

Effects of Prior Conception, Exploration, Discussion, Dissatisfaction and Application (PEDDA) Model and PEDDA-Animated Instructional Model on Achievement of Pre-Service Chemistry Teachers'

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Abstract

This study sought to determine the effect of Prior conception, Exploration, Discussion, Dissatisfaction and Application (PEDDA) model and PEDDA-ANIMATED instructional model on achievement of male and female pre-service chemistry teachers in Delta State. Two research questions and three hypotheses that were tested at 0.05 level of significance guided the study. The population of the study consisted of seventy two (72) pre-service chemistry teachers and the sample for the study was made up of forty (40) pre-service chemistry teachers drawn from the only Federal College of Education and one State College of Education (using simple random sampling-balloting technique) located in the State. A quasi- experimental design was used for the study because intact classes were used. The two Colleges of Education were randomly assigned to PEDDA instructional strategy and PEDDA- ANIMATED instructional strategy using toss of coin. Electrochemistry Achievement Test (EAT) developed by the researchers and found to be valid and reliable was used for data collection. The groups received pre-test and post-test independently. The research questions were answered using mean and standard deviation while Analysis of Covariance (ANCOVA) was used to test the hypotheses. The findings showed that there was no statistical significant difference in the mean achievement scores of pre-service chemistry teachers' taught electrochemistry with PEDDA and those taught using PEDDA-ANIMATED instructional strategy and there was no interaction of instructional strategy with gender among others. Based on the findings it was recommended among others that the National Commission for Colleges of Education (NCCE) should incorporate PEDDA and PEDDA –Animated instructional strategies in the National Certificate of Education (NCE) minimum standards as part of the strategies for teaching especially the science courses.

Keywords: Chemistry, achievement, electrochemistry, PEDDA model, PEDDA-ANIMATED instructional model and Pre-service teachers

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Introduction

Science and technology education are critical to sustainable national development. The pace of science and technological transformation has been on the increase curbing numerous challenges on daily basis. Chemistry is one of the three basic sciences taught at the Senior Secondary School level in Nigeria.

At the National Certificate in Education (NCE) level, chemistry education is designed to produce competent chemistry teachers with the capacity to encourage the spirit of inquiry in the learners and to apply the skills and knowledge to solve day-to-day problems (NCCE, 2020). However, these objectives are yet to be achieved in our secondary schools given the poor academic achievement of students in chemistry recorded in recent times (Eze, Obielumani & Okotcha, 2020). The identified importance of chemistry education raises the concern about pre-service chemistry teachers' ability to prepare students for the 21st century knowledge the society needs to curb some scientific problems. Research (Okotcha, Oghenejode & Eze, 2021; Okotcha, 2018) has shown that chemistry students still have some misconceptions in electrochemistry. It is pertinent to note however that no education system can rise above the level of its teachers (FRN, 2004). The persistent difficulties students may be having in chemistry concepts especially electrochemistry could be because the pre-service teachers' preparation programs in Colleges of Education are still based predominantly on traditional practices such as lecture method (Agoro, 2013) which does not give them the opportunity to deal with some of the misconceptions they have in a particular concept. Hence, after graduation, they find it difficult to teach the students effectively leading to low achievement. Hence, there is need to prepare the pre-service teachers for effective service delivery.

The pre-service chemistry teachers have been taught using the conventional lecture method, there is need to expose them to inquiry based methods of teaching that are student centered strategies which could remove misconceptions students have in electrochemistry and equip them for the service ahead. Such inquiry based strategies include Prior conception, Exploration, Discussion, Dissatisfaction and Application (PEDDA) and PEDDA ANIMATED instructional models. Prior conception, Exploration, Discussion, Dissatisfaction and Application (PEDDA) is a five step conceptual change instructional model developed by Nworgu (1996) based on adaptations from Stofflet and Stoddarts (1994). The acronym PEDDA was derived from the initial letters of the processes involved. The processes are: determination of Prior knowledge, Exploration of the phenomenon, Discussion of the experiment, Development of dissatisfaction with prior conception and Application, while the PEDDA ANIMATED instructional model is the animated form of PEDDA.

Animation is defined by Byrne, Catrambone and Stasco (1999) as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena. Adapting the PEDDA step-by-step processes into computer animation of electrochemistry may help to foster exploration and inquiry on the part of the pre- service teachers which will help them in their service delivery. These step- by- step sequences of PEDDA-ANIMATED instruction which may have a wider application should be imbibed by pre-service chemistry teachers during training at the colleges to become competent teachers with the capacity to further encourage the spirit of inquiry and greater achievement among the students at the secondary school and basic education levels and to apply the knowledge to solve day- to -day problems. The aforementioned models involve exploration and provide the learner with the opportunity to test a range of his preconceptions/ misconceptions against actual

experience from his own activities and apply the new experiences in order to experience its usefulness (Madu, 2004). Thus, exploring phenomena before explaining them is critical for conceptual change learning which leads to greater achievement. Hence, the researchers deemed it necessary to investigate the effects of Prior conception, Exploration, Discussion, Dissatisfaction and Application (PEDDA) and PEDDA- ANIMATED instructional models on achievement of pre-service chemistry teachers.

