

Effects of Glencoe's and Rusbult's Problem-Solving Instructional Strategies on Students' Cognitive and Skills Achievement in Electrical Installation and Maintenance Work in North-Central

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ABSTRACT

The study determined the Effects of Glencoe's and Rusbult's Problem-Solving Instructional Strategies on Students' cognitive and skills Achievement in Electrical Installation and Maintenance Work in technical Colleges in North-Central, Nigeria. The study adopted a factorial research design using pretest, posttest, non-equivalent control group design. The study was conducted in the North-central geo-political zone of Nigeria. The population for this study comprised of 1013 NTC II student of EIMW in the 29 accredited technical colleges in North-central of Nigeria. A simple random sampling technique and purposive sampling technique were used for the study. The instruments used for data collection were validated by three experts, two from Department of Industrial and Technology Education Federal University of Technology Minna and National Examination Council Minna (NECO). The reliability coefficient of: EIWCAT was determined as 0.80 and EIWPAT was 0.82. Data were collected through physical administration of the research instruments. The data collected were analyzed using mean and standard deviation to answer all the research questions while ANOVA for hypotheses. Findings from the study revealed that students taught EIMW using Rusbult's problem-solving strategy had higher mean skill achievement, students taught EIMW using Glencoe's problem-solving strategy had higher mean cognitive achievement scores than students taught using Rusbult's problem-solving strategy among others and the based on the findings from the study, it was recommended among others that, EIMW teachers should adopt the use of: Rusbult's problem-solving strategy to enhance students' skill achievement and Glencoe's problem-solving strategy to enhance students' cognitive achievement.

Keywords: *Rusbult's and Glencoe's problem-solving strategy, Electrical Installation and Maintenance Work, technical College, students' and cognitive achievement.*

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I. INTRODUCTION

Technical colleges are established with the aim of producing craftsmen in various disciplines. Their existence is to stimulate technological and industrial growth by developing and utilizing technologies for industrial and economic advancement. Technical college is an integral part of the total educational system in Nigeria. The goals of technical colleges, as stated by Federal Republic of Nigeria (FRN, 2013) are, to provide trained manpower in the applied sciences, technology and business, particularly at craft, advanced craft and technician levels; provide the technical knowledge and vocational skills necessary for agricultural, commercial and economic development; and give training and impart the requisite skills to individuals who shall be self-reliant economically and in tune with latest technology. In technical colleges, students are trained to acquire relevant knowledge and skills in different occupations for employment in the world of work (NBTE, 2018). The courses offered at these technical colleges includes general subjects which are offered by all students such as mathematics, English languages, social studies, civic education, physics, chemistry and religion. While trade areas among others which are optional are Carpentry and Joinery, Motor Vehicle Mechanics (MVM), Blocklaying and Concreting, Computer Craft Studies (CCS) and Electrical Installation and Maintenance Work (EIMW).

This EIMW is one of the engineering trades offered in Nigerian Technical colleges, it involves the application of scientific knowledge in the design, selection of materials, construction, operation and maintenance of Electrical equipment. EIMW in Nigeria Technical Colleges was designed to produce competent craftsmen that are expected to test, diagnose, service and completely repair any fault relating to electrical installation main units and systems to the manufacturers' specification as indicated in the Technical College curriculum for EIMW (NBTE, 2018). According to NBTE, the curriculum of EIMW is structured in foundation and trade modules which consist of general education such as mathematics, English languages, social studies, civic education, physics, chemistry and religion, theory and related courses, workshop practice, industrial training components and small business management and entrepreneurial training.

The entrepreneurial training needed by the students is to prepare them for changes and challenges that has necessitated a shift from instructional strategies which are based on the behavioral learning theories to those rooted in cognitive psychological learning theories for which Glencoe and Rusbult's problem-solving strategies are one (Teman and Dauda, 2019). Problem-solving plays a very important role in Education, as it is used to train students to apply scientific knowledge and skills learned.

