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INFLUENCE OF PROBLEM-BASED LEARNING IN CHEMISTRY ON ACADEMIC ACHIEVEMENT OF HIGH SCHOOL STUDENTS IN OSUN STATE, NIGERIA

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ABSTRACT: *The aim of this study was to investigate the Influence of Problem-Based learning in Chemistry education on academic achievement of school students. To achieve this purpose, three research questions were generated. The study adopted a descriptive survey design. Purposive sampling technique was used to select 300 senior secondary two (S.S.2) science students and data was collected by administering a questionnaire on the influence of problem-based learning in Chemistry education on academic achievement of school students. Data generated was analyzed using descriptive statistics. The findings of this study revealed various activities engaged in by students during PBL lessons. Based on the findings, a number of recommendations were made.*

KEYWORDS: Problem-Based Learning, Academic achievement, Higher-order thinking, Pedagogical Approach.

INTRODUCTION

Problem-Based Learning (PBL) is an alternative approach to teaching which is not prescriptive in nature. Krajcik (2008) cited in Khairiree and Kurusatian (2009) points out that problem-based learning makes use of problem as a focus for student investigation and inquiry. Problem-based learning covers a broad family of schemes that include problem solving, project-based teaching, inquiry, case-based instruction and grounded instruction. Students' active involvement in trying to solve some problems or answer some questions is central to all the different strategies listed.

PBL in the view of Torp and Sage (2002) is a strategy that is student-centered, in this methodology students research, explain, and cooperate in order to find meaningful solutions to real life problems. The PBL cycle is made of several steps: PBL is a strategy - A real like problem is presented to students; Students discuss the problem and formulate hypothesis; Students first retrieve prior knowledge and experience relative to the problem next they identify knowledge deficiencies and start making their research; Following, students apply their knowledge to check the validity of their hypotheses in light of what they have learned; At the end of each problem, students make their own reflection on the knowledge acquired (Akinoglu & Tandogan, 2007; Neild, 2004; Wang, Thompson, & Shuler, 1998). Hmelo-Silver (2004) stated that the most important factor of PBL is the problem itself.

Several features are considered essential to develop a good PBL problem: It needs to be complex, open-ended, and ill-structured. (Bridges & Hallinger, 2004; Torp & Sage, 2002). An ill structured problem is problem that is incompletely defined and not easily resolved with any degree of certainty.

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Furthermore, it has multiple solutions with none clearly superior. (Duch, 1996; Torp & Sage, 2002). It must be realistic and resonate with the students' experiences and it should support intrinsic motivation. (Torp & Sage, 2002); It must lead students to generate hypotheses and defend them to others in their group. Students publicly articulate their current state of understanding, enhancing knowledge construction and setting the stage for future learning. (Duch, 1996); It must afford feedback that allows students to evaluate the effectiveness of their knowledge, reasoning, and learning strategies. And it should challenge students to develop higher order thinking skills (Hmelo-Silver, 2004).

PBL requires changes in the teacher's lesson planning, instruction delivery, classroom setting, and information assessment (Torp & Sage, 1998). In PBL, teaching is instructing and , it is grounded on the fact that students are self independent learners who can construct their own knowledge if necessary direction is provided by their instructor. The teacher's role in PBL is critical; a good facilitator will guide his/her students through the different phases of the PBL process. The teacher insures the involvement of all the students in the learning process where they exchange information with their peers by projecting their own thoughts and commenting on each other's ideas (Torp & Sage, 2002).

The teacher in PBL encourages students to use logical thinking by breaking down the given problem, thereby developing higher order thinking skills. The teacher also urges students to retrieve prior knowledge and discuss it with their group members by asking probing questions. PBL tutor models problem solving skills needed to assess one's reasoning (Akinoglu & Tandogan, 2007), unlike conventional strategies where the teacher is the leading figure. Chin and Chia (2004) indicated that in PBL, students assume a different role than that in the conventional teacher-centered process in which information is presented to them by the teacher. In PBL, students must play a more active role, that of a highly motivated learner, arriving with significant intellectual capacity and background information. PBL presents the students with the chance of appraising their own understanding, and detecting their own learning needs.

With PBL students become more experienced at accumulating, organizing, and storing information in a useable form for future use, as well as, confronting and resolving complex, realistic problems. Active participation within the small group requires good interpersonal skills, which include: listening, negotiating, compromising, educating peers, giving and receiving criticism, and motivating others. The teacher is a mentor who guides his students during their group work and helps them to find the knowledge needed to find the problem solution (Bayard, 1994; Stepien & Gallagher, 1993; Woods, 2003).

