mathematics F (1, 249) = 0.353, p>.05, Partial $\eta 2$ = .001, but the interactive effect of gender and birth order F(3,249)=2.854, p<.05, partial $\eta 2$ =.034. The result emerging from the study of Adeleke (2007) showed that there is an insignificant statistical difference in the problem-solving performance of male and female students in simultaneous linear equations across three categories of students with ($mean_1$ = 8.14; $mean_2$ = 7.66, df = 122, t = .51, p< .05). In another Nigerian study conducted in Bauchi State, Khadijatu (2017) reported that there were no significant mathematics performance differences based on gender, although female scored higher. In a meta-analysis of 242 studies, released between 1990 and 2007 on gender and performance differences in mathematics, Lindberg et al. (2010) discovered that the findings in the studies analysed, support the view that similar performance was recorded for both male and females (d = .05, VR = 1.08).

Studies have attempted to explain possible reasons for gender variation in the performance in mathematics. Particularly, attitudes, self-efficacy and achievement motivations towards mathematics are accountable factors which place boys in a favourable position over girls (Eccles, Wigfield, Harold, & Blumenfeld, 1993; Kurtz-Costes, Rowley, Harris-Britt, & Woods, 2008; Rodríguez, Regueiro, Piñeiro, Estévez, & Valle, 2020)(. Boys tend to be self-confident in their skills, are motivated and interested in mathematics which helps in neutralising their level of anxiety leading to a good performance in the subject (Rodríguez et al., 2020). On the other hand, high levels of test anxiety affect the performance of girls due to their low levels of interest, perception of control and value placed on Mathematics (Else-Quest, Hyde, & Linn, 2010; Fredricks & Eccles, 2002; Frenzel, Goetz, Pekrun, & Watt, 2010; Ganley & Lubienski, 2016; Guo, Parker, Marsh, & Morin, 2015; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002;

Preckel, Goetz, Pekrun, & Kleine, 2008; Rodríguez et al., 2020). Having explored the literature, it was deduced that the effect of gender on the performance of secondary school students in Mathematics, is still a subject of debate. Although a growing body of literature tends to favour males, but revealed non-significant differences (excluding a few studies with contrary reports). The literature on gender differences and performance, within the Nigerian context, appears scanty, giving rise for a study to be carried out to put findings in perspective. Thus, we may get to understand that cultural differences could play a role in affecting performance based on gender. The finding on gender differences on performance in Mathematics may also make a substantial contribution to the ongoing arguments in the literature.

1.2. Test Anxiety and Performance in Mathematics

Test anxiety is a combination of psychological over-arousal tension and somatic symptoms, along with worry, dread, fear of failure, that occur before or during test situations. Test anxiety involves situation like thinking about an upcoming test a day before, or having negative feelings such as fear, perceived incompetence, or low self-concept when faced with a challenging task. Test anxiety exists when one feels incapable of solving a potential problem in a given testing situation. A test-anxious person is one who possesses attitudes and habits indicative of a negative self-concept such as self-perceptions, esteem, belief and expectations (Spielberger, 1972). Such self-damaging attitudes predispose test-anxious individuals to experiences such as fear especially in the performance of physical activities including test-taking. In the field of assessment, educational measurement and evaluation, it is a known fact that test anxiety affects students' academic abilities and achievements in tests (Etuk, 2019). Test anxiety is contemporarily conceived by scholars as having two dimensions – emotionality and worry. Emotionality is to the affective domain of learning, what worry is to the cognitive domain of learning (Cassady & Johnson, 2002; Liebert & Morris, 1967). Test anxiety can affect the everyday life of an individual especially adolescents (Lufi, Okasha, & Cohen, 2004).

It is widely known in the field of cognitive psychology that there is an inverse relationship between students' test-anxiety and performance in Mathematics and other disciplines (Cassady & Johnson, 2002; Owan, Bassey, Omorobi, & Esuong, 2020; Owan, Etudor-Eyo, & Esuong, 2019; Rana & Mahmood, 2010; Smith & Smith, 2002; Syokwaa, Aloka, & Ndunge, 2014) which supports the Eysenck's Attentional Control Theory (Eysenck, Derakshan, Santos, & Calvo, 2007). This theory explains that the efficient functioning of students' attention is affected by anxiety, by decreasing the processing power and impairing the attentional control. Steinmayr, Crede, McElvany, and Wirthwein (2016) buttress that the theory explains anxiety as a factor affecting students' cognitive ability. Thus, students' ability to focus attentively on academic- or exam-related tasks is reduced, with students focusing their attention on other competing stimuli inherent in them or the environment (Steinmayr et al., 2016). Although the focus of the studies (cited above) were on Mathematics, specific emphases were not paid to the two aspects of test anxiety (emotionality and worry) advocated by Spielberger (1980). Hence, conclusions from such studies were too general and not specific.

A review of some specific studies in Mathematics reveals that there is an ongoing debate among scholars on the effect of test anxiety on performance. For instance, in a meta-analysis, a weak negative correlation was recorded between test anxiety worry and students' achievement (Schwarzer, 1990; Seipp, 1991) implying that high levels of academic achievements are attributed to low levels of worry among students. In a related but slightly opposite study, the emotional dimension of test anxiety was discovered to have a little effect on students' achievement (Deffenbacher, 1980). However, in direct contrast to the study of Deffenbacher, the results of Wigfield and Meece (1988) rather showed that emotionality as a dimension of test anxiety is high and negatively associated with students' performance than worry. The positions in these studies are well documented, however, students' performance was treated generally with only two studies focusing on performance in Mathematics.

