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PRE-SERVICE TEACHERS' AWARENESS OF INNOVATIVE TOOLS IN CHEMISTRY TEACHING

Yusuf B. NUSIRAT
Kwara State College of Education (Technical) Lafiagi, Nigeria
nusiratyusuf@gmail.com

Imam T. BASHIRAT
University of Ilorin, Ilorin, Nigeria
lamidi.bt@unilorin.edu.ng

Ahmed A. TAWA
Kwara State Polytechnic Secondary School, Ilorin, Nigeria
Biolatawa68@gmail.com

Abstract: *The best way to pave way for usage of effective tools for teaching of chemistry called for awareness of the tools by the prospective users which are the pre-service teachers. This study was carried out to investigate pre-service chemistry teachers' awareness of innovative tools in teaching chemistry. One hundred and eighty-two pre-service chemistry teachers from both university and colleges of education were involved in the study. The sample size which was randomly selected consisted of 82 male and 100 female. A researcher designed questionnaire known as Pre-service Teachers Awareness of Innovative Tools in Chemistry Questionnaire tagged PTAITCQ was the instrument used to collect data for the study. Two experts in the field of Chemistry Education carried out the face and content validity of the instrument while the reliability of the instrument was determined using Cronbach alpha in which reliability coefficient of 0.75 was arrived at. The data analysis was carried out with mean and standard deviation while the four null hypotheses formulated were tested using t-test at 0.05 level of significance. Findings revealed that pre-service chemistry teachers were aware of four out of the 10 innovative tools. The respondents have positive views about the roles of innovative tools. It was also reported that gender influenced the respondents' awareness of innovative tools for teaching chemistry while pre-service institution of learning did not. It is therefore recommended that there is the need for creation of awareness of all the necessary innovative tools used in teaching of chemistry.*

Key words: *awareness; chemistry; innovative; pre-service; teachers.*

Introduction

In the 21st Century, nations' economical, educational and social structures have been greatly affected by scientific and technological development of these countries. Hence, there is need to fashion out new approaches to teach science (Tekerek & Karakaya, 2018). Science in the 21stCentury should be productive, open to innovations and able to solve problems. Citizens in this era are expected to be entrepreneurs and lifelong learners, and need to be trained in order to live in the complex environment that he finds himself (Erdogan & Ciftci, 2017). The scientific knowledge should be such that will cater for needs of human beings in order to meet up the 21st century requirements. This can be achieved when the teachers of chemistry are trained with and utilize innovative tools for learning. Innovative tools are those tools that are used to engage students in learning so as to make it effective Whitman (2018). Such tools are expected to ease teaching and learning processes for both teachers and students.

Wagner (2008) opined that educational environment in the present generation should provide avenue for the development of necessary learning skills which are otherwise known as 21st century skills. Some of these skills are as follows: critical thinking and problem-solving, collaboration across network and leading by influence, agility and adaptability, initiative and entrepreneurialism, accessing and analyzing information, effective oral and written communication, curiosity and imagination. All these skills are necessary to meet up with standard of learning in the 21st century. The best way to achieve this is by making use of innovative approaches which require use of innovative tools especially those that has to do with information communication Technology ICT. Ulah, Khan and Khan (2017) observed that majority of the innovative tools are rooted in ICT. Hence, the use of ICT for teaching and learning has been seen as internationally accepted occurrence which is used to aid conventional way of teaching so as to promote effective teaching.

In recent years, there is a lot of focus on use of innovative tools around the world. Countries that wish to have a say on the international platform and accord with knowledge of technological development should prioritize the use of innovative tools for teaching and learning. The current reform in science education requires a considerable change in how science is taught, as well as change in professional development and practices at all levels. Science can be described as acquisition of knowledge about nature phenomenon in the environment which is of different categories depending on the nature of investigation e. g. Chemistry, biology, physics etc. Omorogbe and Ewansiha (2013)

described it as organized set of knowledge which exists in form of concepts, laws, principle etc. It deals with getting update knowledge about what takes place in the surroundings. The importance of science in the development of any nation cannot be overemphasized since science is the foundation of technology, agriculture, industrial and economic advancement (Hornby, 2010).

