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RELATIVE EFFECTIVENESS OF CASE-BASED AND COLLABORATIVE LEARNING STRATEGIES ON STUDENTS' ACHIEVEMENT AND RETENTION IN NIGERIA SENIOR SECONDARY SCHOOL PHYSICS

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Abstract:
This study investigated the relative effectiveness of case-based and collaborative learning strategies on students' achievement and retention in senior secondary school physics. The study adopted pretest, posttest control group quasi experimental design. Simple random sampling technique was used to select three schools used for the study. The sample used for the study was eighty five (85) senior secondary two (SS 2) physics students randomly selected from the three schools in Ileoluji/Okeigbo Local Government Area of Ondo State, Nigeria. The study made use of Physics Achievement Test (PAT) with internal consistency of 0.84 using Kuder Richardson Formular 21. The data collected were analysed using Analysis of Covariance and Scheffe post hoc analysis was used to obtain the direction of significance. From the findings, it was observed that, learning strategies had significant main effect on students' achievement ($F_{(2,82)}$= 134.97, p = 0.000) and retention ($F_{(2,82)}$= 20.67, p = .000) in the concept of optics in physics. The results of the Scheffe post hoc analysis indicated that, case-based learning strategy was the most effective in facilitating students' achievement and retention in the concept of optics. This was followed by collaborative learning strategy while conventional learning strategy was found to be the least facilitative. Conclusion from the findings led to the recommendation that, teachers should be encouraged to adopt the use of case-based and collaborative learning strategy in teaching the concept of optics in physics in order for the students to develop problem solving skills, construction of knowledge and student-centred activities.

Keywords: case-based learning, collaborative learning, achievement, retention

1. Introduction

In order to further the development of science and technology in Nigeria, the national objectives of physics education at the secondary school level as stated in the National Policy on Education (FRN, 2013) sees to expose the students to:

- basic physics concepts;
- creativity and development of process skills and correct attitudes;
- individual experimentation, questioning and problem-solving using simple inexpensive equipment;
- the role and significance of physics in the study of other disciplines;
- the relevance of physics to the society; and
- co-curricular activities designed to inculcate a deeper appreciation of science and technology and their role in the development of human society.

Following from above, secondary school physics curriculum in Nigeria should stress unifying theories, principles and laws rather than acquaintance with a mass of facts. The foundation for better performance in physics takes its root from the first year of the senior secondary school (Akinbobola, 2006). The physics curriculum at this level emphasizes that, students must be well developed at the lowest level of cognitive domain, that is, knowledge before moving into the other two levels (understanding and thinking) if physics is to be well understood by them at their early introduction of the subject (Adeoye, 2000). The lack of proper attention to this aspect of the physics curriculum by the respective physics teachers has led to students' perception of physics as difficult subject (Akinbobola & Afolabi, 2009). This has affected students' attitude (Akinbobola, 2009) and has subsequently led to declining in enrolment and poor performance in physics (Akinbobola, 2010). It is therefore expected that physics teachers should be intellectually and professionally competent to meet the demands of today's world of scientific and technological growth and development. To encourage this trend, several authorities advocated through research endeavour, diverse innovative teaching-learning strategies and methods about how students should be motivated to learn in order to attain the goals of instructional objectives (Akinbobola, 2015). Such innovative learning strategies that could be manipulated include case-based and collaborative learning strategies.

Case-based learning (CBL) strategy is a pedagogical learning strategy that uses case studies as active learning tools (Rybarczck, Baines, McVey, Thompson & Wilkins, 2007). A case study is composed of an engaging and/or controversial issue, usually a dilemma that requires a basic understanding of scientific themes or principles. Case-based learning strategy is a type of problem based learning that has the capacity of promoting active learning and is favoured by constructivist theory. Constructivist sees acquisition of knowledge as being constructed by individuals through their own experience and this approach to learning emphasizes the use of authentic, challenging problems where students make meaning through active participation (Afolabi & Akinbobola, 2007).

