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Research Paper

Assessment of effect of jigsaw puzzle model on PGDE students' learning of difficult concept in educational statistics

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Abstract. Determining the effect of anxiety; performance; on instruction given using Jigsaw Puzzle Model (JPM) on Post Graduate Diploma in Education (PGDE) students' learning of difficult concept in Educational Statistics were among the objectives of the study. True - experiment- pre test- post test control group design was adopted for the study. The population of the study consisted of 50 (30 male and 20 female) 2015/2016 Academic session PGDE students from Faculty of Technology Education (FTE), Abubakar Tafawa Balewa University (ATBU) Bauchi. Proportional stratified random sampling technique using hat and drawn method was used to select 48 (24 experimental and 24 control groups) PGDE students. Revised Mathematics Anxiety Rating Scale (RMARS) by Baloglu and Zelhart (2007) and Mathematics Attitude Scale (MAS) by Tapia (1996), in addition to that Teacher -made Achievement Test (TAT) were used for data collection. Hypotheses were tested at α = 0.05 level of significance. Results from the study showed that Educational Statistics instruction given using JPM had effect on PGDE student's anxiety ($F_{(4.812)}$ = .033, ρ<.05); there is also statistically significant difference in performances between control and experimental groups on the post test ($F_{(5.816)}$ = .007, ρ<0.05). Instructors to make uses of JPM in delivering lectures involving identified difficult concept to learn by students; similar study to be carried out were the recommendations made from the study.

Keywords: Effect, jigsaw puzzle model, PGDE student.

INTRODUCTION

Educational statistics is often a compulsory unit of university courses such as psychology, business studies, health sciences and research fields in various courses. Students enrolled at undergraduate and post graduate levels would almost invariably offer a course in statistics. Yilmaz (1996) observed the goals of education statistical in institutions of learning to include ability for one to collect and analyse data and displaying statistical results, graphically.

While many instructors of educational statistics are likely to focus on transmitting knowledge, many students are likely to have trouble due to either cognitive or non-cognitive factors such as knowledge or application of a particular concept or negative attitudes or beliefs toward the course educational statistics (Gal and Ginsburg, 1994).

Attitude affects student's achievement towards educational statistics (Muhammad, 2015). Baloglu (2004: 38) said "most college students experience high statistics anxiety and many students regard statistics as the most difficult and least pleasant course". Lawrence *et al.* (2013) observed that any innovation that could increase students' engagement, improve attitudes, or reduce anxiety among the students would be particularly important. From above reports and findings of scholars in the field were acknowledged. Although one could deduce

that, students perceived the course as tough and not relevant to the field of their study. In fact, many students particularly those with poorer quantitative skills, have phobias or barriers regarding learning of statistics. Indeed, these affect their academic achievement in the course (educational statistics). But there is need to examine the concepts students find difficult to learn in Educational statistics and use modern methods of instruction so that its effects on students' academic achievement in the course (educational statistics) could be determined.

Academic achievement in any course of study is a combined combination of three variables (attitude, anxiety and performance). Student's low anxiety in any course is associated with higher attitude which in turn lead to higher academic achievement while the reverse is the case (Kankia, 2015).

Teaching methods affect student achievement. Poor methodology of teaching contributes to the problems students encounter in learning mathematics and other related courses to it (Blanco, 2001; Leangson and Limjamp, 2005).

There is need to come up to with methods that would improve student achievement in educational statistics especially on the Post Graduate Diploma in Education (PGDE) students who were graduates in various fields without having background on educational statistics.

Jigsaw Puzzle Model (JPM) is a method or strategy used by teachers in teaching mathematics in secondary schools (Teacher Vision, 2000-2016). It is defined as a co operate learning technique in which students work in small groups in which members of the class are organised into "Jigsaw" groups. (Teacher Vision, 2000-2016). In simple terms, JMP is the combination of discovery and group method of teaching to form a single method. JPM can be used in a variety of ways for a variety of goals, but it is primarily used for the acquisition, and presentation of new materials and concepts students find difficult to learn. The strategy allows for an efficient way to learn content through development of listening, engagement and empathy skills, an interaction among students and away for student to work independently in groups (Teacher Vision, 2000-2016). Muhammad (2015) observed that 67% of PGDE students find learning of the concepts and application of hypothesis testing as difficult. However, if the JPM method is applied to Post Graduate Diploma Students in Education (PGDE) on learning the concept on hypotheses testing (concept student find difficult to learn) to what extent its application affect student academic achievement in educational statistics? To what extent JPM affect PGDE student's anxiety, attitude and performance in educational statistics?