Using a longitudinal reciprocal approach, based on cross-lagged structural equation modelling, the results of Steinmayr et al. (2016) revealed amongst others, that a negative effect existed between the worry component of test anxiety and students' achievement in schools; and low rates of academic achievement is associated with high rates of worry as a test anxiety component (Steinmayr et al., 2016). This finding also aligns with the results of other studies (Eysenck et al., 2007; Williams, 1991) showing that the cognitive aspect of test anxiety (test anxiety-worry) explained a significant amount of variance in students declining performance in schools. Notwithstanding the exciting findings and approach adopted by these studies, it is quite unclear whether these studies had focused on the subject of Mathematics or something else. It was reported that students with high test anxiety, as well as those with moderate anxiety showed lower academic performance; while students with low levels of test anxiety performed best in mathematics (Vogel & Collins, 2002). It has been discovered that many students possess a high level of anxiety (79%); the high anxiety harmed the quality of academic result recorded by students (Syokwaa et al., 2014). Furthermore, it was contended that the high level of anxiety also affects the psychological disposition of students, which in turn, affects their ability to face test items confidently (Owan et al., 2019).

However, a growing body of contrasting findings reported in some studies suggests that the perceived widely-known inverse association between test anxiety and performance is still a topic of debate and is yet inconclusive. For instance, a study reported a positive correlation ($r = .23$, $p = .000$) between students' test anxiety and performance in Iran (Yousefi, Talib, Mansor, Juhari, & Redzuan, 2010). Elsewhere, Meece, Wigfield, and Eccles (1990) studied mathematics anxiety and students' performance using a longitudinal approach, but found no statistically significant direct effects between the two variables. This presents a case that arguments are still ongoing in the scientific realm of research on this matter. In another study, it was shown that there is a significant positive relationship between urban and rural students' test anxiety and their performance in Mathematics in Rivers State, Nigeria (Mkpaoro & Nwagu, 2019). The authors discussed the implication of the findings that an increase in students' test anxiety leads to increased students' performance in mathematics (Mkpaoro & Nwagu, 2019). The authors further attributed the positive relationship to environmental factors such as school location, classrooms, field, teachers/students, school types and others (Mkpaoro & Nwagu, 2019).

The positive relationship found by Mkpaoro and Nwagu is quite surprising, indicating that much research on test anxiety and performance in Mathematics is still plausible to redress certain issues while contributing to the debate. In other recent studies (Owan et al., 2020; Owan et al., 2019) it was discovered that test anxiety is negatively correlated with students' performance in Mathematics ($B = -.159$; $\beta = -.561$; $t = -12.248$; $p < .05$) and ($r = -339$, $p<0.05$). In another study, it was disclosed that state of test anxiety (high, average or low) has a significant bearing on junior secondary students' performance in subjects such as Mathematics, English, and Social Studies respectively (Bassey & Effiom, 2018). The authors discovered further that students' performance in Mathematics, English and Social studies respectively, was higher when students test anxiety was low, average, and high, in that order (Bassey & Effiom, 2018).

The findings from all cited studies have all made their unique contributions based on the sample statistic of the respondents which has resulted in conflicting reports. The debate presented by the studies (as cited) implies that much research is still needed to justify the findings of previous efforts. Also, majority of the studies on test anxiety and performance appears to be dominant in the foreign literature, with only a few Nigerian studies observed. This creates a need for studies within the Nigerian context, to be explored. The few Nigerian studies assessed test anxiety and performance in Mathematics, but measured test anxiety as a general construct without focusing on the specific dimensions of test anxiety (emotional and worry). This study would bridge this gap by becoming the first Nigerian study to investigate the effect of test anxiety in terms of emotional, worry and total dimensions on performance in mathematics. Globally, this study is also the first to examine the interactive effect of TA-W, TA-E and TA-T on students' performance in Mathematics, previous studies have only assessed their main/partial effects on performance.

1.3. Test-Item Scrambling and Performance in Mathematics

The scrambling (arrangement, order, permutation) of test items can affect the performance of students in an examination where test items are not always arranged in ascending order of difficulty. It is true that many teachers or organizations do alter the position of test items as a means of cushioning the problem of examination malpractice. The Joint Admission and Matriculation Board (JAMB) in Nigeria for instance, uses this approach in their Unified Tertiary Matriculation Examination (UTME). However, this approach has been debunked as it has been found to affect the performance of students in multiple-choice items in Mathematics, English Language and Science examination (Ollennu & Etsey, 2015). Studies have also advocated for a sequence to be adopted that would enable individual examinees to respond to test items in ascending order of difficulty or ability (Anastasi, 1975; Guttman, 1944; Hauck, Mingo, & Williams, 2017; Munz & Jacobs, 1971; Paretta & Chadwick, 1975; Schee, 2013; Soureshjani, 2011).

