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Effects of Meta-Learning on the Academic Achievement and Content Retention of Engineering Trades Students in Technical Colleges in Nigeria

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Abstract: This study determined the effect of meta-learning teaching method on academic achievement and content retention of engineering trades student in order to improve their academic performance in technical colleges. The study employed a quasi-experimental research design involving experimental and control groups plus pre-test and post-test. A simple random sampling technique was used to select 26 technical colleges, 26 MVM teachers and 582 MVM students for the study. Instrument used for data collection was Motor Vehicle Mechanics Works Achievement Test (MVMWAT) validated by experts with a reliability coefficient of 0.86 and items difficulty indices which ranges from 0.32 to 0.84 together with items discrimination indices of 0.33 to 0.88. Data were analyzed with the percentage, mean, standard deviation and Analysis of Covariance (ANCOVA). It was found that meta-learning teaching method improves students' academic achievement and content retention in engineering trades. The study recommends among others that teachers of engineering trades subjects in technical colleges should adopt meta-learning teaching method to improve teaching and learning effectiveness and the academic achievement of students.
Keywords: Meta-learning teaching method; Engineering trades; Motor vehicle mechanics; Academic achievement; Content retention.

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Introduction

Engineering trade is one of the Technical Vocational Education and Training (TVET) programmes offered in technical colleges for the purpose of producing craft skilled manpower required for the Nigeria's economic and technological development. The engineering trade curriculum which is aimed at training and imparting necessary practical skills leading to the production of craftsmen/craftswomen is developed by National Board for Technical Education (NBTE). These trained craftsmen/craftswomen will be enterprising and self-reliant in any of the engineering trade areas (NBTE, 2003) necessary for solving industrial and economic problem of the nation (Federal Republic of Nigeria [FRN], 2013).

This is done by incorporating into the technical colleges' curriculum the necessary practical skills work (up to 65%) to enable the students create job by using their abilities, knowledge, initiatives and creativity for self-reliance.

However, with all the efforts put in by the teachers in effectively imparting the required mechanical knowledge and skills to the technical college engineering trades students over the years in Nigeria, the academic achievement of the students have consistently remained unimpressive. The National Business and Technical Examinations Board (NABTEB) results of students (2006-2018) has remained a disturbing issue as the National Technical Certificate (NTC) graduate always come out with lower grades and sometimes end up failing the subject.

The major cause of this setback in students' academic achievement according to Oyenuga (2010) is the instructional delivery approach that is adopted for teaching the trades. Most of the teachers use the conventional lecture teaching method which leaves the student ill-equipped to competently respond to most assessment posed to them. Kumazhege (2016) also advanced reasons such as excessive use of lecture method; lack of improved instructional methods and lack of student's interest in learning as reasons for the deteriorating status of students' performances in the trades. If this situation is allowed to continue unchecked, the objectives of TVET, as enshrined in National Policy on Education on the students of engineering trades will be negatively affected. The attitude of students, parents, and society at large towards engineering trades will also be affected negatively. Hence, teachers in achieving engineering trade objectives must adopt an effective method of lesson delivery that will assist the learners develop physically, intellectually, emotionally, morally and socially in a manner that he/she will be able to exploit his potentials maximally (Saba, Ma'aji and Tsado 2011).

Eze, Ezenwafor and Molokwu (2015) observed that the lecture teaching method widely adopted in Nigerian technical colleges is more teacher-centered than learner-centered. The teacher-centered teaching emphasizes teaching more than learning and pays little or no attention to the process of learning thereby dwarfing students' creative thinking which is necessary in today's workplace where there is constant changes in engineering as a result of technological advancement. The surest way to prepare students for a changing world is to give them the tools to be versatile, reflective, self-directed and self-reliant. It is important, therefore, to engage students' creative thinking in order to develop their problem solving skills by adopting student-centered approach like meta-learning. Meta-learning can help students in engineering trade with varied tasks of learning and it sets students up to succeed in life and provide self-directed learning throughout their lives, as the world continues in sophistication, workers need to be dynamic.