Even with the application of scientific knowledge and skills learned by graduates from these technical colleges they still perform poorly in their national examination especially in EIMW and as a result of this poor performance of EIMW student in this technical colleges, most of these graduates are faced several challenges and most people enjoy the stimulating challenge of a good problem and the satisfaction of solving it. You feel this satisfaction more when you master the tools of problem solving (Rusbult, 1989). Rusbult believes that you get "oriented" by using all available information (words, pictures, and free information) to form a clear, complete mental picture of the problem situation. By reading the problem statement carefully, you get accurate comprehension, the meaning of words and sentence structure in order to gather all the important facts. Most problems are written clearly, so use standard reading techniques to accurately interpret what is written. The description of the four-step plan of the Rusbult problem-solving strategy include giving orientation on the problem; plan on how to solve the problem; take action by solving the problem, and also ensure whether the problem has been properly solved. In Rusbult problem solving, the teacher gives detailed explanation to students at every stage of solving the problem and also provides the procedures for solving the problem where necessary (Rusbult, 1989).

It is believed that some students don't spend time identifying the problem, which makes it more challenging for them to create, execute, and analyze the effectiveness of a solution plan (Glencoe, 1989). Glencoe therefore proposed four phases of problem solving (Exploration, planning, solving and examination). In exploration phase, students brainstorm and study the problem properly in order to understand it. In planning phase, the students identify the basic facts and materials needed for solving the problem. At this phase too, the students identify the parameters, formula or diagrams that are required for solving the problem. In solving phase, the students carry out the plan prepared and solve the problem identified. The last phase of the problem is examination where the students examine their answers carefully to see if it fits the facts given in the problem or the problem has been adequately solved (Teman & Dauda, 2019). In Glencoe problem solving, the teacher serves as guide or facilitator at every phase of the problem solving. Academic achievement connotes performance in school subject as symbolized by a score on an achievement test. Achievement is the outcome of education which involves the determination of the degree of attainment of the learner in tasks, courses or programmes to which the learner is sufficiently exposed. Ogbuanya and Akinduro (2017) recommends that EIMW instructors should use appropriate instructional materials, methods and strategies to render the teaching and learning of EIMW enjoyable, interesting and to improve achievement.

However, achievement in EIMW relates to accomplishment of learning by a student in both cognitive and psychomotor domain of learning. The word cognitive relates to knowledge and the development of mental and intellectual abilities. It involves thinking, reasoning and remembering (Gall, 2017). Psychomotor or skill achievement involves manipulative or practical skills. Gall explained that skill achievement test involves the use of tools and equipment in a direct assessment of the amount of practical skills possessed by the student. Psychomotor deals with the development of muscular skills and coordination including the use of senses and the brain. Psychomotor emphasizes motor skill, manipulation of materials, objects or any performance task requiring neuromuscular coordination (Flavell, 2016). The psychomotor achievement of students is the translation of their performances in practical test into scores which indicates the skills they have acquired through training especially in EIMW (Akinwumi & Falemu, 2018). Based on the foregoing, it becomes necessary to investigate the efficiency of problem-solving approach on students' cognitive and skills achievement in EIMW especially in teaching topics such as battery charging and electric machines. This study therefore has ascertained whether Glencoe and Rusbult problem solving strategies was better in enhancing

students' cognitive and skill achievement in Electrical Installation and Maintenance work trade at Technical Colleges.

1.2 Statement of the Research Problem

The EIMW students upon graduation, are expected to possess skills among others in domestic and industrial installation, as well as having the ability to operate, maintain and repair electrical and electronic equipment (Bakare, 2012). It is hoped that these skills will boost their chances at establishing enterprise and self-reliance. The realization of this objective rests hugely on the quality and strategies of instruction they receive from the teacher. The EIMW students have been reported to perform poorly in EIMW related subjects in their final examinations for some years now. An analysis of National Business and Technical Examination Board (NABTEB) examinations conducted in May/June for EIMW students in government technical colleges in North-Central Nigeria, from 2011 to 2018 revealed that students perform poorly (Guardian, 2019). Sadly, EIMW graduates are deficient in employability skills, workplace skills and job generation competencies (Abubakar and Danjuma, 2012). This abysmal outing at final and college examinations could be linked to a few factors but most prominently the use of inappropriate and uninspiring teaching methods by the teachers. Akinwumi and Falemu (2018) revealed that most teachers adopt teaching methods that are easy to implement in the classroom, but most of the time inadequate and inappropriate for teaching trades like EIMW because the methods and strategies do not provide a link between the industry and classroom situation.