The value and significance of science in modern day world can definitely not be over-emphasized, as no nation can attain a sustainable development in its economy without the involvement of science and technology. The study of science actually leads to the technological development of any nation. The national policy on education (FRN, 2009) was formulated in recognition of the need for economical and technological advancement of Nigeria which necessitates that appropriate measures be put in place in order to achieve the country's set goals. In the national policy on education, effort is made to lay more emphasis on the teaching of science and providing a strong foundation of science from the primary to the tertiary level (FRN, 2009). Chemistry is a branch of physical science which links physical and biological science together.

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Jegede (2007) stated that Chemistry occupies a central position among the science subjects and that it is a core subject for the medical sciences, textile technology, agricultural science, pharmacy, printing technology and chemical engineering to mention just a few. Chemistry can be conveniently referred to as the mother of science due to its inevitability in the understanding of science. Chemistry is now a compulsory science subject at the secondary school level (FRN 2009), due to its immense contribution to nation building and quality of life. However, these advantages of chemistry, which are very essential for human development, are eluding the present day learners, because of the difficulties they experience in learning its content.

The demanding nature of contemporary world and the dynamic technological changes we experience perpetually demand that individuals equip themselves with the skills of explicating, examining, conceiving, synthesizing, researching, and communicating so as to cope with these changes. Our society will need individuals who will be able to provide lucid solutions to complex problems, students should be properly trained therefore in order to possess rhe necessary skills required to take decisions in real life situations. In this regard, Gallagher, Stepien, Sher, and Workman (2001) have stated that most of the questions that teachers ask in conventional teaching are direct questions which do not stimulate higher-order thinking. Educational reform must therefore take place in schools, new strategies that teach students how to solve problems effectively are therefore needed. This necessitated this study.

LITERATURE / THEORETICAL UNDERPINNING

PBL is based on constructivist assumptions about learning. According to Jonassen (1991), constructivism can be described in terms of five tenets about knowledge, meaning making (reality) and learning. Attention in chemical education was for a very long time focused on how knowledge is constructed in the mind of the learner. Learners are viewed as having a pre-existing cognitive structure, and the learning process involves addition and change to this structure.

In another but related perspective, Hung (2002) posits that PBL has its foundation in theories of situated learning. Brown, Collin and Duguid (1989) proposed situated learning and stated that meaningful learning takes place when it's rooted in a physical and social context as similar as possible to that in which the learning would be applied. An idea which is in contrast to the way most formal learning took place at that time that is devoid of authentic context and far removed from any aspect of actually using what is to be learned. Situated cognition proposed that the contextual setting of knowledge is essential and that meaning making is embedded in the relationship that we construct between ourselves as learners and our surrounding situations and interactions (Hung, 2002).

The meaningful context of learning is to a large extent provided by the ill structured problem the learners are solving, in a problem-based learning. This learning situation bears a lot of similarities with what we do in our everyday and professional lives, where we are continuously solving ill-structured problems. Since meaning is derived from the contexts in which learners work, knowledge that is situated in specific contexts is more meaningful, better retained, more integrated and easily transferrable, than ideas that are presented as theories and abstracted from contexts, which have little or no meaning to learners.

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Knowledge is better represented and better useful when constructed for solving problems, thereby resulting in task-related procedural knowledge.

The theoretical underpinning for this study can therefore be entrenched in both situated cognition and constructivist beliefs about learning. Both proposed that knowledge does not take place until a learner's mind has interacted with the world it experiences through its interactions.

PBL therefore fosters these types of interactions.

Purpose of the Study

This study aimed at investigating the extent to which the influence of Problem-based learning in a Chemistry unit will have on students' academic achievement. Specifically the purposes are to:

1. Examine the activities that students experience during PBL lessons.
2. Investigate students' general perceptions of PBL lessons.
3. Ascertain specific problems faced by students when exposed to the PBL approach.

Research Questions

In achieving the purpose of this research, this study intends to answer the following three researches Questions:

1. What are the activities that students experience during PBL lessons?
2. What are students' general perceptions of the PBL lessons?
3. Are there specific problems faced by students when exposed to the PBL approach?