Meta-learning is a student-centered approach to teaching and learning. It fosters the process of self-reflection and learning how to learn, as well as the building of knowledge, skills and character (Bialik & Fadel, 2015). Meta-learning teaching method treats learning as a process. Learning is a skill: the more you practice, the better your performance and achievement and the content retained. Meta-learning begins with raising awareness of learning, listening for feedback, praising advancement, and getting lots of practice. Maudsley (1979) describe meta-learning as the process by which learners become aware and increasingly in control of habits of perception, inquiry and growth that they have internalized. Interestingly, meta-learning could enhance students' academic achievement as it assists learners to have a deeper awareness of the context and content of the learning process. It involves the learner who is intentionally aware of the learning processes and sequence which include learner`s attention,

thinking attitudes, beliefs, expectations, learning strategies, motivations, prior knowledge, memory and understanding (Ogwo & Oranu, 2006). Ogwo and Oranu further opined that teachers can successfully adopt meta-learning, which include: discuss the objectives with the students before starting each lesson, outline the thinking process skills involved in every aspect of lesson and the best techniques of assisting the students to think through them, use different attention-sustaining strategies for making students conscious of the tasks at hand and specify different evaluation tasks and questions for each stage of instruction.

According to Eze, Ezenwafor and Molokwu (2015), implicit in meta-learning conception are that students need to have knowledge of how they learn, they have the motivation to be proactive in managing themselves in this way and they have the capacity to regulate their learning. Therefore, meta-learning is awareness and understanding of the phenomenon of learning itself as opposed to subject knowledge. Hesson and Shad (2007) posited that this teaching method promotes interest, analytical research, critical thinking and enjoyment of the teaching-learning process among students. Consequently, it is considered to be more effective in improving students' academic achievement since it does not centralize the flow of knowledge from teacher to students. There is the need meta-learning to be able to effectively recognize our weaknesses and push ourselves to improve. Relevant skills in meta-learning such as planning skills, executing skills, monitoring skills and evaluating skills forms learners learning interest. This study was therefore considered important as it will provide empirical data on the effect of meta-learning teaching method on the achievement and content retention students in technical colleges.

Purpose of the Study

The main purpose of the study was to determine the effect of meta-learning on the academic achievement and content retention of engineering trades students in technical colleges in Nigeria. Specifically, the study determined the:

1) Academic achievement of engineering trades students taught using meta-learning teaching method and those taught using lecture teaching method;
2) Content retention of engineering trades students taught using meta-learning teaching method and those taught using lecture teaching method.

Research Questions

The following questions were formulated and guided the study as follows:

1) What is the academic achievement of engineering trades students taught using meta-learning teaching method and those taught using lecture teaching method?
2) What is the content retention of engineering trades students taught using meta-learning teaching method and those taught using lecture teaching method?

Hypotheses

The study tested the following hypotheses at 0.05 level of significance:

1) There is no significant difference in the mean academic achievements of engineering trades students taught using meta-learning teaching method and those taught using lecture teaching method
2) There is no significant difference in the mean content retention of engineering trades students taught using meta-learning teaching method and those taught using lecture teaching method

Method

The study adopted pre-test and post-test quasi experimental design. The experimental group was taught with meta-learning teaching method while the control group was taught with lecture teaching method. Pre-test was carried out before the experiment and post-test was administered after the experiment on the two groups. This is in line with the recommendation of Oyenuga (2010) that quasi-experimental design can be used when it is not possible for the researcher to randomly sample the subject and assign them to treatment groups without disrupting the academic programmes of the schools involved in the study. The study was carried out in all the Government Science and Technical Colleges (GSTCs) in the North East States of Nigeria. The States include: Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe States. The population of the study comprised all the teachers and all the NTC II students offering engineering trades in the 37 technical colleges under study in the 2018/2019 academic session. A simple random sampling technique was adopted to select 26 technical colleges that offer Motor Vehicle Mechanic (MVM) of engineering trade and the technical colleges that were used in the experimental and the control groups. The 26 MVM teachers and 586 MVM students in each of the intact class constitute the sample that was use for the study. Therefore, the intact class selected in each of the technical colleges chosen for the study serve as either experimental or control group.