The problem of poor performance at final examinations, as well as the lack of adequate requisite skills for survival in the world of work, is worsened by the fact that the teaching methods adopted by the teachers might mostly be 'talk-and-chalk' based-methods and so are void of student participation in the learning process. This makes it paramount to seek strategies for teaching EIMW that aims at improving its understanding and performance by students both theoretically and practically. Some of the teaching methods that could prepare EIMW for entry-level jobs, advancement in the workplace and higher-order thinking and problem-solving work skills are; Glencoe's and Rusbult's Problem-Solving Strategies. Hence, the problem of this study is to examine the effects of Glencoe's and Rusbult's Problem-Solving Strategies on students' skills and cognitive achievement in EIMW in technical colleges.

Aim and Objectives of the Study

The aim of this study was to determine the effects of the Glencoe's problem-solving strategies (GPSS) and Rusbult's problem-solving strategies (RPSS) on student cognitive and skills achievement in EIMW in Technical Colleges. Specifically, the objectives of the study is to determined the effect of

1. Glencoe's and Rusbult's problem-solving strategies on students' cognitive achievements in electrical installation and maintenance work (EIMW).
2. Glencoe's and Rusbult's problem-solving strategies on students' skill achievement in electrical installation and maintenance work (EIMW).

Research Question

The following research questions were formulated based on the objectives of the research.

1. What is the effects of Glencoe's and Rusbult's problem-solving strategies on students' cognitive achievement in EIMW?
2. What is the effects of Glencoe's and Rusbult's problem-solving strategies on students skills achievement in EIMW?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance

HO₁: There is no significant difference between students cognitive achievement mean scores in EIMW when taught using Glencoe's and those taught using Rusbult's problem-solving strategies

HO₂: There is no significant difference between students skills achievement mean scores in EIMW when taught using Glencoe's and those taught using Rusbult's problem-solving strategies

II. METHODOLOGY

A factorial research design was used in this study. Specifically, the pretest, posttest, non-equivalent control group design was adopted for the study. According to Gall, *et al.*, (2017) Factorial design involves having more than one independent variable, or factor, in a study. This study was conducted in the North-central geo-political zone of Nigeria. The population for this study comprised of 1013 NTC II students of EIMW in the 29 accredited technical colleges in North-central geo-political zone of Nigeria. The NTC II students were used for the study because of the nature of NBTE curriculum for technical colleges which provides that the topics on battery charging and electrical machines are taught in the second year of EIMW trade. A simple random

sampling technique and purposive sampling technique was used in the study, the simple random sampling technique was used to select 12 technical colleges from the list of 29 in the North Central geo-political zone with sample size of 430 NTC II EIMW students.

Random sampling technique was used to assign one Technical College (TC) each to the two treatment groups, Glencoe's problem-solving strategy and Rusbult's problem-solving strategy in each state. Six technical colleges were assigned to GPSS while six technical colleges were also assigned to RPSS. Therefore, six intact classes comprising 209 students were assigned to GPSS, while the six intact classes comprising 221 were assigned to RPSS. Furthermore, purposive sampling technique was used to assign 56 students to high ability level, 158 students to ability level and 216 students to low ability level. Three instruments were used in the study. They are: Electrical Installation Work Cognitive Achievement Test (EIWCAT). The researcher prepared two sets of lesson plans that was used for teaching the two experimental groups. These were prepared to cover the two main topics and sub-themes of the study. Each set contained 10 lesson that was used for teaching EIMW for ten weeks. One set of lesson plans was prepared based on Glencoe's Problem-Solving Instructional Strategies and Rusbult's problem-solving instructional strategies respectively. The instruments for collection of data for the study and the lesson plans were validated by three experts from the Department of Industrial and Technology Education, Federal University of Technology Minna. The instruments; Electrical Installation Work Cognitive Achievement Test (EIWCAT), Electrical Installation Work Psychomotor Achievement Test (EIMWPAT) were subjected to a pilot test that ascertained their reliabilities. This was done by administering them to the 40 NTC III EIMW students of Government Technical College, Malali Kaduna State. After this, the coefficient of internal consistency of EIWCAT was determined using Kuder-Richardson formula 20 (K-R 20) and it was found to be 0.80. K-R 20 was used in establishing the reliability of EIWCAT because it is a multiple-choice test.