The purpose of the study was to determining the effects of JMP on PGDE students' achievement in educational statistics. Specifically, the study determined the effect of anxiety on instruction given using JPM on PGDE students' learning of difficult concept in educational statistics; effect of attitude on instruction given using JPM on PGDE students' learning of difficult concept in educational statistics; and effect of instruction given using JPM on PGDE students' performance on learning difficult concept in educational statistics.

To achieve the purpose of the study above, the following research questions guided the study:

i. What is the effect of anxiety on instruction given using JPM on PGDE students' learning of difficult concept in educational statistics?
ii. What is the effect of instruction given using JPM on PGDE students' attitude on learning difficult concept in educational statistics?
iii. What is the effect of instruction given using JPM on PGDE students' performance on learning of difficult concept in educational statistics?

Hypotheses

The following hypotheses were tested at $\alpha = 0.05$, level of significance:

Ho_1: Instruction given using JPM will not have significance effect on PGDE students' anxiety on learning difficult concept in educational statistics.
Ho_2: Instruction given using JMP will not have significance effect on PGDE students' attitude towards learning difficult concept in educational statistics.
Ho_3: Instruction given using JPM will not have significance effect on PGDE students' performance on learning of difficult concept in educational statistics.

Significance of the study

In this study, the outcome could be of significance to administrators' lecturers' and research students'. For administrators, it could assist them in monitoring through providing the necessary facilities that could enhance effective uses of JPM in teaching and learning. For the teachers, it could assist them with strategy for adopting JPM in educational statistics instructional delivery. For the research students, it could assist through providing them with research methodology and open opportunity for new direction on research related to educational statistics.

METHODOLOGY

Research design

True - experiment- pre test- post test control group design was adopted for the study. Table 1 shows a symbolic representation of the study design.

Table 1. Symbolic representation of the study design.

Group	Pre-test	Applied	Post test
G_{TEST}	P_E-ANXIETY-1 P_E-ATTITUDE-1 P_E-ACHIEVEMENT-1	$X_{Treatment}$ - **JPM** applied to educational statistics instruction	P_E- ANXIETY-2 P_E- ATTITUDE-2 P_E-ACHIEVEMENT-2
$G_{CONTROL}$	P_C-ANXIETY-1 P_C-ATTITUDE-1 P_C-ACHIEVEMENT-1	No treatment	P_C- ANXIETY-2 P_C- ATTITUDE-2 P_C-ACHIEVEMENT-2

Table 2. Summary of the experimental and control group based on gender as used in the study.

Gender	Experimental	Control	Total
Male	14	14	28
Female	10	10	20
Total	24	24	48

$G_{EXPERIMENTAL}$ – experimental group; P_E- ANXIETY—1-2, P_E-ATTITUDE-1-2, P_E-ACHIEVEMENT-1-2- pre test and post test, educational statistics achievement, attitude and anxiety results of experimental group; $G_{CONTROL}$ – control group; P_C-ANXIETY-1-2, Pc-ATTITUDE-1-2, P_C-ACHIEVEMENT-1-2, pre test and post-test educational statistics achievement, attitude and anxiety results of control group; $X_{TREATMENT}$ – JPM on educational statistics instruction applied to experimental group (Table 1).

The experimental group was exposed to treatment (educational statistics instruction using JPM) and the control group was not exposed to treatment. No threat to internal and external validity encountered since the two groups have similar characteristics like location, gender and age.

The study was carried out at Department of Education Foundation (DEF), Faculty of Technology Education (FTE), Abubakar Tafawa Balewa University (ATB) Bauchi, for a period of 2 weeks with 3 hours of instruction (Saturdays) for each group. The researcher is the instructor (with 27 years of secondary school mathematics teaching experience and 5 years of PGDE lecturing experience in research methods and educational statistics) in order to control the instruction quality variable (Okigbo and Okeke, 2011). The population of the study consisted of 50 (30 male and 20 female) 2015/2016 academic session PGDE students whose average age stood at 34 years. The population of the students also cut across graduates with various areas of specialization that includes education administration and planning, guidance and counselling, measurement and evaluation, technology education, vocational education and science education. Proportional stratified random sampling technique using hat and drawn method was used to select 48 (24 experimental and 24 control groups) PGDE students (Table 2).