The Guttman (1944) model of test item sequence leads the line of studies that shows a perfect scrambling of test items. The Guttmann scale indicates a hierarchical arrangement of test items from easy to difficult. The model also depicts how the probability of students' scores should be distributed. Studies adopting this model, must ensure that test items are arranged in a systematic and logical order according to some particular rationale. They must be arranged in a manner that that allows students to get a previous item correct as they progress. For instance, when an examinee responds correctly to say item number 3, it logically implies that the examinee should respond correctly to item 1 and 2 (since they are believed to be relatively easier). Thus, multiple-choice Mathematics test items should be arranged in ascending order of difficulty or amount of abilities (Guttman, 1944). The Gutman scale has been widely used in many theoretical, policy and applied studies in the field of psychology, measurement and beyond (e.g. (Abdi, 2010; Etuk, 2019; Gothwal, Wright, Lamoureux, & Pesudovs, 2009; Lincoln & Gladman, 1992; Maggino, 2014; McIver & Carmines, 1981; Podell & Perkins, 1957; Tractenberg, Yumoto, Aisen, Kaye, & Mislevy, 2012; Wallin, 1953)).

Different studies have been conducted on test scrambling, albeit different terms have been used interchangeably in place of test item scrambling. Other terms used popularly in related studies include test item order, sequence, arrangement, permutation, and position. Studies on test item order reveal a relationship with students' performance (Russell, Fischer, Fischer, & Premo, 2003; Soureshjani, 2011). It is also indicated that for English Language, Mathematics and Science at the BECE level, when the order of items is altered, the difference in performance is statistically significant (Ollennu & Etsey, 2015). The type of examination used is significantly related to performance (Russell et al., 2003) suggesting that question scrambling impacts are significant when different examination paper types are used. It is also revealed that a statistically significant sequencing effect exist for management courses, while the effect of question sequencing was not statistically significant for marketing courses (Russell et al., 2003). It has also been disclosed that the sequence of items affects foreign language learners' performance, with students taking easy-to-difficult test outperforming those taking the difficult-to-easy test (Soureshjani, 2011).

Another study maintains that arrangement based on ascending order of difficulty has a positive and significant effect on students' performance in mathematics; items arrangement based on descending order of difficulty has a positive but insignificant effect on the performance of students in mathematics; lastly, item arrangement based on no particular order of difficulty has a positive and significant effect on students' performance (Opara & Uwah, 2017). However, the results of Schee (2009) which reported that students' performance was not affected by test items order, but rather by academic achievement in prior courses, has presented a case that further research in this area is necessary. More so, another did not also find a significant relationship between test item order and performance in English Language but for Mathematics (Alakayleh, 2017). This finding has implication for the conduct of future studies to validate the results obtained. In the same vein, a study found that there were differences in the performance of students in Mathematics based on item arrangement, the authors, however, attributed these

differences to be due to chance (Plake, Patience, & Whitney, 1988). This implies that observed differences in the mean performance of students as reported by Plake et al were not statistically relevant, calling for more studies to the area. From another context, Lane, Bull, Kundert, and Newman (1987) maintained that there are inconsistent effects of different test item order on performance based on gender. This implies that there is a mixture of conflicting findings in the results obtained through different studies, making it reasonable for further exploits to be carried out.

Based on the literature reviewed in this section, it was observed that test items scrambling and academic performance among students has been extolled in the literature. Many studies tend to agree that, item scrambling has a significant influence on students' performance, with a growing body of studies presenting contrasting evidence. This suggests that there are inconclusive evidences arising from the results of different investigations, warranting the need for further studies. In the Nigerian context, little seems to be known of the influence of test item scrambling on performance in Mathematics due to the paucity of research evidence. Such a gap (especially in context) has further made the conduct of this study imminent as it would present a case for Nigeria. Therefore, this study has a unique contribution to make to the existing body of knowledge as it will contribute to the ongoing global debate, while also addressing the literature gaps in the Nigerian perspective.

1.4. Research question

i. What is the extent of students' pre-test and post-test performance in Mathematics based on gender?
ii. What is the rate of students' test-anxiety in terms of the dimension of worry, emotion and total?
iii. What is the extent of students' post-test performance in Mathematics based on test anxiety worry, emotion and total?
iv. What is the extent of students' post-test performance in Mathematics based on test item scrambling?

1.5. Hypotheses

The following hypotheses were formulated to guide the study:

i. There is no significant effect of gender on students' pre-test and post-test performance in Mathematics.
ii. There is no significant post-test mean differences in the performance of students in Mathematics based on test anxiety worry, emotion and total.
iii. There are no significant interactive effects of test-anxiety worry, emotional and total on students' post-test performance in Mathematics.
iv. Test item scrambling does not significantly impact students' post-test performance in mathematics.

2. MATERIALS AND METHODS

2.1. Population, Sample and Procedure

This study targeted a population (N) of 9,052 SS3 students distributed across 101public secondary schools in Ikom Education Zone of Cross River State, Nigeria. Proportionate sampling procedure was adopted in selecting a sample of 1,358 respondents (688 males = 50.7%; 670 females = 49.3%) representing 15% of the total population. This study adopted the pre-test post-test control group quasi-experimental research design, with two experimental (treatment) groups and one control group. The researcher made first contact with the selected participants where a pretest comprising of randomly arranged test items in Mathematics was administered to all the selected students. During the pretest, the researcher assigned serial numbers to all the students and urge them to write it on their answer scripts and keep safe. After the pre-test, the sample of respondents was randomly assigned to the three groups in a systematic manner using the numbers written on their answer scripts.