Then the inter-rater coefficient, which is the reliability value was calculated using Pearson's Product Moment Correlation (PPMC) and it yielded 0.82. Similarly, the reliability of EIWII was determined using Cronbach's Alpha and it yielded 0.81. The EIMW teachers administered the pretest to the two treatment groups (Glencoe Problem solving strategies group and Rubusult problem solving strategies group) in their respective schools. In the pretest, the EIMW cognitive Achievement Test, EIMW psychomotor Achievement Test on both the two experimental groups respectively. Objective answer sheets were provided for the students to choose correct answers for the EIMW Cognitive achievement test. The EIMWPAT scores were collected from the EIMW teachers after treatment. The exercise provided post treatment data for each of the two dependent variables (Cognitive Achievement and Skill Achievement) after the treatment. Data collected for the study was analysed as follows: Mean and Standard deviation was used to answer all the research questions. Hypotheses formulated for the study were tested using analysis of covariance (ANCOVA) at $p < 0.05$ level of significance.

III. RESULTS

Research Question 1

What is the effect of Glencoe's and Rusbult's problem-solving strategies on students' cognitive achievement in EIMW?

The data for answering research question two is contained in Table 2.

Table 2: Mean of Pre-test and Post-test Cognitive Achievement Scores of Students Taught EIMW Using Glencoe's and Rusbult's Problem-Solving Strategies

Groups	N	Pretest		Posttest		Mean Gain
		Mean	SD	Mean	SD	
Glencoe's Problem-Solving Strategy	221	13.57	4.50	78.43	1.89	64.86
Rusbult's Problem-Solving Strategy	209	13.32	3.71	71.72	1.59	58.40

Table 2 show that, students taught EIMW using Glencoe's problem-solving strategy had pre-test mean cognitive achievement score of 13.57 with standard deviation of 4.50 and post-test score of 78.43 with standard deviation of 1.89. The mean gained between the pre-test and post-test mean cognitive achievement scores of the students taught EIMW using Glencoe's problem-solving strategy was 64.86. The students taught EIMW using Rusbult's problem-solving strategy had pre-test mean cognitive achievement score of 13.32 with standard deviation of 3.71 and post-test score of 71.72 with standard deviation of 1.59. The mean gained between the pre-test and post-test mean cognitive achievement scores of the students taught EIMW using Rusbult's problem-solving strategy was 58.40. This indicated that, even though both instructional strategies are good in improving students learning, students taught EIMW using Glencoe's problem-solving strategy had higher mean cognitive achievement scores than students taught using Rusbult's problem-solving strategy.

Research Question 2

What is the effect of Glencoe's and Rusbult's problem-solving strategies on students' skills achievement in EIMW?

The data for answering research question one is contained in Table 1 below.

Table 1: Mean of Pre-test and Post-test Skill Achievement Scores of Students Taught EIMW Using Glencoe's and Rusbult's Problem-Solving Strategies

Groups	Pretest			Posttest		Mean Gain
	N	Mean	SD	Mean	SD	
Glencoe's Problem-Solving Strategy	221	23.23	3.16	75.37	1.63	52.14
Rusbult's Problem-Solving Strategy	209	20.60	2.84	78.89	1.97	58.29

Table 1 showed that, students taught EIMW using Glencoe's problem-solving strategy had pre-test mean skill achievement score of 23.23 with standard deviation of 3.16 and post-test score of 75.37 with standard deviation of 1.63. The mean gained between the pre-test and post-test skill achievement scores of the students taught EIMW using Glencoe's problem-solving strategy was 52.14. The students taught EIMW using Rusbult's problem-solving strategy had pre-test mean skill achievement score of 20.60 with standard deviation of 2.84 and post-test score of 78.89 with standard deviation of 1.97. The mean gained between the pre-test and post-test skill achievement scores of the students taught EIMW using Rusbult's problem-solving strategy was 58.29. This indicated that, even though both instructional strategies are good in improving students learning, students taught EIMW using Rusbult's problem-solving strategy had higher mean skill achievement scores than students taught using Glencoe's problem-solving strategy

Hypothesis One

There is no significance difference between students' cognitive achievement mean scores in EIMW when taught using Glencoe's and those taught using Rusbult's problem-solving strategies.