Case-based reasoning has much in common with constructivism; both assume that a learner builds his knowledge from his experience. Both see learning as active and also, the learner plays an intentional role in deciding what to learn and in going about the activities of learning. Case-based reasoning reasoning has so much in common with constructionism; the approaches value learning from concrete experiences and the interpretations of the individual. However, case-based reasoning goes further than both constructionism and constructivism; it defines a model of cognition (including knowledge and processes structures) that can be turned to for predictions and advice and that can be simulated on a computer as a test of ideas. Like constructionism and constructivism, case-based reasoning has lessons for the designer of technological learning aids and the teacher.

Case-based reasoning makes suggestions about how to motivate and enhance students' experiences so that they can draw productive lessons from their experiences and makes suggestion about how to encourage transfer of knowledge so that lessons learned might be applied in more than one situation. It suggests help learners might need so that they can turn their experiences into easily reusable and accessible cases in their memories (Guzdial, 1991; Kolodner, 1993; Shabo, Nagel, Guzdial & Kolodner, 1997).

The sequential phases of case-based learning strategy include:

- Recognize potential issues
- Brainstorm for connection
- Obtain additional references and resources
- Design and conduct scientific investigations
- Produce materials that support understanding of conclusions
- Possess all the types of learning (knowledge and skills) you want students to achieve (Stanley & Waterman, 2000).

According to Kolodner (1993), case-based learning occurs when the students is an active agent in the process. The type of deep learning is critical in disciplines where students are to apply their knowledge and skills upon graduation. Practice with "real life" scenarios can provide them with the confidence, analytical and decision-making skills that they will need to become effective practitioners. Case study is an effective strategy to ignite inquiry in students. It is also a means of participatory and dialogical teaching and learning by group discussion of actual events (Kolodner, 1993).

For successful implementation of case-based learning strategy:

- Teachers should be ready to assume a new role in the classroom
- Adequate school resources and facilities are needed to back up case-based learning.
- Teachers should be acquainted with certain skills which include providing timely assistance to students, and managing the structure of the activities in the most effective manner (Guzdial, 1991).

Case-based learning strategy suggests ways of making learning from hands-on activities more effective by:

- making sure students have the opportunity to iteratively apply what they are learning, getting real feedback about what they have done so far, being helped to explain what happened if it was not what was expected, and having an opportunity to try again and again until they are successful and come to a full understanding of what they are learning;
- making sure to include in the classroom all kinds of discussions and activities that ask students to reflect on their experiences, extract what they are doing and learning and articulate it for themselves or others; and
- making sure students anticipate the kinds of future situations in which they will be able to apply what they are learning (Kolodner, 1993).

According to Kolodner (1993), case-based learning strategy suggests:

- Resources that might be useful during learning; these include well-indexed libraries of expert cases and well-indexed libraries that hold the ideas and lessons learned by their peers.
- Activities that can enhance learning in any setting; these include writing cases to share with others, reading the cases of expert and preparing them for other students to learn from.
- Ways of managing a student-centered problem-based, or design-based classroom so that students help each other move forward at about the same pace; these include gallery walks for sharing ideas keeps everyone at about the same pace and also, achieves of on-line cases allow those who can move forward at a foster pace to gain from the experience of those who came before.
- Ways of creating useful case libraries without an undue amount of up-front work by the teacher; these include seed a case library with several cases that model what is expected, and then have students each year and add to that case library for students in the years to come.

Case-based learning is enhanced in many institutions because, it teaches relevant facts, principles and concepts within the context of authentic or real world situation. Context is thought to be more motivational to students and it provides a concrete framework from which difficult concepts can be more easily understood. Also, case-based learning reduces the potential for "inert" knowledge. Inert knowledge is learned concept that is impossible; it was learned in unorganized patterns, typically out of all context or retention to reality (Kolodner, Crismond, Gray, Holbrook & Puntambekar, 1998).