The splitting process was randomized systematically to ensure that participants of similar characteristics are found in each category. The categorisation of students was done using assigned serial numbers given to them

during the pre-test. The process followed an arithmetic progression with a common difference of three. Thus, participants with serial numbers 1, 4, 7, 10, 13, 16, 19 . . . were categorised into Experimental group 1 (EG_1), while the subjects with serial numbers 2, 5, 8, 11, 14, 17, 20. . . were categorised into Experimental group 2 (EG_2) and those with serial numbers 3, 6, 9, 12, 15, 18, 21 . . . were categorised into the Control group. Consequently, a total of 453 students were assigned to EG_1 and EG_2 respectively; while a total of 452 students were assigned to the control group (CG).

The following week, the researcher made second contact to collect test anxiety and post-test data. Before the treatment, the researcher administered a Test Anxiety Inventory (TAI) (discussed later) to all the students in their various groups according to their assigned serial numbers. Upon completion, the administered TAIs were retrieved, then the post-test was administered after a short break of 20 minutes. The short break was to allow respondents ease and relief themselves of stress, urine and so on, to avoid distraction during the post-test. During the treatment, students in the EG_1 were given question paper "type A", which contains Mathematics test-items arranged from easy to difficult. Students in the EG2 were offered the question paper type B, containing Mathematics test items arranged from difficult to easy. Lastly, students in the CG were given randomly arranged (scrambled) mathematics test items of no particular order of difficulty. The post-test lasted for 50 minutes, giving slow respondents an opportunity to complete theirs. At the end of the exercise, the administered test scripts were retrieved from the participants for analysis. All the participants showed up for both the pre-test and post-test, making it possible for data to be collected from the entire sample of respondents. Hence, there were no issues of missing data

2.2. Instruments and Measures

2.2.1. Test Anxiety Inventory

The Test Anxiety Inventory (TAI) was used to measure the test anxiety levels of students before taking the post-test. The TAI was specially designed with three sub-scales – Test Anxiety Total (TAI – T), Test Anxiety-Worry (TAI-W) and Test Anxiety-Emotional (TAI-E) (Spielberger, 1980). Generally, TAI comprised 20 items arranged on a 4-point Likert scale. Response options range from Almost Never (1 point) to Almost Always (4 points) (Spielberger, 1980). Specifically, the sub-scale TAI-T was designed with four items, TAI-W and TAI-E had eight items respectively. The reliability of the instrument was originally ascertained using Cronbach alpha with the coefficients of α=0.96, α=0.91, α=0.91 for TAI-T, TAI-W, and TAI-E respectively, indicating that the instrument is internally consistent for measurement (Spielberger, 1980). A reliability of the instrument was also performed by the researcher on the Nigerian participants using the Cronbach alpha technique. Coefficients of 0.86, 0.91 and 0.89 obtained for TA-W, TA-E, and TA-T further confirmed that the instrument is internally consistent for use on the Nigerian population. Apart from this study, TAI of Spielberger has been widely used in many psychological or anxiety-related kinds of research (Chapell et al., 2005; Owan et al., 2020; Szafranski, Barrera, & Norton, 2012) proving its reliability and validity in different contexts.

2.2.2. Mathematics Achievement Test

A Mathematics Achievement Test (MAT) developed and validated by Etuk (2019) was used to measure students' performance in Mathematics. The MAT comprised 30-items multiple-choice test items with four options (A – D). The instrument's face, content and construct validity were established Etuk (2019). In terms of content validity, items were developed from areas such as number and numeration (30%), algebraic processes (20%), mensuration (15%), trigonometry (20%), statistics and probability (5%) and geometry (10%), with their weighting in bracket (Etuk, 2019) Items difficulty index (p-values) ranged from .20 to .80, while item discrimination index (d-values) ranged from -.25 to .88 (Etuk, 2019) The first question paper type (A) was the easy-to-difficult (ED) arrangement in which the 30 items were re-arranged from the easiest item to the most difficult using their calculated p-values. The second question paper type (B) was the difficult-to-easy (DE) arrangement, where the

items were rearranged from the most difficult to the easiest item. The third question paper was the random (R) arrangement, where the items were arranged randomly scrambled. The equivalent reliability established for the MAT were 0.71 for ED – DE, 0.81 for ED – R, and 0.82 for DE – R (Etuk, 2019). Unlike the former TAI, this instrument has not been used widely, however, the researcher adopted this instrument for two reasons. First, it was adopted due to its sound psychometric properties. Secondly, it was adopted since it has previously been used on a similar set of respondents.

2.3. Procedure for Data Analysis

Students' responses to the MAT and TAI were scored accordingly and coded on a person-by-item matrix. Descriptive statistics such as mean and standard deviation were used to analyze summarized data and also answer the research questions. Inferential statistics such as independent t-test, one-way analysis of variance (ANOVA) and analysis of covariance (ANCOVA) were employed (where applicable) in the test of hypothesis. All computations were aided through the use of SPSS version 23 software.