The data for testing hypothesis two is contained in Table 3

Table 3: Analysis of Covariance for the test of Significance Difference Between Students' Cognitive Achievement Mean Scores in EIMW When Taught Using Glencoe's and Rusbult's Problem-Solving Strategies

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1322.16 ^a	2	661.082	896.60	.000
Intercept	197319.92	1	1973.92	2676.72	.000
Pretest	1007.36	1	1007.36	1366.26	.000
Group	281.02	1	281.02	381.14	.000*
Error	314.83	427	.737		
Total	25911.00	430			
Corrected Total	1636.998	429			

a. R Squared = .808 (Adjusted R Squared = .807)

Table 3 show the F-calculated value for testing the significance difference between the cognitive achievement scores of students taught EIMW using Glencoe's and those taught using Rusbult's problem-solving strategies. The F-calculated value of 381.14 was obtained with associated exact Sig. 2 tailed value of 0.00. Since the associated Sig. 2 tailed value of 0.00 is less than 0.05, the null hypothesis which stated that there is no significance difference between students' cognitive achievement mean scores in EIMW when taught using Glencoe's and those taught using Rusbult's problem-solving strategies is rejected. This implied that, there is significance difference between students' cognitive achievement mean scores in EIMW when taught using Glencoe's and those taught using Rusbult's problem-solving strategies.

Hypothesis Two

There is no significance difference between students' skills achievement mean scores in EIMW when taught using Glencoe's and those taught using Rusbult's problem-solving strategies. The data for testing hypothesis one is contained in Table 3.

Table 4: Analysis of Covariance for the test of Significance Difference Between Students' Skills Achievement Mean Scores in EIMW When Taught Using Glencoe's and Rusbult's Problem-Solving Strategies

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
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Corrected Model	834.17 ^a	2	417.08	223.48	.000
Intercept	4014.83	1	401.83	215.92	.000
Pretest	598.62	1	598.62	320.76	.000
Group	18.15	1	18.15	9.72	.002*
Error	796.89	427	1.86		
Total	2730.00	430			
Corrected Total	1631.06	429			

a. R Squared = .511 (Adjusted R Squared = .509)

Table above shows the F-calculated value for testing the significance difference between the skill achievement scores of students taught EIMW using Glencoe's and those taught using Rusbult's problem-solving strategies. The F-calculated value of 9.72 was obtained with associated exact Significant Two Tailed (Sig. 2 tailed) value of 0.02. Since the associated Sig. 2 tailed value of 0.02 is less than the stated level of significance (0.05), the null hypothesis which stated that there is no significance difference between students' skills achievement mean scores in EIMW when taught using Glencoe's and those taught using Rusbult's problem-solving strategies is rejected. Hence, there is significant difference between students' skills achievement mean scores in EIMW when taught using Glencoe's and those taught using Rusbult's problem-solving strategies.

Findings of the study

1. Glencoe's problem-solving strategy is more effective in student cognitive achievement than Glencoe's problem-solving strategy
2. Rusbult's and Glencoe's problem-solving strategies are effective in improving students skill achievement in EIMW but Rusbult's problem-solving strategy over Glencoe's problem-solving strategy.
3. There was significant difference between students' cognitive achievement mean scores in EIMW when taught using Glencoe's and those taught using Rusbult's problem-solving strategies
4. There was significant difference between students' skills achievement mean scores in EIMW when taught using Glencoe's and those taught using Rusbult's problem-solving strategies.