Case-based learning becomes cae-based reasoning when more than one case is provided. Case-based reasoning involves reasoning about multiple cases and how prior solutions can be adapted to new problems or how prior cases are related to new cases (Zimring, Do, Domeshek & Kolodner, 1995). Case-based reasoning explicitly integrates learning memory, and reasoning. A reasoner is a person that has goals. It seeks to navigate its world in such a way that its goals are successfully achieved. It has experiences, some not so pleasant and some pleasant; some not as successful and some successful, that allow it to learn about its environment and means of using the environment to achieve its goals. As it has experiences, it seeks to learn the attitude,

knowledge, principles, concepts and skills that will allow it to achieve its goals more productively in the future, anticipating when those lessons might be useful to its future, and labeling its experience in a later situation. A case-based reasoned is also engaged in noticing the similarities and differences between similar situations and experiences so that it can draw inferences about its world and notice the little differences that suggests when each of the lessons he has learned is most appropriately applicable (Puntambekar, Nagel, Hubscher, Guzdial & Kolodney, 1997).

Collaborative learning is a personal philosophy, not just a classroom technique. In all situations where people come together in groups, it suggests a way of dealing with people, which respects and highlights individual group members' abilities and contributions. As a pedagogy, collaborative learning involves the entire spectrum of learning activities in which group of students work together in or out of class. It can be as simple and informal as pairs working together in a think-pair-share procedure, where learners consider a question individually, discuss their ideas with another learner to form a consensus answer, and then share their results with the entire class, to the more formally structured process known as cooperative learning. Collaborative learning is a way of bringing changes or innovations into teaching in Nigerian secondary school (Akinbobola, 2005). It inculcates the spirit of team work into the students which is needed among scientists in particular. It involves interaction among students in order to enhance learning (Johnson & Johnson, 1987 cited in Akinbobola, 2005).

There are three basic ways that learners can interact with each other to see who are the best students in the class, learners can work individually on their own toward an established criterion, or learners can work together cooperatively, taking responsibility for each other's learning as well as their own (Johnson & Johnson, 1987 cited in Akinbobola, 2005). Collaborative learning can be very useful in the development and understanding of a new topic, and as a follow-up approach by learners on a new topic thought. In collaborative learning, the class is divided or arranged into 3, 4 or 5 groups, depending on the size of the class and the nature of the work to be done. The basis for the strategy is that the students will be actively involved in the learning process and as the students are in a free atmosphere, they are likely to learn effectively through the help of their mates rather than when the teacher does all the teaching (Johnson & Johnson, 1987 cited in Akinbobola, 2005).

Collaborative learning strategy is an instructional strategy in which students are divided into small group between 3 and 5 of mixed abilities in order to work cooperatively so as to reach a common learning goal (Akinbobola, 2005). The use of collaborative learning strategy includes five major steps:

1. Divide a class into small groups usually of about 5 students
2. Provide a task, usually designed ahead of time, for the small groups to work on.
3. Reconvene students into plenary session to hear report from the small groups and negotiate a consensus of the class as a whole.
4. Lead students to compare the classes' plenary consensus with the current consensus of the knowledge community.

5. Evaluate explicitly the quality of students' work.

Identified in Teach Thought (2016) are some ways to include best practices for collaborative learning in the classroom:

- Establish group goals.
- Keep group midsized.
- Establish flexible group norms.
- Build trust and promote open communication.
- For large tasks, create group roles.
- Create a pre-test and post-test.
- Consider the teaching process itself as part of assessment.
- Consider using different strategies.
- Allow groups to reduce anxiety.
- Establish group interactions.
- Use a real world problems.
- Focus on enhancing problem-solving and critical thinking skills.
- Keep in mind the diversity of groups.
- Groups with an equal number of males and females are best.
- Use scaffolding or diminished responsibility as students begin to understand concepts.
- Include different types of learning scenarios.
- Technology makes collaborative learning easier.
- Value diversity, that is, create a classroom environment that encourage independent thinking and teach students the value of multiplicity in thought..

2. Statement of the Problem

As Nigeria and the world at large evolve deeper into knowledge age, this massive societal transformation is creating learning needs very different from those that our educational systems were designed to meet especially in the learning of Physics in this 21st century. Currently in Physics teaching and learning, schools lack proper funding for building new classrooms and laboratories, for adequate classroom maintenance and for providing resources and facilities. The classroom experience shows that a large number of the secondary school Physics students face considerable difficulty in appreciating and learning Physics concepts in a meaningful way, especially in laboratory activities. This is a clear reflection in their poor ability to apply Physics concepts to explain ordinary natural phenomena, make predictions in given situations and solve simple day-to-day problems. This requires the adoption of new learning strategies by teachers that can help to meet the new learning needs of students. Hence, which of the strategies; case-based learning, collaborative learning or expository learning would prove most effective in facilitating students' achievement and retention in the concept of optics in senior secondary school in Nigeria Physics?