3. RESULTS

3.1. Research Question 1

What is the extent of students' pre-test and post-test performance in Mathematics based on gender? Students pre-test and post-test mean performance results Table 2 indicates that male students achieved mean performances of 14.27 and 15.00, with standard deviations of 7.324 and 7.940 in the pre-test and post-test respectively. Female students' pre-test and post-test mean performance stood at means of 13.65 and 14.83, with standard deviations of 7.578 and 8.186 respectively. This result indicates that male students' performance in Mathematics is higher than that of females in the pre-test and post-test respectively.

Table-2. Summary of students' pre-test and post-test mean performance in Mathematics based on gender.

Performance in Math	Gender	N	$\bar{X}$	SD	SE
Pre-test	Males	688	14.27	7.324	.279
	Females	670	13.65	7.578	.293
Post-test	Males	688	15.00	7.940	.303
	Females	670	14.83	8.186	.316

3.2. Research Question 2

What is the rate of students' test-anxiety in terms of the dimension of worry, emotion and total? The results in Table 3 shows that 40.2% of the students had high TA-W, 30.1% had average TA-W, while 29.7% of the respondents had low TA-W.

Table-3. Frequency distribution showing the number and percentage levels of students' tests anxiety.

Dimension of test anxiety	Level of anxiety	F	%	Cum. %
Test Anxiety Worry	High	546	40.2	40.2
	Average	409	30.1	70.3
	Low	403	29.7	100.0
	Total	1358	100.0	
Test Anxiety Emotion	High	576	42.4	42.4
	Average	380	28.0	70.4
	Low	402	29.6	100.0
	Total	1358	100.0	
Test Anxiety Total	High	608	44.8	44.8
	Average	363	26.7	71.5
	Low	387	28.5	100.0
	Total	1358	100.0	

In terms of test anxiety emotion, 42.4% of the respondents reported high TA-E, 28.0% reported average TA-E, and 29.6% reported low TA-E. For test anxiety total (TA-T), 44.8% indicated that they possess a high rate of TA-T, 26.7 reported average TA-T, while 28.5% of the respondents reported having low TA-T. Therefore, a higher percentage of students showed high levels of TA-W, TA-E and TA-T.

3.3. Research Question 3

What is the extent of students' post-test performance in Mathematics based on test anxiety worry, emotion and total? Students' post-test performance in Mathematics based on test anxiety Table 4 reveals, in the worry dimension, that students' performance was highest when TA-W was low ($\bar{X}$ = 20.17, SD = 7.622). Students performance was higher when TA-W was at the average level ($\bar{X}$ = 15.11, SD = 6.495); while it was lower when TA-W was at a high level ($\bar{X}$ = 10.89, SD = 7.116). In the test-anxiety emotion (TA-E) dimension, Table 4 reveals further that students' post-test performance in Mathematics was highest when TA-E level was low ($\bar{X}$ = 21.54, SD = 7.255). Students' post-test performance in Mathematics was higher when TA-E level was at an average level ($\bar{X}$ = 14.94, SD = 5.972); while it was lowest when students' TA-E level was high ($\bar{X}$ = 10.28, SD = 6.391). In the test anxiety total (TA-T) dimension, it is shown that students' post-test Mathematics performance was highest when TA-T level was low ($\bar{X}$ = 20.65, SD = 6.840). Furthermore, students' performance was higher when TA-T level was at average ($\bar{X}$ = 15.93, SD = 6.309); while it was lower when TA-T level was high ($\bar{X}$ = 10.66, SD=7.210). Generally, the results in Table 4 suggest that students' performance is higher when test anxiety level is low, average and high, in that order.

Table-4. Mean and standard deviation of students' post-test performance in mathematics based on the dimensions of test anxiety.

Dimension of test anxiety	Level of anxiety	N	$\bar{X}$	SD	SE
Worry	High	546	10.89	7.116	.305
	Average	409	15.11	6.495	.321
	Low	403	20.17	7.622	.380
	Total	1358	14.92	8.060	.219
Emotion	High	576	10.28	6.391	.266
	Average	380	14.94	5.972	.306
	Low	402	21.54	7.255	.362
	Total	1358	14.92	8.060	.219
Total	High	608	10.66	7.210	.292
	Average	363	15.93	6.309	.331
	Low	387	20.65	6.840	.348
	Total	1358	14.92	8.060	.219

3.4. Research Question 4

What is the extent of students' post-test performance in Mathematics based on test items scrambling? The post-test mean performance in Mathematics based on test-items scrambling Table 5 indicates that students' post-test performance is highest when Mathematics test items are arranged from easy to difficult ($\bar{X}$ = 18.08, SD =

7.661). Furthermore, students' performance is higher when Mathematics test items are randomly arranged ($\bar{X}$ = 15.07, SD = 8.630); while it is lower when test items are arranged from difficult to easy ($\bar{X}$ = 11.61, SD = 6.402).

Table-5. Mean and standard deviation of students' post-test performance in Mathematics based on test items scrambling.