The instruction covered topic related to concepts and hypothesis testing that includes concept of critical and non-critical region, ρ-value and α–value (level of significance) reading values from tables and solving problems involving acceptance and rejection of hypothesis. The content of the topic was extracted from Educational Statistics (Code PGDE689) 1st semester course outline.

Adaptation was made on the two out of three instruments for data collection. These instruments consisted of Revised Mathematics Anxiety Rating Scale (RMARS) by Baloglu and Zelhart (2007) and Mathematics Attitude Scale (MAS) by Tapia (1996). In addition to that Teacher-made Achievement Test (TAT) developed validated and used for the study. The RMARS used had 10 items likert type that required student to indicate his/her level of anxiety on each item based on response ranging from Not at all, A little, A fair amount, Much and very much, Within 20 minutes. A reliability coefficient of 0.73 was established for the items. While 10 items to be completed within 20 minutes were used for the MAS likert type with responses ranging from Strongly Agree, Agree, Undecided, Disagree and Strongly Disagree. The maximum score for both RMARA and MAS is 50 while the minimum score is 10. Higher score for RMARS indicates high anxiety while higher score for MARS indicates positive attitude. Consist of two sections A and B. the first four questions from section A were fill in the blank, questions 5, and 6 were objectives with options a to d, question 7, and 8 were true of false question while the remaining question 9 and 10 on section B were essay question. The maximum score for all the items is 50 marks and one hour was the allowed for the students to complete the questions. The TAT items were validated by the most senior lecturer in education statistics from the DEF, ATB Bauchi.

Table 3. Pre-test result mean, standard deviation and t-test on anxiety, attitude and performance.

Factor	Group	N	Mean	SD	t-test value	Df	P
Anxiety	Control	24	17.54	3.203	.285	46	0.777
	Experimental	24	17.29	2.866			
Attitude	Control	24	11.96	3.183	-.318	46	.752
	Experimental	24	12.21	2.167			
Performance	Control	24	11.54	3.283	.052	46	.959
	Experimental	24	11.50	2.167			

At $\alpha = 0.05$, $\rho > 0.05$

Instructional tools

Two lesson plans were used. The experimental group lesson plan was designed for educational statistics instruction using JMP while the control group traditional lesson plan was used.

Experiment procedure

During the first stage, the instruments for data collection were applied to the experimental and control groups as a pre-test. The independent t-test applied to determine if there is significance difference between the experimental and control groups in terms of the independent variables revealed no significance difference Table 3. And it was concluded that the pre-test scores for the experimental and control groups were similar. Any difference observed on the post-test between the two groups would be attributed to the treatment effect.

Following the applications of the pretest, the instruction began. The experimental part of the study continued throughout the period of 2 weeks, 3 h per week. The learning requirements of the two groups were similar however, the instructional designs of the two groups was different. JMP method was used in given the instruction for the experimental group. And the activities involved group work, while the control group was given the traditional instruction. Treats to internal and external validity like reactive effect was prevented by not informing the students about the experiment. The experimental process was completed by applying post-test to both groups at the end of the 2 weeks, following the end of the training activities. The test for both groups was marked over 30.

Method

The experimental group was divided into 4 (6 members) for each JPM. The groups were named A, B, C and D, characterised by diverse gender, ethnicity, ability and state of origin. Group leaders were randomly selected for each group. The group leaders were given instruction on team work.

Lesson objective

At the end of the lesson student should be able to solve 2 problems each that would require them to determine critical and non critical region and also, determine whether to accept or reject the null hypotheses using i. ρ-value and ii. values from tables.

To achieve the objective, the lesson was divided into 3 segments of 1 h each for both experimental; and control group separately for a period of two weeks (Appendix)

The data was analyzed using mean and standard deviation and t-test, and Analysis of Covariance (ANCOVA) was used to test the hypotheses. The administration and collection of the instruments was done by the researcher.