3. Purpose of the Study

The study tends to investigate relative effectiveness of case-based and collaborative learning strategies on students' achievement and retention in senior secondary school Physics.

3.1 Hypotheses

Ho_1: There is no significant difference in the academic achievement of Physics students taught with case-based, collaborative and expository learning strategies.

Ho_2: There is no significant difference in the retention of Physics students taught with case-based, collaborative and expository learning strategies.

3.2 Research Method

The study adopted pretest, posttest control group in quasi experimental design. Simple random sampling technique was adopted to select three schools used for the study in Ileoluji/Okeigbo Local Government Area of Ondo State, Nigeria. The sample used for the study was eighty five (85) senior secondary two (SS 2) Physics students. The study made use of Physics Achievement Test (PAT) with internal consistency of 0.84 using Kuder-Richardson formular 21. One intact class was randomly selected from each school used for the study. Experimental group 1 was taught the concept of optics with case-based learning strategy. Experimental 2 was taught with collaborative learning strategy while the control group was taught the concept of optics using expository learning strategy. The teaching for experimental and control groups lasted for six weeks. Retention test took place two weeks after the posttest. The pretest, posttest and retention test contained the same questions except that it was reshuffled before administration in each case. The data collected were analysed using Analysis of Covariance and Scheffe post hoc analysis was used to obtain the direction of significance.

4. Results

Hypothesis 1: There is no significant difference in the academic achievement of Physics students taught with case-based, collaborative and expository learning strategies

The results in Table 1 shows that, the main effect of treatment (instructional strategies) on students' academic achievement in the concept of optics in Physics was significant ($F_{(2, 82)} = 134.97$, $P = .000$). Therefore, the null hypothesis stating a non-significant difference in the academic achievement of Physics students taught with case-based, collaborative and expository learning strategies was rejected. This implies that, the three types of learning strategies (case-based, collaborative and expository) differ significantly in their enhancement of the achievement of Physics students in the concept of optics. Table 1 also shows a multiple regression squared index (R^2) of .79. This implies that, 79% of the total variance in the achievement of students in the concept of optics in Physics is attributable to the influence of learning strategies.

Table 1: One way Analysis of Covariance (ANCOVA) of posttest scores of students taught with case-based, collaborative and expository using pretest scores as covariates

Dependent Variable: Posttest Scores						
Score of Variation	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Square**
Corrected Model	2965.92[a]	3	955.31	106.26	.000	.794
Intercept	2106.34	1	2106.34	234.30	.000	.746
Pretest	12.35	1	12.35	1.37	.523	.006
Treatment	2426.76	2	1213.38	134.97	.000	.767
Error	728.53	81	8.99			
Total	75428.31	85				
Corrected Total	3594.45	84				

a = R Squared = .794 (Adjusted R Squared = .788)

To find the order of effectiveness of the learning strategies and direction of significance under investigation, the posttest scores were subjected to Scheffe multiple comparison test for post hoc analysis as shown in Table 2.

Table 2: Result of Scheffe's post hoc test for multiple comparison of instructional strategies on students' achievement in Physics

Dependent Variable: Posttest Scores						
(I) Instructional Strategies	**(J) Instructional Strategies**	**Mean Difference (I – J)**	**Std. Error**	**Sig.**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
Collaborative	Case-based	-7.27*	.80	.000	-9.10	-5.45
	Expository	3.82*	.81	.000	2.00	5.65
Case-based	Collaborative	7.27*	.80	.000	5.45	9.10
	Expository	12.20*	.74	.000	10.50	14.00
Expository	Collaborative	-3.82*	.81	.000	-5.65	-2.00
	Case-based	-12.20*	.74	.000	-14.00	-10.50

* = The mean difference is significant of the .05 level

As shown in Table 2, the mean difference between case-based and collaborative was 7.27, between case-based and expository was 12.20, and between collaborative and expository was 3.82. This implies that, case-based learning strategies are the most effective in facilitating students' academic achievement in the concept of optics in Physics. This is followed by collaborative while expository learning strategy is the least effective in facilitating students' academic achievement in the concept of optics in Physics.