Students' achievement connotes academic performance in school subject as symbolized by a score or mark on achievement test. According to Danladi (2017), students' academic achievement is quantified by a measure of the students' academic standing in relation to those of other students of his age. Ogunsaju (2004) stated that the academic standard in all Nigeria educational institutions has fallen considerably below societal expectations. One of the reasons for the low standard could be associated with the quality of teachers trained in the colleges of education (Adeyemi & Adeyemi, 2014). A strong relationship exists between high-quality instruction, teacher professional development and students' achievement (Araoye, 2013). Hence this study is imperative. Another variable that can affect achievement is gender.

Gender refers to the social or cultural construct characteristics, behaviours and role which society ascribes to males and females. The issues of gender in science have continued to receive attention by researchers. Gender poses instructional challenges to teachers. This has been a crucial matter to the educationists. Gender, according to Onah (2011), refers to the content of masculinity and femininity found in an individual. It varies from time to time and from place to place. Issues that are multidimensional in outlook as they relate to the teaching and learning of science in this regard have been very contentious. The issues of parity and disparity in the achievement of male and female science students have formed an important focus of research in recent years. This is in

recognition of influence of gender and the position of the learner in any learning process. Adapting an approach that takes into account the relationship and interaction between males and females is imperative. Hence, there is need to investigate the effect of PEDDA and PEDDA- ANIMATED instructional strategies and ascertain their impact on achievement of both male and female pre-service chemistry teachers.

Statement of the Problem

Chemistry education as an aspect of science education aims at developing individuals who would be able to apply skills and knowledge gained in solving everyday problems in the society for sustainable development. This laudable objective is a function of the science teacher. Prospective science educators at the Colleges of Education need to be exposed to inquiry teaching strategies that could remove all forms of misconceptions students may have in a particular concept especially electrochemistry against the traditional lecture method of instruction which is predominantly used. This will lead to greater achievement in the subject. It is the duty of the chemistry teacher to select and utilize appropriate instructional strategies in lesson delivery. The ability of chemistry teachers in particular to select and utilize the appropriate instructional strategies in their lesson delivery is a function of the pre-service and in-service training they received from the teacher producing institutions and departments. Hence, there is need to expose the pre-service chemistry teachers to innovative methods that will help to remove all forms of misconceptions they may be having in electrochemistry thus preparing them for the task ahead. This underscores the need for this study. Hence, the problem of the study posed as a question is: what is the effect of PEDDA and PEDDA- ANIMATED instructional strategies on achievement of pre-service chemistry teachers.

Goals and Objective

The general objective of the study is to find out the effect of PEDDA and PEDDA-ANIMATED instructional strategies on achievement of pre-service chemistry teachers in Colleges of Education in Delta State. Specifically, the study hopes to determine the:

1. Relative effectiveness of PEDDA and PEDDA - ANIMATED instructional strategies on pre-service teachers' achievement in chemistry.
2. Influence of gender on pre-service teachers' achievement in chemistry.

Research questions

1. What is the effect of PEDDA and PEDDA- ANIMATED instructional strategies on pre-service teachers' achievement in chemistry?
2. What is the influence of gender on pre-service teachers' achievement in chemistry?

Hypotheses

The following hypotheses that were tested at 0.05 level of significance guided the study

H₀₁: There is no significant difference in the mean achievement scores of pre-service teachers' taught electrochemistry with PEDDA and those taught using PEDDA-ANIMATED instructional strategy.

H₀₂: There is no significant difference in the mean achievement scores of male and female pre-service teachers' when exposed to PEDDA and PEDDA- ANIMATED instructional strategies.

H₀₃: There is no significant interaction effect of instructional strategies and gender on pre-service teachers' mean achievement scores in chemistry.

Methodology

Research Design

The study adopted the quasi-experimental design because intact classes were used. The intact classes were randomly assigned to experimental groups E₁ and E₂.

Area of the Study

The study was carried out in Delta State. The choice of the state was based on the observed misconceptions students still hold in electrochemistry. Also, the researchers reside in the state hence it gave them the opportunity of supervising the research.

Population of the Study

The population of this study consisted of all the 200 level chemistry students in the only Federal College of Education and the two State Colleges of Education in Delta State numbering seventy- two (72) students (62 girls and 10 boys).