Test item order	N	$\bar{X}$	SD	SE
ED	453	18.08	7.661	.360
DE	453	11.61	6.402	.301
R	452	15.07	8.630	.406
Total	1358	14.92	8.060	.219

3.5. Hypotheses 1

There is no significant effect of gender on students' pre-test and post-test performance in Mathematics. The independent t-test results for equality of means between male and female pre-test and post-test performance in Mathematics Table 6 was used to test this null hypothesis. Based on the results, it was discovered that the mean differences of 0.617 and 0.176 recorded between male and female in favour of males, see Table 2 in the Mathematics pre-test and post-test is not statistically significant at the .05 alpha level and 1356 degrees of freedom. Consequently, the null hypothesis is retained and the conclusion is that there is no significant effect of gender on students' pre-test and post-test performance in Mathematics.

Table-6. Summary of independent t-test for equality of means between male and female students' performance in mathematics in pre-test and post-test.

Performance in Math	t	df	Sig.	$\bar{X}$ Difference	SE Difference
Pre-test	1.525	1356	.127	.617	.404
Post-test	.402	1356	.688	.176	.438

3.6. Hypotheses 2

There are no significant post-test mean differences in the performance of students in Mathematics based on test anxiety worry, emotion, and total. The ANOVA results Table 7 reveals that test anxiety worry (TAT-W) has a significant effect on students' post-test performance in Mathematics F (2, 1355) = 198.655, p = .000. The results also indicate that test anxiety emotion (TA-E) has a significant effect on the post-test Mathematics performance of students F (2, 1357) = 350.265, p = .000. Furthermore, it is indicated that test anxiety total (TA-T) has a significant effect on students' post-test mathematics performance F (2, 1357), p = .000. Going by the significance of these results in the three dimensions, the null hypothesis was rejected, while the alternate hypothesis is upheld. This implies that there is a significant post-test mean difference in the performance of students in Mathematics based on test anxiety worry, emotion, and total. However, the Tukey post hoc test of multiple comparison was performed to show the pair-wise mean differences and ascertain those that are significant See Table 8.

The result depicted in Table 8 shows that the mean difference (9.279) in the post-test Mathematics performance of students with low and high levels of test anxiety worry (TA-W) is significant. When performance in Mathematics post-test was compared between students with low and average TA-W, the mean difference (5.056) was significant. When students with average and high TA-W were compared, there was a significant mean difference (4.223) in their post-test performance in Mathematics.

In the dimension of test anxiety emotion (TA-E), the mean difference (11.265) in the post-test mathematics performance of students with low and high levels of test anxiety is significant. The comparison between students with low and average levels of TA-E reveals a significant mean difference (6.600) in their post-test Mathematics

performance. Comparison of post-test performance in Mathematics between students with average and high levels of TA-E, reveals a significant mean difference (4.664).

In the test anxiety total (TA-T) dimension, the result in Table 8 reveals that there is a significant mean difference (9.994) in the post-test Mathematics performance of students with low and high levels of TA-T. Also, there is a significant mean difference (4.720) in the post-test mathematics performance of students with low and average levels of TA-T. Furthermore, there is a significant mean difference (5.274) in the post-test Mathematics performance of students with average and high levels of TA-T.

Table-7. One-way analysis of variance (ANOVA) results in summary showing students' post-test performance in Mathematics based on test anxiety dimensions.

Test anxiety	Source	SS	Df	MS	F	Sig.
Worry	Between Groups	19987.353	2	9993.677	198.655	.000
	Within Groups	68165.410	1355	50.307		
	Total	88152.763	1357			
Emotion	Between Groups	30042.700	2	15021.350	350.265	.000
	Within Groups	58110.063	1355	42.886		
	Total	88152.763	1357			
Total	Between Groups	24132.223	2	12066.111	255.380	.000
	Within Groups	64020.540	1355	47.248		
	Total	88152.763	1357			

Table-8. Tukey Honest Significant Difference Test showing the significant pair-wise comparison of students' post-test performance in mathematics based on test-anxiety dimensions.

Test anxiety	Level of test anxiety		I – J	SE	Sig.
	I	J			
Worry	Low	High	9.279*	.466	.000
		Average	5.056*	.498	.000
	Average	High	4.223*	.464	.000
Emotion	Low	High	11.265*	.426	.000
		Average	6.600*	.469	.000
	Average	High	4.664*	.433	.000
Total	Low	High	9.994*	.447	.000
		Average	4.720*	.502	.000
	Average	High	5.274*	.456	.000

Note: *. The mean difference is significant at the 0.05 level.

3.7. Hypotheses 3

There is no significant interactive effect of test-anxiety worry, emotional and total on students' post-test performance in Mathematics. The test of between-subject effects Table 9 reveals that students' TA-W has a significant main effect on students' post-test mathematics performance F (2, 1330) = 30.634, p = .000 < .05. There is also a significant main effect of TA-E on students' post-test performance in Mathematics F (2, 1330) = 103.849, p = .000 < .05. There is a significant main effect of TA-T on students' mathematics post-test performance F (2, 1330) = 28.811, p = .000 < .05. The interaction between TA-W and TA-E on students' post-test Mathematics performance is not statistically significant F (4, 1330) = 0.832, p = .505 > .05. The interactive effect of TA-W and TA-T on students' post-test Mathematics performance is statistically significant F (4, 1330) = 16.588, p =.000 <.05. The interaction between TA-E and TA-T on students' post-test performance in Mathematics is significant F (4, 1330) = 2.433, p = .046 < .05.