Hypothesis 2: There is no significant difference in the retention of Physics students taught with case-based, collaborative and expository learning strategies

Table 3: One way Analysis of Covariance (ANCOVA) of retention scores of students taught with case-based, collaborative and expository using pretest scores as covariates

Dependent Variable: Retention Scores						
Score of Variation	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Square**
Corrected Model	4404.22[a]	3	1468.07	257.11	.000	.898
Intercept	162.43	1	162.49	28.45	.000	.254
Pretest	766.23	1	766.23	134.19	.000	.036
Treatment	236.04	2	118.02	20.67	.000	.321
Error	462.25	81	5.71			
Total	98762.00	85				
Corrected Total	4688.47	84				

a = R Squared = .794 (Adjusted R Squared = .788)

The results in Table 3 shows that, the main effect of treatment (learning strategies) on students' retention in the concept of optics in Physics was significant ($F_{(2, 82)} = 20.67$, P = .000). Therefore, the null hypothesis stating a non-significant difference in the retention of Physics students taught with case-based, collaborative and expository learning strategies was rejected. This implies that, the three types of learning strategies (case-based, collaborative and expository) differ significantly in their enhancement of the retention of Physics students in the concept of optics. Table 3 also shows a multiple regression squared index (R^2) of .873. This implies that, 87.3% of the total variance in the retention of students in the concept of optics in Physics is attributable to the influence of learning strategies.

To find the order of effectiveness of the instructional strategies and direction of significance under investigation, the retention scores were subjected to Scheffe multiple comparison test for a post hoc analysis as shown in Table 4.

Table 4: Result of Scheffe's post hoc test for multiple comparison of instructional strategies on students' retention in Physics

Dependent Variable: Retention Scores						
(I) Instructional Strategies	**(J) Instructional Strategies**	**Mean Difference (I – J)**	**Std. Error**	**Sig.**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
Collaborative	Case-based	-8.62*	1.024	.000	-10.68	-6.56
	Expository	5.38*	1.024	.000	3.32	7.66
Case-based	Collaborative	8.62*	1.024	.000	6.56	10.68
	Expository	15.10*	1.033	.000	13.13	17.18
Expository	Collaborative	-5.38*	1.024	.000	-7.44	-3.32
	Case-based	-15.10*	1.033	.000	-17.18	-13.13

* = The mean difference is significant of the .05 level

As shown in Table 4, the mean difference between case-based and collaborative was 8.62, between case-based and expository was 15.10, and between collaborative and expository was 5.38. This implies that, case-based learning strategies are the most effective in facilitating students' retention in the concept of optics in Physics. This is

followed by collaborative while expository learning strategy is the least effective in facilitating students' retention in the concept of optics in Physics.

5. Discussion

The result of hypothesis one indicted that, a significant difference exists among the academic achievement of Physics students taught with case-based, collaborative and expository learning strategies. The result of the Scheffe post hoc analysis indicated that, case-based learning strategies was the most effective in facilitating students' achievement in the concept of optics. This was followed by collaborative learning strategies while expository learning strategy was found to be the least facilitated. This might be due to the fact that, case-based learning strategy is a student-centred with intense interaction between learners as they build their knowledge and work together as a group to examine the case. Also, case-based learning strategy provides learners with relevant opportunity to put theory into practice. Real world or authentic contexts expose learners to view points from multiple sources and see why people may want different outcomes. Students can also see how a decision will have impact on different participants, both positively and negatively. Also, in their effort to find solutions and reach decisions through discussion, learners sort out, collected data, apply analytic tools, articulate issues, reflect on their relevant experiences, and draw conclusions they can relate to new situations. In the process, the learner acquire substantive knowledge and develop analytic, collaborative and communication skills.