METHODOLOGY

The research design for this study was descriptive survey type. The purpose of these include: To collect data describing existing phenomena, to identify problems or justify present conditions and or practices, to evaluate and determine what others are doing with similar problems and benefit from their experiences and making future plans and decision. The target population for this study consists of Ten (10) high schools in Oriade local Government Area of Osun State in Nigeria.

A random sampling method was used to select 30 Students from five (5) private owned and five (5) public high schools in Oriade local Government area of Osun state in Nigeria. In all, 300 student comprising of high School two students were sampled. High school two students were sampled because they are believed to have been facing Chemistry problems since they were in high school 1, so they should be familiar with Chemistry problems and be able to say specifically what their perception to Chemistry problems was.

The instrument used was a structured questionnaire termed Problem-Based Learning in Chemistry Education Students Academic Achievement in Questionnaire. (PBLCEQ) for

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students. The questionnaire was in two sections. (I.e. section A contains a Bio-data of the respondent, section B contains items relating to each of the research questions earlier formulated for the research).

The instrument of the study was subjected to vetting with regard to validity. The face and content validity were ensured by writing items in clear expression, devoid of ambiguity as per-face validity. For content validity, appropriate enter ion reference was carefully done, in which the content of the questions was made to conform to what the objective of the study are. Also the instrument was critically examined by some selected experts in the faculty of education of two universities in southwest Nigeria, to ensure that the test items measure what they are supposed to measure. This allows necessary modification before the final draft and the subsequent administration of the research instruments.

Test-Retest method was used to determine the reliability of the instruments. The questionnaire was trial tested. The trial test was done by administering it thrice on the same set of students who were not part of the participants for the study within an interval of two weeks. The responses from the two sets of questionnaires were analyzed and comparison was made from both scores to show whether the instrument was reliable to perform the purpose for which they were design or not.

The researcher personally visited the Ten (10) high schools and administered questionnaires to students. The questionnaire was administered personally to the respondents in the selected schools and responses were gathered for analysis. Before starting the study, the school principal, science coordinator, and students were informed about all aspects of the study. An oral informed consent was received from students, while a written consent was provided by the school principal and the science coordinator. A descriptive and influential statistics were used to show the distribution of students' answers to each of the questions presented in the questionnaire.

RESULTS AND FINDINGS

Research Questions

1. What are the activities that students experience during PBL lessons?

The items that measure the activities experienced during PBL lessons were subjected to descriptive statistics and the result is as shown in Table 1.

Table 1: Activities Experienced During PBL Lessons

Items	SA	A	U	D	SD	RII	P
Group work	63	153	27	21	28	0.52	9th
Seeking solutions	77	142	26	29	26	0.54	7th
Being responsible to learning	81	137	26	30	26	0.54	7th
Valuing different point of views	82	148	23	25	23	0.56	5th
Working with problems	78	131	30	34	27	0.53	8th
Other people's expressions	93	140	20	19	28	0.57	4th
Teacher's feed back	98	137	25	22	18	0.58	3rd
Application of abstract concepts to real situation	72	143	31	32	22	0.54	7th

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Cooperative working	109	140	19	15	17	0.60	2nd
Reflection on several alternatives	90	126	29	36	12	0.55	6th
Examination and evaluation of many sources of information	97	140	20	25	18	0.58	3rd
Additional reading	123	131	16	15	14	0.62	1st

Table 1 shows the activities experienced by students during PBL lessons and the activities were: additional reading first, followed by cooperative working, examination and evaluation of many sources of information, other people's expressions, valuing different point of views, reflection on several alternatives, application of abstract concepts to real situation, being responsible to learning, seeking solutions, working with problems, while group work took the last position. These were the activities experienced by students during PBL lessons.

2. What are students' general perception of PBL lessons?

The items that measure students' general perception of PBL lessons were subjected to descriptive statistics and the result is as indicated in Table 2:

Table 2: Students' General Perception of PBL Lessons

Items	SA	A	U	D	SD	RII	P
I feel comfortable working and participating in small groups.	81	175	8	23	13	0.59	1st
I feel the instruction of my Chemistry lessons is similar to other classes that I have taken elsewhere.	66	155	21	36	22	0.54	4th
I am confident in my ability to identify and search for information that is needed to solve a problem in Chemistry.	95	144	17	21	23	0.58	2nd
I feel the teacher is primarily responsible for my Chemistry learning.	80	153	21	22	24	0.56	3rd
There are multiple opportunities to work in groups.	102	135	17	20	26	0.58	2nd

Table 2 shows students' general perception of PBL lessons which were that: firstly, the students feel comfortable working and participating in small groups, followed by confidence in the ability to identify and search for information that is needed to solve a problem in Chemistry, availability of multiple opportunities to work in groups, feeling that the teacher is primarily responsible for their Chemistry learning, and feeling that the instruction of their Chemistry lessons is similar to other classes that they have taken elsewhere. These were the students' general perception of PBL lessons.