The instrument used for data collection was Motor Vehicle Mechanics Works Achievement Test (MVMWAT) containing 40 multiple choice items developed from the curriculum content for National Technical Certificate (NTC) II base on table of specification using Bloom's cognitive domain of educational objectives. Each item has four options and each correct answer has 1 point while each incorrect answer has 0 point. The test items covered cooling, lubrication, suspension, steering and brake systems. The instrument was face and content validated by four experts, two from the Department of Technology Education Modibbo Adama University of Technology Yola and two from Abubakar Tafawa Balewa University Bauchi. To ensure the content validity, a table of specification on the MVMWAT which ensured an appropriate distribution of its items, with respect to the relevant content area as well as the cognitive objective levels was applied based on the Bloom's taxonomy of educational objectives. Based on the table of specification, items for the MVMWAT were developed. The content area for the study was analyzed into cognitive domain of knowledge, comprehension and application in the table of specifications. This is because MVMWAT is a multiple choice instrument therefore its items were limited to only three stages of cognitive domain as shown in Table 1.

Table 1. Table of Specifications Used for MVMWAT

S/n	Content	Items	Thinking Level			%
			Knowledge	Comprehension	Application	
1	Cooling System	8	3	3	2	20
2	Lubrication Systems	8	3	4	1	20
3	Suspension Systems	8	4	2	2	20
4	Steering Systems	8	3	3	1	20
5	Brake Systems	8	3	3	2	20
Total		**40**	**16**	**14**	**9**	**100**

Cronbach alpha method was use to establish the reliability coefficient of the instruments MVMWAT whereby the instrument was trial-tested in GSTC Jos Plateau State and the data obtained was use to determine the reliability coefficients of 0.86.

Furthermore, MVMWAT was item analyse and was found with item difficulty indices which ranges from 0.32 to 0.84 and item discrimination indices of 0.33 to 0.88. These values are above the suitable rating and meets the conditions of a difficulty index of between +20 to 80 and a discrimination index of +0.2 and above as acceptable quality for an item (Okoro, 2006).

The pre-test was then administered to the study sample after which the items on the instrument were re-organized before administering the post-test at the end of the experimental period. The pre-tests and post-tests scores of the groups were collected and used in the analysis. Data were analyzed with the percentage, mean and standard deviation to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance with the statistical package for social sciences (SPSS). The mean difference between the pre-test and post-test scores of the experimental and control groups was used to answer the research questions. For analysis of data relating to the null hypotheses, if P-value is less than the level of significance (P<0.05), then reject null hypothesis but if otherwise, accept the null hypothesis.

Results

Research Question 1

1) What is the academic achievement of engineering trades students taught using meta-learning teaching method and those taught using lecture teaching method?

Table 2. Mean and Standard Deviation of the Experimental and Control Groups' Achievement Scores in Pre-Test and Post-Test

Teaching Method	Pre-Test			Post-Test		Mean Difference
	N	$\bar{X}$	δ	$\bar{X}$	δ	
Experimental group Meta-learning	304	21.63	3.746	72.34	15.48	50.71
Control group Lecture	282	21.69	3.987	58.28	15.65	36.59

Table 2 revealed that the percentage mean difference of achievement score of students taught MVM using meta-learning was 50.71 while that of students taught using lecture was 36.59. Students taught using meta-learning teaching method therefore perform better than students taught using lecture method of teaching.

Research Question 2

2) What is the content retention of engineering trades students taught using meta-learning teaching method and those taught using lecture teaching method?

Table 3. Mean and Standard Deviation of the Experimental and Control Groups' Content Retention

Teaching Method	Post-Test			Content Retention		Mean Difference
	N	$\bar{X}$	δ	$\bar{X}$	δ	
Experimental group Meta-learning	304	72.34	15.48	59.07	13.871	13.27
Control group Lecture	282	58.28	15.65	41.18	11.893	17.10

Table 3 revealed that the percentage mean difference of content retention score of students taught MVM using meta-learning was 13.27 while that of students taught using lecture was 17.59. Students taught using meta-learning teaching method therefore have high content retention than students taught using lecture method of teaching.