The development of nations depends basically on the level of scientific and technological literacy possessed by the citizenry. Science and its application have become important for sustainable development in all nations' economy. Science is a discipline which comprises of many branches such as biology, physics and chemistry etc. Chemistry is a branch of science that is important in the technological development of a nation. Chemistry has aided the advancement of technology via its principle in modern discoveries (Asiyai, 2005), therefore, chemistry, as a science subject taught at secondary school level, plays an important role in scientific and technological development of a nation through its modern inventions. Chemistry is a science subject which has to do with provision of adequate knowledge about matter, which is everything surrounding us. It is a scientific knowledge required by technologists to provide human needs such as food, cloth, shelter etc. Hence, chemistry can be seen as scientific knowledge which has direct impact on human sustainability as a result acquisition of the knowledge should be of great concern to all. However, researches have revealed that the causes of dwindle in academic performance of senior school chemistry students in Nigeria include the abstract nature of chemistry (Samba & Eriba, 2012), ineffective methods of teaching, and lack of teaching aids (Ojukwu, 2016). Hence, there is the need to design innovative tools to teach chemistry in order to make the concepts real.

Innovative tools are learning tools that assist teachers in implementing effective and efficient learning. A great number of innovations emerge day to day within the educational system. Recent innovative tools include Videogames, Online Chemistry Drills, Simulation, Virtual Laboratories, Animation, Web Quest, Edmodo, Kahoot, Google classroom, ClassMarker (Whitman, 2018; Ryan, 2019). The introduction of innovative tools to teaching and learning of science would assist learners to benefit more from content of instruction. In a like manner, Udu (2018) observed that using innovation in science education results to productive teaching and learning that will improve students' performance in science subjects. The role of innovative tools in chemistry teaching cannot be overemphasized. Innovative tools have helped in transforming the abstractness of chemistry into reality, and also helped the students to become creative, problem-solvers, and equipped them with scientific process skills. Innovative tools also make science learning interesting as they provide hands-on experience which

makes students develop positive attitudes and curiosity towards science concepts, especially chemistry.

Teachers play a key role in the effectiveness of learning activities. They are the bedrock of the society, and must be well-trained and embrace technological education. It is therefore important that pre-service science teachers, who are the practitioners of reform movements in science education, are trained to use innovative tools for classroom practices (Lee, & Nason 2012; Ingec & Erdemir, 2016). In order to prepare them for task ahead in the teaching and learning enterprises there is need for them to be aware of innovations in the field of science such as innovative tools used in teaching and learning of chemistry. Pre-service teachers are those who are still undergoing training in the teaching profession courses, or individuals without a prior teaching qualification who enrolled in a pre-service teacher education program (TEP). Pre-service science teachers who are future science teachers need to be aware of, and trained on, the use of innovative tools in teaching of chemistry.

In order to reduce the abstractness in teaching and learning of chemistry concepts, there is the need to make use of innovative tools in the teaching and learning of the subject. This is because there is general belief by experts in the field of chemistry education that chemistry is a science subject that is difficult and abstract in nature Samba and Eriba (2012), in which the difficulty and abstractness have been attributed to different factors. For instance, Johnstone (2000) submitted that difficulty experienced by students can be traced to two major reasons which are nature of the subject and the approaches employed by the teachers in teaching the subject. Nature of chemistry is such that the concepts can be represented in three different ways which are macro, submicroscopic and symbolic (Johnstone, 2000).

The macro form of representation is seen as the experimental stage which can be experienced using the sense organs. The submicroscopic is the use of atoms, ions and molecules to describe what happen at the micro level of representation while the use of symbols to describe the two other levels is regarded as symbolic representation. Students do find it difficult to comprehend the use of the three levels but chemistry experts navigate easily while using the three forms of representation. In order to cater for the difficulty and abstractness experience by students in learning chemistry concepts in term of both the nature of the subject and ways of teaching it, there is the need to make use of innovational tools which will encourage student-centered learning as the best form of learning recognized by constructivists such as Vygotsky (1978).

Hence, the use of innovative tools for teaching of chemistry by chemistry teachers especially those that has to do will ICT will not only solve the difficulty experienced in learning of chemistry due to nature of

chemistry it will also go a long way in encouraging the students to study on their own otherwise known as student-centered learning. Therefore, pre-service chemistry teachers' awareness of these innovative tools is as important as chemistry concepts they need to teach in future. Several studies have been conducted as regard innovative approach in teaching and learning of science. Such studies include Oyelekan, Igbokwe and Olorundare (2017) who investigated science teachers' utilization of innovative strategies for teaching school science in Ilorin, Nigeria. The study reported that out of the 36 innovative teaching strategies the teachers majorly used two and the rest were rarely used but both experience and qualification did not influence the teachers' utilization of the strategies.

Saudale, Lerrick, Parikesit and Mariti (2019) who carried out study on chemistry teachers' awareness, understanding and confidence toward computational tools for molecular visualization, the study showed that the teachers were aware of some of the computational tools but they were not aware of some. Another study was carried out by Samuel (2020) who investigated chemistry teachers' awareness and application of innovative instructional strategy, findings from the study revealed that the chemistry teachers were aware of innovative teaching strategies and they also apply them in their daily teaching.