RESULTS

Results from Table 3 show the pre-test mean, SD and t-test of the independent variables (anxiety, attitude and performance). From the result, it was concluded that the two groups are equal; any difference observed between the groups may be attributed to treatment effect.

Ho_1: Instruction given using JPM will not have significance effect on PGDE students' anxiety on learning difficult concept in educational statistics.

To test the Ho_1, the assumptions for ANCOVA were checked. Results computed from the equality of the regression slopes lines formed using on students' anxiety on learning difficult concept in educational statistics post-test dependent variable and Levene Test for the equality on students' anxiety on learning difficult concept in educational statistics post-test scores revealed that $F_{(.22)} = .64$, $\rho > 05$ and $F_{(.29)} = .10$, $\rho > .05$. These result satisfied the assumptions of the ANCOVA. The result of Ho_1 is shown on Table 4.

Table 4. ANCOVA for the students' anxiety on learning difficult concept in educational statistics. Post-test mean scores which were adjusted according to the pre-test scores.

Factor	Source	Sum square	df	Mean square	F	Sign	η^2
Anxiety	Corrected model	152.852	2	76.426	18.901	.000	.457
	Intercept	7.511	1	7.511	1.858	.180	.040
	Pretest	139.831	1	139.831	34.581	.000	.435
	Group	**19.458**	**1**	**19.458**	**4.812**	**.033***	**.097**
	Error	181.960	45	4.044			
	Total	7319.000	48				
	Corrected Total	334.813	47				

$\rho > 0.05$

Table 5. ANCOVA for the students' attitude on learning difficult concept in educational statistics. Post-test mean scores which were adjusted according to the pre-test scores.

Factor	Source	Sum square	df	Mean square	F	Sign	η^2
Attitude	Corrected model	57.941	2	28.971	3.104	.055	.121
	Intercept	207.827	1	207.827	22.264	.000	.331
	Pre-test	5.858	1	5.858	.628	.432	.014
	Group	**53.631**	**1**	**53.631**	**5.745**	**.021***	**.113**
	Error	420.059	45	9.335			
	Total	13546.000	48				
	Corrected Total	478.000	47				

$\rho < 0.05$

Table 4 shows anxiety as a factor. From the results in Table 4, ANCOVA computed revealed $F = 4.812$ with $\rho = .033$. From the result, Ho_1 was rejected ($F_{(4.812)} = .033$, $\rho < .05$).

Ho_2: Instruction given using JMP will not have significance effect on PGDE students' attitude towards learning difficult concept in educational statistics.

The results were tabulated in Table 5.

Table 5 shows attitude as a factor. From the results in Table 5, ANCOVA computed revealed $F = 5.745$ with $\rho = .021$. From the result, Ho_2 was rejected ($F_{(5.745)} = .021$, $\rho < .05$).

ANCOVA assumptions for equality of regression slope lines and homogeneity of the variances were checked and satisfied ($F_{(.103)} = .75$, $\rho > .05$ and $F_{(1.853)} = .18$, $\rho > .05$) before testing the Ho_2.

Ho_3: Instruction given using JPM will not have significance effect on PGDE students' performance on learning of difficult concept in educational statistics.

Result obtained also from testing equality of regression slope lines and Levine's test for homogeneity of variances on students' performance on learning of difficult concept in educational statistics revealed no significant differences ($F_{(.020)} = .89$, $\rho > .05$ and $F_{(.254)} = .617$, $\rho > .05$). These fulfilled the ANCOVA assumptions. Based on that, the Ho_3 which stated that instruction given using JPM will not have effect on PGDE students' performance on learning of difficult concept in educational statistics was tested and the result was given in Table 6.

Table 6 shows Performance as a factor. From the result on Table 6, ANCOVA computed revealed $F = 5.816$ with $\rho = .020$. From the result, the Ho_3 was rejected ($F_{(5.816)} = .007$, $\rho < 0.05$).

Findings

Educational statistics instruction given using JPM had significant effect on:

1. PGDE student's anxiety on learning difficult concept in educational statistics.
2. PGDE student's attitude towards learning of difficult concept in educational statistics.
3. PGDE student's performance on learning of difficult concept in educational statistics.