Hypothesis 1

1) There is no significant difference in the mean academic achievements of engineering trades students taught using meta-learning teaching method and those taught using lecture teaching method

Table 4. ANCOVA of Academic Achievement of Students Taught Using Meta-learning and Lecture Teaching Methods

Source of Variance	Sum of Squares	df	Mean Square	F	P-value
Corrected model	33669.139	11	3060.831	85.279	0.000
Intercept	118549.705	1	118549.705	3302.944	0.000
Pre-Test	5858.609	1	5858.609	1.228	0.312
Teaching Methods*States	27654.591	10	27654.591	77.049	0.000
Error	20602.087	574	35.892		
Total	2562152.160	586			
Corrected total	54271.226	585			

Table 4 revealed that the F-calculated value for meta-learning and lecture teaching methods across the schools in North East States is 77.049 with significance of F at 0.000, which is less than 0.050. The null hypothesis is therefore rejected at 0.05 level of significance. There is significant difference in the mean academic achievements of engineering trades students taught using meta-learning teaching method and those taught using lecture teaching method.

Hypothesis 2

2) There is no significant difference in the mean content retention of engineering trades students taught using meta-learning teaching method and those taught using lecture teaching method

Table 5. ANCOVA of Content Retention of Students Taught Using Meta-learning and Lecture Teaching Methods

Source of Variance	Sum of Squares	df	Mean Square	F	P-value
Corrected model	32634.909	11	16317.455	97.239	0.000
Intercept	41815.259	1	41815.259	249.185	0.000
Pre-Test	218.602	1	218.602	1.303	0.254
Teaching Methods *States	32454.925	10	32454.925	193.405	0.000
Error	97832.069	574	167.808		
Total	1709026.240	586			
Corrected total	130466.978	585			

Table 5 revealed that the F-calculated value for content retention of students taught using meta-learning and lecture teaching methods across the schools in North East States is 193.405 with significance of F at 0.000, which is less than 0.050. The null hypothesis is therefore rejected at 0.05 level of significance. There is significant difference in the mean content retention of engineering trades students taught using meta-learning teaching method and those taught using lecture teaching method.

Discussion

The findings of the study revealed that students taught using meta-learning achieved higher score. This indicates that meta-learning is effective in improving students' academic achievement in engineering trades. The study further showed that the outcome is the same in all the technical colleges in the North East States. Hence, the use of meta-learning teaching method improved students' academic achievement than using lecture teaching method. The findings supports the views of Tebabal and Kahssay (2011) that the primary purpose of teaching is to bring about fundamental change in learning. The higher mean scores achieved by students taught with meta-learning also agrees with the position of Zacharia, Chin and Daud (2010), Adumola (2011) and Ganyaupfu (2013) that teachers need to be conversant with different teaching methods, select and use appropriate ones based on the nature of the subject. The less achievement by students taught with lecture method of teaching confirms the observation of Bala (2006) and Zacharia, Chin and Dauda (2010) that the method often creates frustration and learning difficulties for students leading to low academic achievement. But the high score achieved by students taught with meta-learning goes a long way to show its efficacy in improving students' academic achievement as posited by Greitzer (2002), Hesson and Shad (2007) and Ganyaupfu (2013) among others. The finding that location of institution did not significantly influence academic achievement of the technical college students in both teaching approaches is in line with Ayeduso (2001) who asserted that technical college students across the states have equal potential and ability if given support and motivation.

Conclusion

The study found out that the use of meta-learning teaching method is more effective in improving the academic achievement of students in the technical colleges irrespective of their location.

Recommendations

Based on the findings of this study, the following recommendations were made:

1) Teachers of engineering trades subjects in technical colleges should adopt meta-learning teaching method to improve teaching and learning effectiveness and the academic achievement of students.

2) Curriculum planners should recommend a wide use of meta-learning by teachers at all levels of the education system and ensure its effective application.

3) Supervisory agencies like the National Board for Technical Education (NBTE) should organize seminars and conferences on the use of meta-learning for teachers of technical colleges.

4) Students should also be encouraged to practice meta-learning, this will help in coming closer to the understanding of the engineering concepts as this will make learning more concrete.

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