Sample and Sampling Technique

The sample of the study consisted of forty (40) pre-service chemistry teachers in two Colleges of Education-- the only Federal College of Education and one State College of Education which was selected using simple random sampling (balloting technique). The two Colleges of Education were randomly assigned to PEDDA instructional strategy and PEDDA- ANIMATED instructional strategy using toss of coin.

Instrument for Data Collection

The instrument for this study was Electrochemistry Achievement Test (EAT). The Electrochemistry Achievement Test (EAT) was used to test achievement of students in chemistry. EAT was developed by the researchers and it was a multiple –choice test consisting of twenty-five (25) items.

Validation and Reliability of Instrument

The Electrochemistry Achievement test (EAT) was constructed by the researchers and validated by experts in science education. The instrument was trial tested in two colleges of education of another state to determine their reliability. The scores obtained were correlated using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the pre-test to the students in the two groups. After this, the two treatment groups were exposed to the treatments before the post-tests were administered.

Method of Data Analysis

The research questions were answered using mean and standard deviation while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

RESULTS

Research Question One: What is the effect of PEDDA and PEDDA- ANIMATED instructional strategies on pre-service teachers' achievement in chemistry?

Table 1: Mean and Standard deviation of pretest and posttest of the effect of PEDDA and PEDDA- ANIMATED instructional strategies on pre-service teachers' achievement in chemistry

SN	Instructional Mode	N	Pretest		Posttest		Mean Gain
			\bar{X}	SD	\bar{X}	SD	
1	PEDDA	26	23.35	4.45	40.62	4.23	17.27
2	PEDDA-ANIMATED	14	22.36	3.60	41.14	5.02	18.78

Result on Table 1 shows that for each of the groups, the post-test mean scores were greater than the pretest mean scores with the group taught electrochemistry using the PEDDA-ANIMATED

instructional strategy having a higher mean gain ($18.78 > 17.27$). This is an indication that the PEDDA-ANIMATED instructional strategy improved students' achievement in chemistry than the PEDDA model.

H₀₁: There is no significant difference in the mean achievement scores of pre-service teachers' taught electrochemistry with PEDDA and those taught using PEDDA-ANIMATED instructional strategy.

Table 2: Analysis of Covariance (ANCOVA) of the difference in the mean achievement scores of pre-service teachers' taught electrochemistry with PEDDA and those taught using PEDDA-ANIMATED instructional strategy.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Remark
Corrected Model	253.853 ^a	4	63.463	4.235	0.01	0.326	
Intercept	3554.755	1	3554.755	237.188	0.00	0.871	
PretestAch	226.489	1	226.489	15.112	0.00	0.302	
Group	4.877	1	4.877	.325	0.57	0.009	NS
Gender	8.414	1	8.414	.561	0.45	0.016	NS
Group * Gender	10.847	1	10.847	.724	0.40	0.020	NS
Error	524.547	35	14.987				
Total	67364.000	40					
Corrected Total	778.400	39					

Note: NS = Not significant, $\alpha = 0.05$

Table 2 shows that the mean achievement scores of pre-service teachers' taught electrochemistry with PEDDA and those taught using PEDDA-ANIMATED instructional strategy was not statistically significant ($p = 0.57$). Hence, the null hypothesis was not rejected. Inference drawn is that there was no significant difference in the mean achievement scores of pre-service teachers' taught electrochemistry with PEDDA and those taught using PEDDA-ANIMATED instructional strategy.

Research Question 2: What is the influence of gender on pre-service teachers' achievement in chemistry when taught using PEDDA and PEDDA-ANIMATED instructional strategy?

Table 3: Mean and Standard deviation of the influence of gender on pre-service teachers' achievement in chemistry

SN	Gender	N	Pretest		Posttest		Mean Gain
			\bar{X}	SD	\bar{X}	SD	
1	Male	7	21.29	1.89	42.43	1.61	21.14
2	Female	33	23.36	4.42	40.45	4.80	17.09

Result on Table 3 shows that for the male and female students, the post-test mean achievement scores were greater than the pretest mean achievement scores with the male students taught electrochemistry having a higher mean gain ($21.14 > 17.09$). This is an indication that the male students performed higher than the female students.

H₀₂: There is no significant influence of gender on the mean achievement score of pre-service teachers taught electrochemistry with PEDDA and those taught using PEDDA-ANIMATED instructional strategy.

The finding of the study as presented in Table 2 shows the result was not statistically significant ($p = 0.45$). Thus, inference drawn is that there was no statistical significant difference in the mean achievement scores of male and female pre-service teachers' taught electrochemistry with PEDDA and those taught using PEDDA-ANIMATED instructional strategy.