IV. Discussion of Findings

Findings on the effects of Glencoe's and Rusbult's problem-solving strategies on students' cognitive achievement in EIMW revealed that the students taught EIMW using Glencoe's problem-solving strategy had higher mean cognitive achievement scores than students taught using Rusbult's problem-solving strategy. The finding clearly showed that, students' cognitive achievement in EIMW is more enhanced using Glencoe's problem-solving strategy than Rusbult's problem-solving strategy. The finding is similar to the findings of Mandina and Ochonogor (2018) on the comparative effect of two problem-solving instructional strategies on students' achievement in Zimbabwe that revealed Glencoe's problem-solving strategy is more effective in improving the cognitive achievement of students in Stoichiometry than Reda's problem-solving strategy. The effectiveness of Glencoe's problem-solving strategy in improving the cognitive achievement of students in EIMW could be attributed to the exploration and planning phases of the Glencoe's problem-solving strategy that demand students to brainstorm the problem properly in order to understand and identify the basic facts and materials needed for solving the problem. This implied that, the exploration and planning phases could be responsible for the effectiveness of Glencoe's problem-solving strategy over Rusbult's problem-solving strategy in enhancing students' cognitive achievement in EIMW.

Contrary to the stated null hypothesis on the significant difference between students' cognitive achievement mean scores in EIMW when taught using Glencoe's and those taught using Rusbult's problem-solving strategies, the test result revealed statistical significance. The statistical significance recorded is an indication that, there is substantial difference between the mean cognitive achievement scores of students taught EIMW using Glencoe's problem-solving strategy is much higher than that of students taught using Rusbult's problem-solving strategy. However, based on the above findings Nwaodo (2016), in his finding revealed statistical significant difference between the academic achievements mean scores of students taught EIMW using Reda and Rubult problem solving models.

Findings on the effects of Glencoe's and Rusbult's problem-solving strategies on students' skill achievement in EIMW revealed that the students taught using Rusbult's problem-solving strategy had higher mean skill achievement scores than students taught using Glencoe's problem-solving strategy. This indicated that, the students taught EIMW using Rusbult's problem-solving strategy performed better in the skill achievement test than the students taught using Glencoe's problem-solving strategy. The finding is similar to the findings of Nekang (2011) on differential effects of Reda's and Rusbult's problem-solving strategies on male and female students' achievement and interest in trigonometry in Cameroon that revealed students exposed to Rusbult's problem-solving strategies achieved higher in trigonometry achievement test than those exposed to conventional problem-solving strategy.

Furthermore, the test for significance difference between students' skills achievement mean scores in EIMW when taught using Glencoe's and those taught using Rusbult's problem-solving strategies revealed statistical significance. This entailed that, there is much difference between the skills achievement mean scores of students taught EIMW using Glencoe's and those taught using Rusbult's problem-solving strategies. The finding is similar to the finding of Slavin (2017) on the effects of problem solving instructional strategy on academic achievement and retention in ecology among secondary school students in Zaria educational zone that revealed significant difference between the posttest mean scores of the experimental and control group of recall variable in favour of the experimental group.

V. Conclusion

The study shows that students taught EIMW using Rusbult's problem-solving strategy had higher mean skill achievement and interest scores and students taught EIMW using Glencoe's problem-solving strategy had higher mean cognitive achievement scores. The study also revealed that low ability students taught EIMW using Glencoe's and Rusbult's problem-solving strategies had higher mean cognitive and skill achievement. Therefore, it is concluded that, Glencoe's and Rusbult's problem-solving strategies had positive effects on students' cognitive and skill achievement.

VI. Recommendations

Based on the findings from the study, the following recommendations were made:

1. Electrical Installation and Maintenance Works teachers should adopt the use of Rusbult's problem-solving strategy to enhance students' cognitive and skill achievement; and Glencoe's problem-solving strategy to enhance students' cognitive achievement.
2. Science and Technical Schools Board should sensitize and train Electrical Installation and Maintenance Works teachers on the use of Glencoe's and Rusbult's problem-solving strategies in order to enhance students' cognitive and skill achievements.
3. Administrators of technical colleges should encourage the teaching of Electrical Installation and Maintenance Work using Glencoe's and Rusbult's problem-solving strategies in order to enhance students' cognitive and skill achievements.
4. Electrical Installation and Maintenance Work students should be introduced to learn through the use of Glencoe's and Rusbult's problem-solving strategies in order to enhance their cognitive, ability level and skill achievements.

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