Lastly, the interaction between TA-W, TA-E and TA-T on the post-test performance of students in Mathematics is statistically significant F (8, 1330) = 3.195, p =.001 < .05. Based on the result of this interaction (TA-W * TA-E * TA-T), the null hypothesis was rejected while the alternate hypothesis is retained, implying that there is a significant interactive effect of test-anxiety worry, emotional and total on students' post-test performance in Mathematics. However, these three dimensions of test anxiety has no significant effect on students' pre-test

performance in Mathematics F (1, 1330) = 0.879, p = .349 > .05. Furthermore, all the variables in the model accounted for 51.2% (Adjusted R square = .512) of the total variance in students' post-test mathematics performance, with the remaining 48.8% of the total variance explained by other extraneous variables not listed in the model.

Table-9. Analysis of covariance results (ANCOVA test of between-subject effects) showing the main and interactive effects of test anxiety worry, emotion and total on post-test performance in Mathematics.

Source	Type III SS	Df	MS	F	Sig.
Corrected Model	46018.746[a]	27	1704.398	53.801	.000
Intercept	61874.022	1	61874.022	1953.112	.000
Pre-test	27.836	1	27.836	.879	.349
TA-W	1940.966	2	970.483	30.634	.000
TA-E	6579.825	2	3289.913	103.849	.000
TA-T	1825.438	2	912.719	28.811	.000
TA-W * TA-E	105.460	4	26.365	.832	.505
TA_W * TA-T	2102.004	4	525.501	16.588	.000
TA-E * TA-T	308.267	4	77.067	2.433	.046
TA-W * TA-E * TA-T	809.619	8	101.202	3.195	.001
Error	42134.017	1330	31.680		
Total	390352.000	1358			
Corrected Total	88152.763	1357			

Note: a. R Squared = .522 (Adjusted R Squared = .512).

3.8. Hypotheses 4

Test items scrambling does not significantly impact students' post-test performance in mathematics. The one-way analysis of variance results Table 10 shows that there is a significant effect of test items scrambling on students' post-test performance in Mathematics F (2, 1355) = 81.866, p =.000 < .05. Based on this evidence, the null hypothesis is rejected while the alternate hypothesis is hereby retained. By implication, test items scrambling significantly influence students' performance in Mathematics. The Tukey post hoc test of multiple comparisons was performed See Table 11 to show the pair-wise mean differences of students' post-test mathematics performance, based on the various test item order. The results of the Tukey test revealed that there is a significant mean difference (6.472) when the performance of students who took the ED test items were compared with those who took the DE. When the performance of students who took the ED and the R arranged test items are compared, the mean difference of 3.013 is significant. Lastly, the comparison between students' performance in the DE and R arrangements, reveals a significant mean difference of -3.459 (in favour of those who took R).

Table-10. One-way analysis of variance (ANOVA) results in summary showing students post-test performance in Mathematics based on test items scrambling.

Source of variation	SS	Df	MS	F	Sig.
Between Groups	9503.558	2	4751.779	81.866	.000
Within Groups	78649.205	1355	58.044		
Total	88152.763	1357			

Table-11. Tukey Honest Significant Difference (HSD) test of the significant pair-wise multiple comparisons of students' post-test performance in mathematics based on test items scrambling.

Test item scrambling		I – J	SE	Sig
I	J			
ED	DE	6.472*	.506	.000
	R	3.013*	.507	.000
DE	R	-3.459*	.507	.000

Note: *. The mean difference is significant at the 0.05 level.

4. DISCUSSION OF FINDINGS

This study showed that, although male scored higher in pretest and post-test in Mathematics, they did not differ significantly from their female counterparts. The non-significant high performance of males over females may be attributed to the disadvantaged position of female (Fryer & Levitt, 2010; Guiso et al., 2008; Hedges & Nowell, 1995). However, this study agreed that gender does not play a significant role in the performance of students in Mathematics challenging the results of previous studies (Salikutluk & Heyne, 2017; Unodiaku., 2013) which argued that gender significantly affects performance. The differences in the results of previous studies and of the current study may be attributed to the treatment used or the nature of respondents. However, it can be argued that the same classroom conditions which both male and female students of this study were exposed to, may have led to the similar scores recorded. It may be difficult for individuals who receive the same quality of training from an instructor to outperform others significantly, since similar treatments were administered to them. The argument of this study supports the result of a study reporting that gender differences in Mathematics performance were not significantly apparent in classrooms where such norms of masculinity are absent (Salikutluk & Heyne, 2017). Another study did not attribute the differences in the performance of males and females to gender, it was rather attributed to personal or home-related factors may be responsible for the observed difference (Dickerson et al., 2013).