Collaborative learning strategy also prepares learners for real life situation, promotes learners faculty interaction, makes learners to have diverse perspectives and leads to the development of higher level thinking, self-management, oral communication and leadership skills. The result is in agreement with Akinbobola (2005) that, collaborative learning strategy enhances students' performance in senior secondary school Physics in the concept of machines because, students learn more when they work together cooperatively, interact through the use of instructional materials with each other and make sure that all the members of the group understand than when the students work alone. The result is also in line with the findings of Rybarczyk, Baines, McVey, Thompson and Wilkins (2007) that, case-based learning strategy has the capability of promoting active learning by doing. Also, students who used the case study, relative to students who did not use the case study, exhibited a significantly greater learning gain, and demonstrated use of higher-order thinking skills.

The result of hypothesis two indicated that, a significant difference exists among the retention ability of Physics students taught with case-based, collaborative and expository learning strategies. The result of the Scheffe post hoc analysis indicated that, case-based learning strategy was the most effective in facilitating students' retention in the concept of optics. This was followed by collaborative learning strategy while expository learning was found to be the least facilitative. This might be due to the fact that, collaborative learning strategy enhance problem-solving skills because the students are confronted with different interpretations and the peer support system

makes it possible for the learner to internalize both external knowledge and critical thinking skills and convert them into tools for intellectual functioning. Also, collaborative learning strategy provides students with opportunities to analyse, synthesize and evaluate ideas cooperatively. These foster the development of critical thinking through discussion, clarification of ideas and evaluation of other students' ideas.

Case-based learning strategy provides an experience for the students that can be transformed into learning through reflection or experimentation. The strategy has been linked with effective development of critical thinking, problem-solving, reasoning and analysis, which in turn are characteristics of a deep approach to learning. It can also be used to facilitate a model of self-directed and reflective learning that serves students very well in future courses and careers. The result is in agreement with Guzdial (1991), Kolodner (1993) and Rybarczyk, Baines, McVey, Thompson and Wilkins (2007) that case-based learning strategy enhances students' retention, self-esteem and responsibility. It also provides opportunity for learners to put what they have learn in theory to practice.

6. Conclusion

Case-based and collaborative learning strategies had significant main effect on students' achievement ($F_{(2, 82)} = 134.97$, $P = .000$) and retention ($F_{(2, 82)} = 20.67$, $P = .000$) in the concept of optics in Physics. The results of the Scheffe post hoc analysis indicated that, case-based learning strategy was the most effective in facilitating students' achievement and retention in the concept of optics in Physics. This was followed by collaborative learning strategy while conventional learning strategy was found to be the least facilitative. Case-based learning strategy makes students to classify data, use analytic tools, discuss issues, reflect on their related experiences, draw conclusion and apply it to new situations. It also makes students to develop skills in critical thinking and group learning, acquire relevant knowledge, and develop analytic collaborative and communication skills.

Collaborative learning strategy makes the students to apply skill, remember facts, comprehend concepts, analyse and synthesize principles through interaction which are main objectives of Physics education. It also allows students to work at their own pace, learn by doing, enjoy participative learning, demonstrate the practical relevance of theoretical ideas and concepts, and develop interpersonal and communication skills.

6.1 Recommendations

Based on the findings of the study and the conclusion reached, the following recommendations were made:

1. Pedagogical training of teachers in Nigerian Colleges of Education and Universities should incorporate the in-depth study of facilitating case-based and

collaborative learning strategies as a viable alternative to the expository learning strategy to enhance students' achievement and long-term retention in Physics.

2. Education stakeholders should encourage teachers to use case-based and collaborative strategies in facilitating the learning of Physics in class so that students would be able to work on projects and learn Physics using real world examples or cases. It will also help the students to develop problem solving skills, construction of knowledge and student-centred activities.
3. To increase the effectiveness of case-based and collaborative learning strategies, Physics teachers should emphasize the process skills in their classes. These processes are inquiry skills and cooperativeness.
4. Teachers should "mix" the class members in heterogeneous groups in terms of gender, abilities and disabilities so that students get beyond their initial stereotypes and are able to treat each other as fellow group members.
5. Physics book writers should take cognizance of case-based and collaborative learning strategies in writing textbooks in Physics.

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