EFFECTS OF TEST TYPES ON JUNIOR SECONDARY STUDENT COGNITIVE ACHIEVEMENT IN ALGEBRA

[1]Zalmon, Ibaan Gogo & Wonu, Nduka[2]
[1-2]Department of Mathematics/Statistics, Faculty of Natural and Applied Sciences, Ignatius Ajuru University of Education, Port Harcourt, **NIGERIA**
&
Raphael-Emelis Jane Chigozi[3]
[3]Community Secondary School Rumuapara, Port Harcourt, **NIGERIA**
Corresponding Email: wonu.nduka@iaue.edu.ng

ABSTRACT

The research work explored the effects of test types on public junior secondary student cognitive achievement in algebra in Ahoada-East Local Government Area (LGA) of Rivers State using the quasi-experimental research design of the pretest-posttest type. The multiple-choice test was used as the control test type while alternative-response test, matching test and the essay test types were used as the treatment tests. A total of 133 randomly selected JSC3 students from four classes in a school used for the study. The Algebra Achievement Test (AAT) was an instrument developed by the researchers for data collection. Kuder Richardson-21 (KR21) formula was used to establish the reliability of the AAT and the reliability coefficients of 0.82 and 0.78 were obtained for multiple-choice and alternative response test types respectively whereas test-retest method was used to obtain the reliability indices of 0.70 and 0.73 for the matching and essay test types respectively. Data were collected through the direct delivery approach. Descriptive statistics and independent-sample t-test were used for data analyses. Findings of the study revealed a significant difference between the cognitive achievements mean scores of students in algebra evaluated with multiple-choice test type and supply, alternative-response and matching types in favour of the multiple-choice test type. However, there was no significant variation between the cognitive achievement mean scores of students evaluated with the essay and those assed with multiple-choice test types in algebra. Students evaluated with the multiple-choice test and the essay test type achieved significantly better when compared with their achievement, alternative-response and matching test types. Therefore, teachers and examination bodies should prefer the multiple-choice and essay test types, alternative-response and matching test types in evaluating students' achievement in Mathematics.

Keywords: Effects, test types, student, cognitive, achievement, algebra.

INTRODUCTION

The predictable mass failure of most leavers of secondary school in May/June examinations organized by the National Examination Council (NECO), West African Examination Council (WAEC), and the National Business and Technical Examination Board (NABTEB) is worrisome. Zalmon and Wonu (2017) showed that 26 years ago, just 27.31 percent of students in Nigeria got credit or more (A1-C6) while 72.69 percent had pass grade and below (D7-F9) in the May/June West African Senior Secondary Certificate Examination (WASSCE) in General Mathematics. The impact of this abysmal performance of students in Mathematics on the nation's manpower and economic development calls for concern. Nigeria's leaders, stakeholders in the education industry and every citizen of the nation should collaboratively work towards reversing the poor performance trend in Mathematics

education because of its adverse effect on the scientific, economic and technological advancement of the nation.

Many researchers have distinguished various components cited as being answerable for the reliably horrible performance in Mathematics. Poor utilization of innovative instructional strategies, lack of positive student-teacher relationship, deficiency in cognitive skills, lack of instructional materials, job mismatch and deficiency in basic mathematical skills were some of the constraints to effective Mathematics teaching and learning (George & Zalmon, 2019; Zalmon & Charles-Ogan, 2020; Zalmon & Njoku, 2018). A study on constraints to instructional effectiveness and student Mathematics achievement by Wonu and Zalmon (2019) revealed among others that parental factors were the most pressing factor associated with student achievement in Mathematics; followed by student factor, school factor and lecturer or teacher factor. Since no mention is made of test type as a possible factor to student poor performance in Mathematics examinations, this study, therefore, seeks to investigate the effects of test types on the achievement of students in Mathematics.

A test is an evaluation instrument designed to assess the cognitive development of the testee before, during or after instruction. A test is used to ascertain the extent to which an instructional objective as been achieved. A test administered before the instruction is known as a diagnostic test. The formative test is a test given during instruction such as classwork while the test which occurs after the instructional processes is a summative test. Promotional and terminal examinations are examples of the summative test. Ekwueme (2013) defined a test as a set of task systematically constructed, selected and presented under the standard condition to elicit a sample of behaviour based on which an inference about the testees' total behaviour can be drawn.