3. Are there specific problems faced by students when exposed to the PBL approach? \

The items that measure specific problems faced by students when exposed to PBL lessons wer subjected to descriptive statistics and the result is as shown in Table 3:

Table 3: Problems Faced by Students when Exposed to PBL Approach

Items	SA	A	U	D	SD	RII	P
I am curious about how and why things work in solving Chemistry problems.	13	23	8	175	81	0.59	1st

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Chemistry solutions are hard to find due to non-provision of time, space, and material needed.	22	36	21	66	155	0.54	2nd

Table 3 shows students' general perception of PBL lessons which were that: students were not curious about how and why things work in solving Chemistry problems and chemistry solutions are not hard to find because they were provided with enough time, space and materials needed.

DISCUSSION

Research Question 1 stated that: What are the activities that students experience during PBL lessons?, result in Table 1 revealed the analysis of research question 1 which shows the activities experienced by students during PBL lessons and the activities were: additional reading first, followed by cooperative working, examination and evaluation of many sources of information, other people's expressions, valuing different point of views, reflection on several alternative,s application of abstract concepts to real situation, being responsible to learning, seeking solutions, working with problems and lastly, group work.

This finding agreed with the findings of Woods (2003) that described PBL as students' motivator problem solving skills like cooperating, communicating, and researching skills. PBL students have greater ability than conventional students to retain the knowledge they gain since they are actively engaged in the learning process

Research Question 2 stated that: What are the students' general perception of PBL lessons?, the result in Table 2 revealed the analysis of research question 2, which shows the students' general perception of PBL lesson which were that: firstly, the students feel comfortable working and participating in small groups followed by confidence in the ability to identify and search for information that is needed to solve a problem in Chemistry, availability of multiple opportunities to work in groups, feeling that the teacher is primarily responsible for their Chemistry learning, and feeling that the instruction of their Chemistry lessons is similar to other classes that they have taken elsewhere. These were the students' general perception of PBL lessons.

Research question 3 stated that: Are there specific problems faced by students when exposed to the PBL approach? Table 3 showed that: firstly, students are curious about how and why things work in solving Chemistry problems, and secondly, that Chemistry solutions are hard to find due to non-provision of time, space, and material needed. The present findings shows inconsistence with the findings of Bayard (1994) which shows that Students who are used to the traditional lecturing are likely to be uncomfortable when using the PBL approach for the first time.

CONCLUSIONS

This research in which PBL approach was compared to the conventional learning had revealed that PBL approach was more effective in terms of students' achievement towards Chemistry. This implies that using PBL, students' academic achievement was enhanced and their perception about chemistry learning was improved. PBL teachers help their students to acquire skills they need to use in their daily life like cooperation, analysis, communication

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research, synthesis and problem solving skills. Thus, educators are urged to consider the PBL approach as one of their teaching strategies. But students who are used to the traditional lecturing are likely to be uncomfortable when using the PBL approach for the first time.

High schools in Osun state as well as other states in Nigeria should therefore undergo a reform related to the teaching strategies used. Most science teaching is based on lecturing and simple demonstration. Our teaching strategies must be evaluated and new educational strategies that are student centered must be adopted. PBL should be considered an efficient teaching approach to be used.

RECOMMENDATIONS

Based on the conclusion of this study, recommendations are hereby made:

1. Chemistry teachers should adopt the use of problem-based learning technique at all levels of learning.
2. Classroom and chemistry laboratory should be arranged in such a way to give room for effective interaction among students.
3. PBL strategy should be adopted in schools to allow students interactions and encourage higher order thinking level.
4. Conditions for learning should provide students with time, space and resources needed for successful chemistry learning.
5. Teachers should interact with student to focus and support their inquiries, recognize individual differences and provide opportunities for all pupils to learn.

Future Research

Future research can be carried out within or outside the particular geographical environment in which this study was carried out, on the application and use of problem-based learning to other subject areas like Biology, Physics, and Mathematics

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