However, there are limited studies on pre-service teachers' awareness of innovative tools in teaching of chemistry concepts. Thus, the present study investigated the pre-service teachers' awareness of innovative tools in chemistry teaching, which is an important aspect of using innovative approach in the teaching and learning of chemistry. The study also put into consideration the gender and institution of pre-service training of the chemistry teachers. This is because both male and female undergo pre-service training as chemistry teachers likewise the pre-service training mostly takes place in colleges of education and universities in Nigeria, since the institution of training is quite different the pre-service chemistry teachers may also differ in their awareness of the innovative tools for teaching chemistry, hence, the need for investigation of the two variables in the study.

Research Questions

1. Are pre-service chemistry teachers aware of innovative tools in chemistry teaching?
2. What are the views of pre-service chemistry teachers on roles of innovative tools in chemistry teaching?
3. Does gender influence the pre-service teachers' awareness of innovative tools in
   teaching chemistry
4. Does institution influence the pre-service teachers' awareness of innovative tools

5. Does the views of respondents on roles of innovative tools in teaching chemistry
Influenced by gender of the pre-service teachers
6. does the views of respondents on roles of innovative tools in teaching chemistry influenced by gender of the pre-service teachers

Research Hypotheses

The following research hypotheses were tested in the study:

1. There is no significant difference in the awareness of innovative tools in teaching chemistry by pre-service teachers based on gender
2. there is no significant difference in the awareness of innovative tools in teaching chemistry based on the institution of pre-service teachers
3. there is no significant difference in the roles of innovative tools in teaching chemistry based on the gender of pre-service teachers
4. there is no significant difference on pre-service teachers' views of the roles of innovative tools in teaching chemistry based on the institution attended

Materials and Methods

This study is a descriptive researcher of the survey type. Since descriptive research majorly describe how things are and this is what is expected of the study, this is thought to be appropriate. The study involved two colleges of education and two universities students in Kwara State, Nigeria. Total of 200 students were randomly selected from the four institutions but only 182 of the respondents appropriately answered the questionnaire items. The sample consisted of 106 and 76 from the Universities and Colleges of Education respectively, while 82 were male and 100 were female. The instrument used to collect data from the respondents was a researcher designed questionnaire known as Pre-service Teachers Awareness of Innovative Tools in Chemistry Questionnaire tagged PTAITCQ. The questionnaire comprises of three sections. Section A has to do with demographic data of the respondents that is, their gender and institution of pre-service training. Section B is a three point likert scale of Not Aware, Moderately Aware and Fully Aware, asking the students to rate their level of awareness of 10 innovative tools in chemistry presented to them. Section C is a four-point likert scale of Strongly Disagree, Disagree, Agree and Strongly Agree.

Two experts in the field of Chemistry Education carried out the face and content validity of the instrument while the reliability of the instrument was determined by administering the instrument to 20 students that did not take part in the study. The response of the students to the questionnaire items was analysed using Cronbach alpha in which reliability coefficient of 0.75 was arrived at for section B and C of the instrument which shows that the instrument is reliable.

The data analysis was carried out using mean and standard deviation while the four null hypotheses formulated were tested using t-test at 0.05 level of significance. This is thought to be appropriate since the four hypotheses consist of independent variables which occur at two levels that is gender with male and female levels and institution of pre-service training which consists Universities and Colleges of Education, while the dependent variables are the responses of the pre-service teachers to the questionnaire items.

Result

Research Question 1: Are pre-service chemistry teachers aware of innovative tools in teaching chemistry

The pre-service chemistry teachers were aware of only four innovative tools out of the ten presented to them as shown in Table 1. These four are online chemistry drill, simulations, animations and virtual laboratories. The awareness of innovative tools by the pre-service chemistry teachers were determined by comparing the mean value of their responses to each of the tool to the average mean of their response which is 2.0. Those means that are less than 2.0 means the students are Not Aware (NA) of the tools and those mean values which are equal to 2.0 or greater than means the students are Aware (A) of the tool as an innovational one in teaching of chemistry.

Table 1

Descriptive Analysis of Pre-service Teachers Awareness of Innovative Tools in Teaching Chemistry

S/N	Items	Mean	Std. Deviation	Decision
1	Google Classroom	1.52	.749	NA
2	Chem bingo super value game	1.37	.597	NA
3	Online chemistry drill	2.47	.592	A
4	Simulations	2.26	.754	A
5	The chemical Touch	1.75	.802	NA
6	Animations	2.29	.785	A
7	WebQuest	1.88	.748	NA
8	Project Noah	1.55	.776	NA
9	Virtual Laboratories	2.14	.815	A
10	Mosa Mack Science	1.30	.558	NA

Research Question 2: what are the views of pre-service chemistry teachers on the roles of innovative tools in teaching chemistry?