The substance of using tests and other appraisal instruments during the instructional cycle is to oversee, direct and screen student learning progress regarding the course objectives (Alonge, 2004; Kolawole, 2010). Also, such testing empowers the learners to get more involved and focused on the instructional measure and improving their achievement (Bandura, 2002). As indicated by Gronlund and Linn (2010), test or assessment serves three uses to be specific: to design restorative activity for conquering learning lacks; to help in propelling students and to enhance retention and performance of understanding. Learners' reaction to various test types could be to uncover group and individual mistakes requiring adjustment (Gronlund & Linn, 2010). Ekwueme (2013) outlined the importance of administering the test in Mathematics as follows: to check if the lesson is understood by the learners, to see if the objectives of the lesson have been achieved, for the teacher to identify the learner that require attention, to check if the method used by the teacher is effective, to identify those who need counselling and to guide the teacher on who should be promoted.

There are processes of evaluation or administering a test. The test process should involve identifying the performance objectives, choosing a test type, developing a test blueprint or table of specification, designing the test instrument according to the test blueprint, establishing the validity and reliability of the test instrument, administering the test under strict supervision, retrieving the test, marking/scoring the test using a marking scheme/guide and analyzing and presenting the test scores for decision making. Alamina (2008) outlined five steps involved in the evaluation as follows: ascertain what is to be evaluated such as teaching objectives, select a suitable technique or tool for measuring objectives specified, measure the learning outcome using the selected technique of evaluation by administering the test, contrast the outcome of the assessment and what is normal and assess based on

comparison of real result with the normal result; deciding whether the goals have been met. Ekwueme (2013) also presented six processes for evaluation or testing as follows: identification and definition of what traits/attribute to be evaluated, stated behaviorally; choosing and developing an appropriate instrument for measuring the objective which includes the construction of the items, trial testing, validation and reliability; administering of the instrument; scoring of the instrument; decision making and reporting.

Test type refers to the different design of test instruments. Alamina (2008) listed the following as types of test: achievement test, diagnostic test, intelligent test, aptitude test, teacher-made test and standardized test. According to Alamina (2008), achievement test attempt to measure individuals present level on specific knowledge or skills in a planned instruction. Teacher-made tests are test prepared by the teacher while standardized tests are tests designed by measurement experts to obtain indicators of students' performance under a controlled and uniform setting. Teacher-made and standardized test are examples of achievement test (Alamina, 2008). Odli (2006) classified test into objective and essay types. Objective test types are test types which restrict student response to only the option provided. In objectives tests, learners are not allowed any chance to score any mark for an answer barely missed (Odili, 2006). In an essay test, the learner is not limited to a specific strategy however simply needed to give a solution and indicating different strides in the solution. Odili (2006) further grouped the target objective test type into true/false options, multiple-choice, matching items, completion item and multi-facet item.

The true/false objective test which is also known as the alternative response test is a type of objective test in which a statement is made and the testee is relied upon to show whether the assertion is false or true, or an inquiry is posed and the respondent should answer yes or no. A matching test contains two sets of given choices in which the testee is required to match one item from a rundown to another item in the subsequent list. The number of options in a single list should be in any event one more than the number in the subsequent list with the goal that somebody who realizes the response to everything except one of the items will not naturally find the last solution right (Odili, 2006). The multiple-choice test is a kind of objective test which contains a stem (questions or statements) and four or five alternatives. Choices are potential answers of which just one is right while some unacceptable alternatives are called distracters. The testee shows the right alternative by one or the other cycling, underlining, composing the letter before their picked answer or shading where a computer answer sheet is utilized. Jonah-Eteli (1999) portrayed a different multiple-choice test as an inquiry with at least three options out of which one is right; the more the choices the more reliable to a point. Guided multiple-choice objective questions test radiated from guided discovery strategy for educating in which the student is given mathematical tasks and simultaneously given a few prompts, clues and guidelines that could direct the problem-solver tackle the tasks (Oghenevwede, 2012; lgbojinwaekwu, 2015).