H₀₃: There is no significant interaction effect of the instructional strategies and gender on pre-service teachers' mean achievement score in chemistry

The result of the study as presented in Table 2 shows that the result was not statistically significant ($p = 0.40$). Thus, inference drawn is the interaction effect of the instructional strategies

and gender on pre-service teachers' mean achievement score in chemistry was not statistically significant.

Discussion of Findings

Effects of PEDDA and PEDDA- ANIMATED instructional strategy on pre-service teachers' achievement in chemistry

The findings of this study showed that pre-service teachers taught using PEDDA-ANIMATED strategy scored higher than those taught using PEDDA ($18.78 > 17.27$) as shown in Table 1, though this difference was statistically not significant. This means that both strategies are effective in students' achievement. This result is not unconnected with the interactive aspect of the strategies which offers students unique opportunities to be actively engaged in meaningful learning. The pre-service teachers diligently carried out the activities collaboratively interacting with themselves and resources with the teacher facilitating the construction of cognitive imprints guided by students' testing ideas. This agrees with Dewey, Piaget and Vygotsky who maintained that knowledge is constructed by the learners and embodied in human experience. However, in PEDDA-ANIMATED strategy, beside the student's interactive opportunities, the strategy focused learners not only on material activities but also on deep subject matter understanding brought about by watching the animated motion of the molecules (Okotcha, Oghenejode & Eze, 2021; Olodu, 2012). This comprehensive understanding of the content enabled pre-service chemistry teachers to develop mental pictures of movement of ions in solutions since these are not visible. As prospective teachers, the experience obtained in both strategies will hopefully impact positively on their instructional delivery capability. The tempo will in due course improve teacher preparation

for greater teacher effectiveness and may eventually improve their students' achievement at secondary schools.

Influence of gender on pre-service teachers' achievement in chemistry when taught using PEDDA and PEDDA- ANIMATED instructional strategy

The findings of the study as shown in Table 3 revealed that the male pre-service teachers achieved more than their female counterparts ($21.14 > 17.09$). However, the difference was found not statistically significant. This means gender is not a significant factor in determining students' achievement in chemistry. Thus, both male and female pre-service teachers benefited significantly from the two strategies and this gave them equal opportunities. This result disagrees with the findings of Danladi (2016) who noted that males performed significantly more than their female counterparts. However, this result is in line with the findings of Okotcha (2018) who noted that there was no significant difference in the achievement of both males and females. This result supports one of the objectives of the National Senior Secondary School Chemistry Curriculum (2009) which is for students (male and female) to acquire basic theoretical and practical knowledge. Such knowledge will help them to participate in solving both local and national problems. Hence, the male and female pre-service chemistry teachers are hopefully equipped for the task ahead.

Interaction effect of treatment and gender on pre-service teachers' achievement

The result on Table 2 shows that there was no significant interaction effect of treatment and gender on pre-service teachers' mean achievement in chemistry. This means that the strategies did not have different effects on pre-service teachers' achievement depending on gender. In this study, all pre-service teachers (males and females) benefitted equally from the instructional

strategies in terms of achievement. This result is not in agreement with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. Nevertheless the findings of this study is in agreement to the findings of Okotcha (2018) and Danladi (2016) who discovered that there was no significant interaction effect of treatment and gender on students' achievement in chemistry. The absence of interactive effect of strategy and gender on students' achievement in this study could be attributed to the fact that both PEDDA and PEDDA-ANIMATED instructional strategies provided equal opportunity for all students irrespective of gender to be actively involved in interactive learning situations.

Conclusion

From the foregoing discussions based on the findings of the study, PEDDA-ANIMATED and PEDDA instructional strategies improved Pre-service chemistry teachers achievement. Furthermore, there was no significant difference in the mean achievement of male and female pre-service chemistry teachers when taught with PEDDA and PEDDA-ANIMATED instructional strategies. Finally, the interaction effect of instructional strategies and gender on pre-service chemistry teachers' mean achievement score in chemistry was not statistically significant. This means that gender did not interact with the instructional strategies to affect pre-service teachers' achievement. Hence, achievement of the concept under study was due to the specific treatment that was given. The strategies are gender friendly since they gave male and female students equal opportunity which is one of the sustainable development goals.

Recommendations

Based on the findings, the following recommendations are made:

1..The National Commission for Colleges of Education (NCCE) should incorporate PEDDA-ANIMATED and PEDDA instructional strategies in the National Certificate of Education (N.C.E) minimum standard as part of the strategies for teaching especially in the science courses.

2..College of Education Teacher educators (lecturers) should use PEDDA-ANIMATED and PEDDA strategies in teaching pre-service teachers. This will assist the prospective teachers' to acquire the required professional knowledge and inquiry skills which would enable them to become competent chemistry teachers with the capacity to further encourage the spirit of inquiry in the learners and to apply the knowledge to solve day-to-day problems in the dynamic world.

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