The chemistry teachers have positive views about role of innovative tools in teaching chemistry presented to them. They agreed with all the questionnaire items. This is because the mean of each of the item is greater than the average mean of their response which is 2.5. Any mean value less than 2.5 means disagreement and the mean value equals to or

greater than 2.5 is regarded as agreement with the role. Since, all the roles have mean values greater than 2.5 this means the respondents agreed with all the roles of innovative tools

Table 2

Descriptive Analysis of Pre-service Teachers Roles of Innovative Tools in Teaching Chemistry

S/N	Items	Mean	Std. Deviation	Decision
1.	Effective teaching and learning of chemistry concepts is enhanced when innovative tools are utilized by teachers	3.32	.968	A
2.	Students interest and motivation towards chemistry can be improved when teacher utilizes innovative tools in teaching	3.40	.846	A
3.	Using innovative tools to teach chemistry reduces abstractness of some chemistry concepts	2.98	.817	A
4.	The use of innovative tools in teaching and learning of chemistry promote students critical thinking ability	3.24	.756	A
5.	Using innovative tools in learning chemistry equips students with skills to cope with 21st century requirements	3.15	.724	A
6.	Creative problem solving skills of students can be enhanced through the use of innovative tools in teaching in teaching chemistry	3.13	.708	A
7.	Hands on and minds on skills are improved or developed when innovative tools are adopted for teaching chemistry	2.79	.869	A
8.	Self-confidence and technologically inclined students are produced when teachers use innovative tools to teach chemistry lessons	3.05	.852	A
9.	Collaboration is enhanced when innovative tools are adopted in teaching and learning chemistry	3.05	.819	A
10.	Teaching chemistry with innovation tools increases students motivation	3.38	.857	A
11	Students that learn chemistry using innovative tools become inventors and problem solvers	3.21	.869	A

Hypothesis 1: there is no significant difference in the awareness of

innovative tools in teaching chemistry by pre-service teachers based on gender.

Table 3 shows that there is significant difference in the awareness of innovative tools by respondents based on their gender, Male (M= 19.31, SD=2.99) and Female (M=17.91, SD=3.04), t(180) =3.10, p=0.00. Since the p-value is greater than 0.05 this means that there is significant difference in the awareness of innovative tools used in teaching chemistry which is in favour of the male students. Therefore, the null hypothesis formulated is rejected.

Table 3

t-test analysis of Respondents' Awareness of Innovative tools based on Gender

Gender	N	Mean	Std. Dev.	df	t	P	Decision
Male	82	19.31	2.99	180	3.10	.00	Significant
Female	100	17.91	3.04				

Hypothesis 2: there is no significant difference in the awareness of innovative tools in teaching chemistry based on the institution of pre-service teachers.

There is no significant difference in the awareness of innovative tools by respondents based on their institution, College (M= 18.80, SD=2.29) and University (M=18.35, SD=3.55), t(180) =0.98, p=0.33. Since the p-value is less than 0.05 this means that there is no significant difference in the awareness of innovative tools used in teaching chemistry based on the institution of the respondents. Hence, the null hypothesis formulated is not rejected

Table 4

t-test analysis of Respondents' Awareness of Innovative tools based on Institution attended.

Institution	N	Mean	Std. Dev.	df	t	P	Decision
College	76	18.80	2.29	180	0.98	0.33	Not Significant
University	106	18.35	3.55				

Table 5 shows that there is no significant difference in the respondents views of roles of innovative tools based on their gender, Male (M= 35.50, SD=5.80) and Female (M=34.06, SD=6.35), t(180) =1.58, p=0.12. Since the p-value is less than 0.05 this means that there is no significant difference in the views of respondents on the roles of innovative tools used in teaching chemistry based on gender. Therefore, the null hypothesis formulated is not rejected.

Hypothesis 3: there is no significant difference in the roles of innovative

tools in teaching chemistry based on the gender of pre-service teachers

Table 5

t-test analysis of Respondents' Views on Roles Innovative tools based on Gender

Gender	N	Mean	Std. Dev.	df	t	P	Decision
Male	82	35.50	5.80	180	1.58	0.12	Not Significant
Female	100	34.06	6.35				

Hypothesis 4: there is no significant difference on pre-service teachers' views of the roles of innovative tools in teaching chemistry based on the institution attended.