According to Odili (2006), the following precautions should be taken recorded when dealing with the multiple-choice test: the problem should be obviously and compactly expressed in the stem and not in the alternatives, only one task should be included in a question, however much as could reasonably be expected the choices of an item should be of a similar structure and about equivalent length, one and only one right answer should be included in the normal multiple-choice type, every choice where articulations are included should be recorded in a line, the right choices should be put randomly, grammatical cues should not be allowed to give away the right alternative, the negatives should be used only when necessary in the stem and such phrases as "all of these'', "none of the above" should be used with caution. The

multi-facet objective test involves presenting the testee with a situation requiring answering several independent questions using the given data. The completion or supply objective test type demands that the testee supplies the answer by filling in or supplying the correct response. Egbule (2002) as cited in Igbojinwaekwu (2015), defined objective test as a very much organized test item in which the testee or learner is needed to distinguish or choose the right choice from a given arrangement of options and recognized four sorts of objective tests as matching items, true or false / yes or no, multiple-choice, and fill in the blank space. Examining the impacts of these test types on the learning outcomes of students in algebra is the focal point of this investigation.

Statement of the Problem

Researchers have reported on several factors accountable for the pitiable performance of learners in Mathematics without mentioning test type. This exploration is therefore poised to determine the effects of test types on student Mathematics achievement. The study shall answer the question: what is the effect of test type on student cognitive achievement in algebra?

Aim and Objectives of the Study

The aim of e exploration is to investigate the effects of test types on junior secondary student cognitive achievement in algebra. The objectives are to:

1. investigate the difference in the learning achievement of students evaluated with the alternative-response and those assessed using multiple-choice test type in algebra.
2. determine the difference in the learning achievement of students evaluated with the matching and those assessed using multiple-choice test type in algebra.
3. find out the difference in the learning achievement of students evaluated with the essay and those assessed using multiple-choice test type in algebra.

Research Questions

Five research questions guided the study:

1. What is the difference between the achievement mean scores of students evaluated with the alternative-response and those assessed using multiple-choice test type in algebra?
2. What is the difference between the achievement mean scores of students evaluated with the matching and those assessed using multiple-choice test type in algebra?
3. What is the difference between the cognitive achievement mean scores of students evaluated with the essay and those assessed using multiple-choice test type in algebra?

Hypotheses

The study is guided by the following null hypotheses:

1. There is no significant difference between the cognitive achievement mean scores of students evaluated with the alternative-response and those assessed using multiple-choice test type in algebra.
2. There is no significant difference between the cognitive achievement mean scores of students evaluated with the matching and those assessed using multiple-choice test type in algebra.
3. There is no significant difference between the cognitive achievement mean scores of students evaluated with the essay and those assessed using multiple-choice test type in algebra.

METHODOLOGY

Research Design: The quasi-experimental research design of the pretest-posttest type was

adopted. The multiple-choice test was used as the control test type while the alternative-response test, matching test and the essay test types were used as the treatment test. The study investigated the effects of test types on public junior secondary students' cognitive achievement in algebra in Ahoada-East LGA in Rivers State.

Participants: The population of the study consisted of nine hundred and twenty-six (926) junior secondary class three students from the thirty public secondary schools in Ahoada-East LGA. Random sampling technique was used to select one school with at least four forms/groups of JSC3 students and 133 students from four intact classes. Specifically, the students were assigned such that 30 of them took the multiple-choice test, 35 students took the alternative response test, 32 students took the matching test and 36 students took the essay test.

Instrumentation: The Algebra Achievement Test (AAT) was an instrument developed by the researchers for data collection. The AAT had two sections. The first section was designed to obtain bio-data of the respondents while the second part had twenty items for each test type; *multiple-choice*, alternative-response, matching and essay. The multiple-choice test type had four options lettered A-D in each item with one key or correct option and three detractor options. Items of the *alternative-response test* type had two options such as true/false, agree/disagree, or yes/no at the end of each item and students were anticipated to tick the appropriate response as it concerns each of the questions or statement. The statements have provisional right or wrong answers which demand that the student solve the mathematical problem before responding to the alternative options. The stem in the alternative-response test type is a mathematical problem. The *matching test* type was designed for students to match a question to its correct answer using a straight line. The *essay test* type allows the students to solve the questions or stems showing the steps to the solution. Two experts in Mathematics Education validated the instrument. Kuder Richardson formula 21 (KR21) was used to determine the reliability of the AAT and the indices of 0.82 and 0.78 were obtained for multiple-choice and alternative response test types respectively while the test-retest method was used to determine the reliability indices of 0.70 and 0.73 for the matching and essay test types respectively