This study also showed that many students possess a high degree of test anxiety through worries, and emotions, which tends to affect their performance significantly in Mathematics. This strengthens the results of Syokwaa et al. (2014) which also reported that many students possess a high level of anxiety which hurts the quality of academic result recorded by students. The increase in students' anxiety levels is attributed to students' phobia for Mathematics. Many students are afraid of Mathematics because of calculations and perceived complex formulas. Furthermore, it was documented in the presented study that students with high rates of test anxiety (worry, emotion and total) perform significantly poorer in mathematics than those with average and low rates of test anxiety. The reason is that a test-anxious person possesses attitudes and habits indicative of a negative self-concept such as self-perceptions, esteem, belief and expectations (Spielberger, 1972). Thus, such negative self-perceptions about oneself could reduce self-confidence, leading to poor learning outcomes. This also supports the Eysenck's Attentional Control Theory which explains that the efficient functioning of students' attention is affected by anxiety by decreasing the processing power and impairing the attentional control (Eysenck et al., 2007). Thus, in an examination hall, a confident student picks challenges when faced with a tough question, while those with a lack of self-confidence may become afraid and avoid trying. This will lead to poor attention and performance, since the high level of anxiety affects the psychological disposition of students, which in turn, affects their ability to face test items confidently (Owan et al., 2019). This result also corroborates the findings of a study which revealed, amongst others, that a negative effect existed between the worry component of test anxiety and students' achievement in schools; and low rates of academic achievement is associated with high rates of worry as a test anxiety component (Steinmayr et al., 2016).

The study did not find any significant difference in the pre-test scores of students' performance based on test items scrambling. This outcome may be due to the neutral platform in which the pre-test was taken. However, after treatment, significant differences were observed in the post-test performance of students. It was held that students' performance in Mathematics is best when test items are arranged in ascending order of difficulty. This finding aligns with the framework of the Guttman (1944) scale which prescribes that test items be arranged in ascending order of difficulty. The finding also aligns with the results of many studies (e.g. (Hauck et al., 2017; Schee, 2013; Soureshjani, 2011)) which all advocated that a sequence be adopted that would enable individual examinee to respond to them in ascending order of difficulty or ability. The reason is that the arrangement of test items from easy to difficult, allows test-takers to reinforce after getting a previous item correct, increasing their level of interest and motivation to score more. In another instance, the present study also revealed that the scrambling (random

displacement) of test items was found to improve students' performance in Mathematics, more than the arrangement of test items in descending order of difficulty. This supports the finding that that item arrangement based on no particular order of difficulty has a positive and significant effect on students' performance (Opara & Uwah, 2017).

Lastly, it was shown in this study that the interaction of TA-W, TA-E, and TA-T significantly influences students' performance in Mathematics. This finding holds that students with high levels of emotional problems and worries perform poorer in Mathematics than those without such negative psychological attributes. Such poor performance could be attributed to the internal destabilization that comes with worries and emotional problems. A person that worries too much becomes naturally afraid of circumstances surrounding him and may make faulty decisions in such moment. The combination (interaction) of such worries with other emotional problems (e.g. fear, deep feeling of love, anger, or hate) could create an individual with high attention loss. Such a person may be present in a classroom but is not part of the classroom's activities. As earlier stated, this study is the first to examine the interactive effects of TA-W, TA-E and TA-T on performance, therefore, further researches need to be conducted in this regard to validate this finding.

5. CONCLUSION

Based on the findings, the conclusions reached in this study is that gender does not play a significant role in the performance of students in mathematics. Test anxiety in terms of worry, emotion and total affect the performance of students in Mathematics, such that higher levels of anxiety (worry, emotion and total) leads to lower performance in Mathematics. Test items scrambling is a crucial factor that affects the extent to which students perform in Mathematics, with examinations where test items are arranged in ascending order of difficulty, enhancing better performance than randomization and arrangement in descending order of difficulty. The interaction of test anxiety worry, emotion and total causes severe emotional damage which affects students' performance. The implication of this study, first, is that mathematics teachers need to be aware of the non-significant gender effect on performance which can enable them to make placement decisions in the future. Secondly, the levels of students' anxiety need to be known for future educational practices to enable educational managers help those with high anxiety levels, for improved performance in Mathematics and other subjects. Thirdly, having an understanding of the test order effect on performance would redefine prospective assessment practices in education and related disciplines. It would enable teachers and measurement experts to sort test items in a manner that brings out the best performance in students. Based on the conclusion reached in this study, the following recommendations were made:

i. School managers, teachers, parents and the society in general, should desist from the practice of always viewing females as inferior to males in terms of Mathematics ability and competence. This perception if held by the majority of the populace tends to discourage the girl-child from competing favourably with their male counterparts resulting in low self-esteem.

ii. Professional counsellors and para-counsellors should be adequately employed and deployed to various schools to improve the psychological or psychosocial state of learners in secondary education. The presence of these experts in schools will help in addressing the problems of anxiety and negative self-concept among learners.

iii. Every secondary school should ensure that adequate extra-curricular activities such as social gatherings, sports activities, clubs and so on, are regularly provided in schools. This will help in boosting the excitement and confidence levels of students, reducing drastically, anxiety levels inherent in some students.

iv. Before the commencement of any examination or assessment-related activity, students should be exposed to a comic relieving encounter (e.g jokes, set induction, etc). This will spark excitement in the learners prior to the test, leading to a decreased rate of test anxiety.

v. Teachers, measurement experts and evaluators should ensure that for every test or examination activity, test items are arranged from simple to complex. On no account should test items be scrambled as a means of overcoming examination malpractice, instead, other examination malpractice combating techniques should be adopted.

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