Table 6 reveals that there is significant difference in the respondents views of roles of innovative tools based on their institution, College (M= 33.06, SD=7.24) and University (M=35.89, SD=4.90), t(180) =-3.12, p=0.00. Since the p-value is greater than 0.05 this means that there is significant difference in the views of respondents on the roles of innovative tools used in teaching chemistry which is in favour pre-service chemistry teachers in the Universities. Therefore, the null hypothesis formulated is rejected.

Table 6

t-test analysis of Respondents' Views of Roles Innovative tools based on Institution

Institution	N	Mean	Std. Dev.	df	t	p	Decision
College	76	33.06	7.24	180	-3.14	.00	Significant
University	106	35.89	4.90				

Discussion

Based on the data analysis and result, finding from the study revealed that the pre-service chemistry teachers are not aware of all the 10 innovative tools presented to them. This shows that the pre-service chemistry teachers have poor knowledge of innovative tools in teaching chemistry which is not good enough for effective teaching and learning of the subject. The finding is in agreement with that of Oyelekan, Igbokwe and Olorundare (2017) whose finding revealed that science teachers were only familiar with two out of the 36 innovative strategies presented to them when investigating science teachers' utilization of innovative strategies for teaching school science. The finding is also in line with that of Saudale, Lerrick, Parikesit and Mariti (2019) who reported that chemistry teachers were aware of some of computational tools for molecular visualization but they were not aware of some when

the chemistry teachers' awareness, understanding and confidence toward computational tools for molecular visualization was investigated. The study disagreed with that of Samuel (2020) who investigated chemistry teachers' awareness and application of innovative instructional strategy, findings from the study revealed that the chemistry teachers were aware of innovative teaching strategies and they also apply them in their daily teaching.

Another finding from the study revealed that there was significant difference in the awareness of innovative tools in teaching chemistry by the pre-service teachers based on their gender which is in favour of male pre-service teachers. The finding disagreed with that of Samuel (2020) who found that gender did not influence awareness and application of instructional strategies. This may be attributed to the fact that male students are more conversant with the use of computer than their female counterparts which is the basis of all the innovative tools. But finding from the study revealed that there was no significant difference in the views of the respondents regarding the roles of innovative tools in teaching chemistry based on their gender.

Another finding from the study revealed that there was no significant difference in the awareness of the pre-service teachers based on their institution of pre-service training. This study also agreed with that of Oyelekan et al. (2017) who also reported that no disparity in the utilization of innovative strategies by chemistry teachers based on their qualifications. This may be because they are both receiving training as chemistry teachers and thus, they are both exposed to the same innovative tools. But there was significant difference in their views of roles of innovative tools in teaching chemistry which was in favour of the respondents in the universities. This may be due to the fact that the pre-service chemistry teachers from university are at higher place of learning and are more exposed than their counterparts in the colleges of education, and possess broadens knowledge about innovative tools used in teaching chemistry.

Conclusion

As a result of the discussion so far, it can be concluded from the study that the pre-service chemistry teachers were not aware of innovative tools in teaching chemistry. But they were of positive views about roles of innovative tools in teaching chemistry. It can also be concluded that gender influenced the awareness of innovative tools in teaching chemistry by pre-service chemistry teachers which is in favour of male meaning that male respondents were aware of the innovative tools than their female counterparts. However, gender did not influence the views of the respondents regarding the roles of innovative tools, that is both male and female respondents viewed the roles of innovative tools the

same way. Finally, it is concluded that institution attended by pre-service teachers did not influence their awareness of innovative tools. That means respondents from both universities and colleges of education not aware of the innovative tools for teaching chemistry. But their views on the roles of innovative tools were influenced by their institutions in favour of the respondents from university, that is, pre-service teachers from university have positive views of roles of innovative tools in teaching chemistry.

Based on the findings from this study, the following recommendations are thought to be appropriate:

1. There is the need for creation of awareness of all the necessary innovative tools used in teaching and learning of chemistry for pre-service teachers in order to enhance their future teaching of chemistry.
2. Pre-service chemistry teachers should be given the opportunity to put into use the innovative tools in chemistry since they possess positive view about their roles.
3. The female pre-service chemistry teachers should be encouraged to emulate their male counterparts as regard the awareness of innovative tools in chemistry.
4. Institution of pre-service training should not be priority when there is the need to create awareness for the pre-service teachers.
5. Both male and female pre-service chemistry teachers should be given equal opportunity to put the innovative tools to use.
6. The pre-service chemistry teachers' trainers in the Colleges of Education should emulate their counterparts in the Universities by letting their students have adequate knowledge of roles of innovative tools in teaching chemistry.

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