Experimental procedure: The students were taught by their teacher the algebra content of the junior secondary class three Mathematics curriculum which covered topics such as factorization of simple algebraic expressions, factorization of quadratic algebraic expressions, solving simple equations involving fractions and simultaneous linear equations. The treatment tests were administered for the three forms or groups of the class. The multiple-choice test type was administered to the benchmark group while the alternative-response, matching and essay test types were administered to the students in the other three arms of the class. There was no instruction between the control test and the treatment test so that the difference in the performance of students could be attributed to the treatment test type, keeping every other variable constant. Data were collected through the direct delivery approach. The Mathematics teacher in the school assisted the researchers in administering and retrieving the instruments.

Data analysis: Descriptive statistics and independent-sample t-test were used for data analyses.

RESULTS

Table 1: Summary of descriptive statistics

Test type	N	Mean	SD	MD	d	Remark
Multiple choice	30	21.2	4.50	-	-	-
Alternative response	35	15.7	2.98	5.50	1.47	Very large
Matching	32	14.43	3.34	6.77	1.73	Very large
Essay	36	20.35	3.24	0.85	0.22	Small

MD=Mean Difference, SD= Standard deviation, d= Cohen's effect size

The Table 1 and Figure 1 showed the variation between the mean scores of learners evaluated with the alternative-response (M = 15.70; SD = 2.98) and that of those assessed using he multiple-choice (M = 21.20; SD = 4.50) test types in algebra was (MD=5.50, d=1.47) in favour of the multiple-choice test type indicating a large Cohen's effect size. The variation between the mean scores of learners evaluated with the matching (M = 14.43; SD = 3.34) and multiple-choice (M = 21.20; SD = 4.50) test types in algebra was (MD=6.77, D=1.73) in favour of the multiple-choice test type indicating a very large Cohen's effect size. The difference between the mean scores of students evaluated with the essay (M = 20.35; SD = 3.24) and multiple-choice (M = 21.20; SD = 4.50) test types in algebra was (MD=0.85, d=0.22) in favour of the multiple-choice test type indicating a small Cohen's effect size.

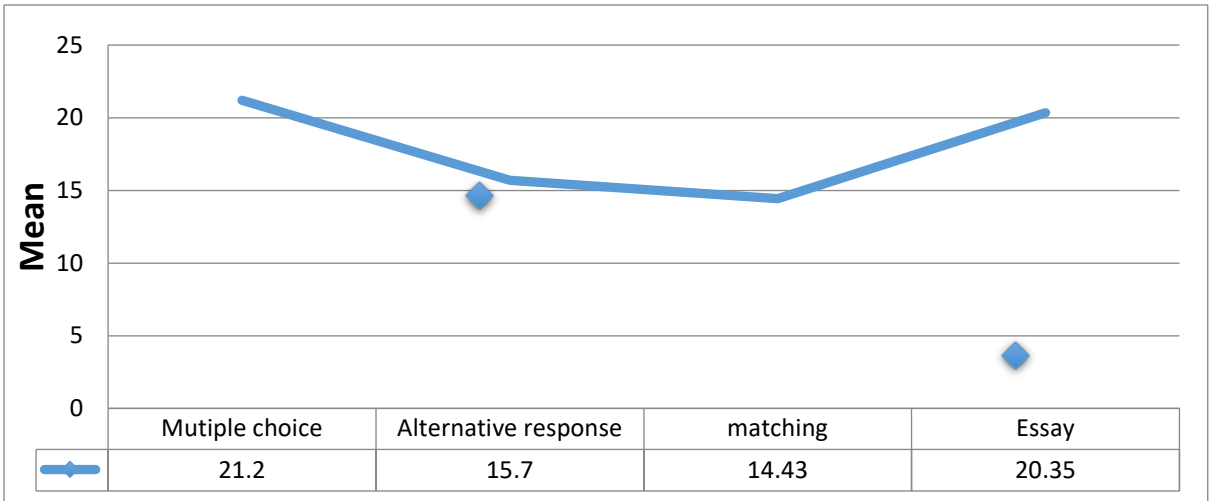

Fig. 1: Student achievement mean scores based on test-type

Table 2: Summary of independent sample t-test on the difference between the mean scores of students evaluated with the alternative response test type and those assessed using multiple-choice test type in algebra

Test type	N	Mean	SD	t	df	p-value
Alternative response	35	15.70	2.98	5.71	63	0.00*
Multiple choice	30	21.20	4.50			

Data in Table 2 showed that the mean cognitive achievement of the students evaluated using

alternative response and those evaluated using multiple-choice varied significantly in algebra (t=5.71, df=63, p=0.00). The null hypothesis one was rejected at .05 level of significance.