DISCUSSION

The results from study assessed the effect of Jigsaw

Table 6. ANCOVA for the students' performance on learning difficult concept in educational statistics. Performance post-test mean scores which were adjusted according to the pre-test scores.

Factor	Source	Sum square	Df	Mean square	F	Sign	η^2
Performance	Corrected model	86.879	2	43.440	3.028	.058	.119
	Intercept	1300.835	1	1300.835	90.672	.000	.668
	Pre-test	4.192	1	4.192	.292	.591	.006
	Group	**83.437**	**1**	**83.437**	**5.816**	**.020***	**.114**
	Error	645.600	45	14.347			
	Total	23483.000	48				
	Corrected Total	732.479	47				

$\rho < 0.05$

Puzzle Model on students' learning of difficult concept in Educational Statistics.

From the anxiety result on Table 3, *Mean* = 17.54, and *SD* = 3.20; *Mean* = 17.29, and *SD* = 2.87 were obtained for both control and experimental group respectively. However, the difference was not significant ($t_{(46)}$ = .285, p> 0.05). Also, the control group has the *Mean* = 11.96, and *SD* = 3.18. While the experimental group *Mean* = 12.21, *SD* = 2.17 on attitude. The t- test computed revealed no significant difference on students' attitude towards learning of difficult concept in educational statistics ($t_{(46)}$ = 0.75, p > 0.05). From Table 3 result also, student's performance on learning of difficult concept in educational statistics revealed *Mean* = 11.54, and *SD* = 3.28; and *Mean* = 11.50, and *SD* = 2.17 for control and experimental group respectively. However, the difference is not significant ($t_{(46)}$ = 0.52, p> 0.05).

The null Hypothesis 1 (Ho_1), shows that by controlling the pre test value there is statistically significant difference between the groups on the post test ($F_{(4.812)}$ = .033, ρ<. 05). Thus, Ho_1 was rejected which implies educational statistics instruction given using JPM had significant effect on PGDE student's anxiety.

The null Hypothesis 2 (Ho_2), was rejected was rejected ($F_{(5.745)}$ = .021, ρ<.05) as revealed on Table 5. This indicates that by controlling the pre test value there is statistically significant difference between the groups on the post test. Finding from this show educational statistics instruction given using JPM had significant effect on PGDE student's attitude towards learning of difficult concept in educational statistics.

The null Hypothesis 3 (Ho_3), was rejected which implies that by controlling the pre test value there is statistically significant difference between the groups on the post test ($F_{(5.816)}$ = .007, ρ<0.05). Finding from this show educational statistics instruction given using JPM had significant effect on PGDE student's performance on learning of difficult concept in educational statistics. The finding is in agreement with Aroson (Teacher Vision, 2000-2016) who observed that students in Jigsaw classroom (experimental group) performed significantly better than the in competitive classroom (control group).

Conclusion

The study assessed the effect of Jigsaw Puzzle Model on Post Graduate Diploma in Education (PGDE) students' learning of difficult concept in Educational Statistics. The effect of JPM on educational statistics instruction was examined using three independent variables (anxiety, attitude and achievement). Findings from the study showed that the use of JPM enhances students understanding of learning difficult concept in educational statistics. It was concluded by recommending instructors to make use of JPM in delivering lectures involving identified difficult concept to learn by students as its increases student's achievement in educational statistics.

RECOMMENDATIONS

The following recommendations were made:

1. Instructors to make use of JPM in delivering lectures involving identified difficult concept to learn by students.
2. Similar study to be carried out.

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APPENDIX

Procedure for experimental group

Step 1
Each student in the experimental group was assigned to learn one segment, making sure group members have direct access only to their own work.
Step 2
Each group was given time to read over their segment twice and become familiar with it.
Step 3
Form temporarily “expert groups” by having one student from each JPM group to present their findings to entire groups and encourage students to ask question.
Step 4
Given time to each JPM group to discuss the segment of experts, main points presentation.
Step 5
The lecturer would give lecture on the 3 segments based on:

i. Concept of critical and non- critical region, P-value and α- value (level of significance).
ii. Using tables and diagram sketch determine the critical and non-critical region.

Solving to problems on hypotheses testing that requires rejection and acceptance of null hypotheses by determining:

a) The table value and diagrammatic sketch representation using critical and non-critical region.
b) by comparing ρ–value and α value.