Table 3: Summary of independent sample t-test on the difference between the mean scores of students evaluated with the matching test type and those assessed using multiple-choice test type in algebra

Test type	N	Mean	SD	t	df	p-value
Matching	32	14.43	3.34	6.69	60	0.00*
Multiple choice	30	21.20	4.50			

Data in Table 3 showed that the mean cognitive achievement of the students evaluated using matching and those evaluated using multiple-choice varied significantly in algebra (t=6.69, df=60, p=0.00). The null hypothesis two was rejected at .05 level of significance.

Table 4: Summary of independent sample t-test on the difference between the mean scores of students evaluated with the essay test type and those assessed using a multiple-choice test in algebra

Test type	N	Mean	SD	t	df	p-value
Essay	36	20.35	3.24	0.87	64	0.39
Multiple-choice	30	21.20	4.50			

Data in Table 4 showed that the mean cognitive achievement of the students assessed using an essay test and those assessed using multiple-choice did not vary significantly in algebra (t=0.87, df=64, p=0.39). The null hypothesis three was retained at .05 level of significance.

DISCUSSION OF FINDINGS

Data in Table 1 showed that the students evaluated using multiple-choice test type outperformed their counterparts who were evaluated using alternative-response test type with a mean difference of 5.50. The independent sample t-test showed in Table 2 showed that the students evaluated using the multiple-choice test type and those assessed using the alternative-response test type varied significantly over achievement in algebra (t=5.71, df=63, p=0.00). This led to the rejection of the first hypothesis was rejected at .05 level of significance. The finding of this study is different from that of Margit and Barbara (2010) who found out that developed response tests are equivalent to multiple-choice tests with multiple responses in number when correct scoring is used.

Data in Table 1 showed that the students evaluated using the multiple-choice test outperformed their counterparts assessed using the matching test type with a mean difference of 6.77. The independent sample t-test in Table 3 showed that the students evaluated using the multiple-choice test type and those assessed using the matching test type varied significantly over achievement in algebra (t=6.69, df=60, p=0.00). The null hypothesis two was rejected at .05 level of significance. Tobih (2018) discovered that outcomes demonstrated that in Mathematics 100 level I (MAT 111) learner performance was significantly better when the subjective test was given to learners contrasted with when both objective and subjective sort of tests were given to the learners, However, in Mathematics

100 level II (MAT 121), learners commonly performed altogether better when both objective and subjective type of tests were given to the learners than when it was subjective sort of test. The investigation presumed that the utilization of the two sorts of the test (objective & subjective) in an assessment is as yet essential and basic for healthy scholarly testing of learner capacity and suggested that the two kinds of tests, should be utilized to assess learners in Mathematics 100

Data in Table 1 showed that the students evaluated using the multiple-choice test outperformed their counterparts assessed using the essay type test with a mean difference of 0.85. The independent sample t-test in Table 4 showed that the students evaluated using the multiple-choice test type and those assessed using the matching test type did not vary significantly over achievement in algebra ($t=0.87$, $df=64$, $p=0.39$). The null hypothesis three was retained at .05 level of significance. Earlier finding by William and William (1994) revealed that there is no significant difference in the achievement of students evaluated with multiple-choice and essay in Economics

CONCLUSION

The study investigated the effects of test types on junior secondary student cognitive achievement in algebra. It was established that there were significant variations between the cognitive achievement scores of students in algebra evaluated with multiple-choice test type and those assessed using alternative-response and matching types in favour of the multiple-choice test type. However, there was no significant variation between the cognitive achievement mean scores of students evaluated with the essay and those assessed using multiple-choice test types in algebra. From the findings of the study, the multiple-choice objective test type and the essay or subjective test type were better test types for evaluation of students' performance in Mathematics. Students evaluated with the multiple-choice test and the essay test type achieved significantly better when compared with their achievement in the alternative-response and matching test types. Therefore, test types affect the cognitive achievement of students in Mathematics.

RECOMMENDATIONS

The study recommended as follows:

1. The multiple-choice objective test type should be preferred to the alternative-response test type in Mathematics examinations.
2. Mathematics teachers should adopt the multiple-choice test type in student evaluation instead of the matching test type.
3. The essay test type and the multiple-choice objective test type should be used independently or jointly in assessing students' Mathematics learning because both test types were found to impact positively on the performance of students.

REFERENCES

Alamina, J. I. (2008). *Fundamental principles of science teaching and learning* (2nd ed.). Port Harcourt: Feni Nigeria Limited.

Alonge, M. F. (2004). *Measurement and evaluation in education and psychology.* Ado-Ekiti: Adebayo Printing Nig. Ltd.

Bandura, A. (2002). Self efficacy mechanism in human agency. *American Psychologist, 77(2)*, 122-147.

Egbule, J.F (2002). *Fundamentals of Test, Measurement and Evaluation*. Owerri Nigeria, Whyte and Whyte Publishers.

Ekwueme, C. O. (2013). *Mathematics teaching and learning in schools.* Calabar: Radiant Ventures Nig. Ltd.

George, N. R. & Zalmon, I. G. (2019). Innovative instructional strategies and senior secondary students' achievement in algebra. *European Journal of Education Studies, 6(9), 193-210.*

Gronlund, N. E., & Linn, R. L. (1990). *Measurement and evaluation in teaching (6th ed.)*. New York: Macmillan.

Igbojinwaekwu, P. C. (2015). Effectiveness of guided multiple choice objective questions test on students' academic achievement in senior school Mathematics by school location. *Journal of Education and Practice, 6(11),* 37-48. Retrieved October 5, 2020 from https://files.eric.ed.gov/fulltext/EJ1081669.pdf

Jonah-Eteli, W.A. (1999). *Measurement and evaluation in education with revision exercises*. Owerri, Nigeria. Springfield Publishers.

Kolawole, E. B. (2010). *Principles of test construction and administration*. Lagos: Bolabay Publications.

Margit, K & Barbara, S (2010). Multiple-choice and constructed response tests: Do test format and scoring matter?. Procedia Social and Behavioural Sciences, 12(2011), 263-273.Retrieved November, 20, 2020 from: https://reader.elsevier.com/reader/sd/pii/S187704281100125X?token=F33C3BD1DD6CAFB21CE9ECB5083289C1E6D037B33AEAD755EF2D17F16C897D99A943A611B85F7C556D8D320873CF1851

Odili, G.A. (2006). *Mathematics in Nigeria secondary schools: A teaching perspective.* Port Harcourt: Rex Charles & Patrick Limited; Anachuma Educational Books.

Oghenevwede, O. E. (2012). Enhancing the retention level of Biology students through the guided discovery instructional method. *Nigerian Journal of Curriculum and Instruction. 19(1)*, 7-12.

Tobih, D. O. (2018). Test types and university students' performance in Mathematics 100. Retrieved October 5, 2020 from https://www.ajol.info/index.php/zjer/article/view/175268.

William, B.W & William E.B (1994). Achievement differences on multiple choice and essay tests in Economics. *American Economic Review, 84(2).* 193-196. Retrieved November, 20, 2020 from: https://www.researchgate.net/publication/4729393_Achievement_Differences_on_Multiple-Choice_and_Essay_Tests_in_Economics/link/0912f509aea/d63db6000000/download

Wonu, N. & Zalmon, I. G. (2019). Constraints to instructional effectiveness and undergraduate student Mathematics learning achievement. *International Journal of Advanced Education and Research, 4(6), 54-64.*

Zalmon, I. G. & Charles-Ogan, G. I. (2020). Impact of student-teacher relationship on senior secondary students' performance in introductory calculus. *International Journal of Advanced Education and Research, 5(1), 1-8.*

Zalmon, I. G. & Njoku, N. A. (2018). Remediation of students' content difficulty in the senior secondary Mathematics curriculum. *Science Teachers Association of Nigeria (STAN) Journal of Issues on Mathematics, 20 (1), 146-155.*

Zalmon, I. G. & Wonu, N. (2017). Comparative analysis of student Mathematics achievement in West African senior secondary certificate examination in Nigeria. *European Journal of Research and Reflection in Educational Sciences, 5(1), 24-31.*