Improving the Academic Achievement and Creativity of Nigerian Students' in Colleges of Education in Genetics using Problem-solving Instructional Strategy

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Abstract

The study investigated whether problem-solving instructional strategy could improve the academic achievement and creativity in genetics among Nigerian students in colleges of education. Research design was Quasi-Experimental that employed pretest and posttest control group design. The population for the study comprised all five Federal Colleges of Education, out of which two were selected using random sampling technique. One hundred students (50 from each of the colleges) were selected by the use of Random Numbers and used as sample for the study. Subjects in experimental group were exposed to treatment for six weeks, while the control group was taught using lecture method for the same period. Instruments for data collection were, Genetics Achievement Test (GAT) which was validated and pilot tested with r = .79, and Ibadan Creativity Assessment Scales (ICAS) adopted from (Wakili, 2007) r = .73, were used for data collection. Two hypotheses were stated and tested at $p \leq .05$ level of significance using t-test statistics. Data collected were analyzed using Statistical Package for Social Sciences (SPSS). The results obtained indicates that Colleges of Education Students taught genetics using problem-solving instructional strategy achieved significantly higher in academic achievement and creativity than their counterparts taught

genetics using lecture method. On the basis of the finding, it was recommended that Federal Colleges of Education lecturers should employ problem-solving instructional strategy in teaching, so as to enhance students' academic achievement and creativity in genetics.

Keywords: Academic Achievement, Creativity and Problem-solving

Introduction

The global community has achieved unprecedented breakthroughs in technology and constant change in many aspects of life that brings with it challenges to educators more than ever before in the area of developing students who will be adaptable in fast-changing environments. As a result of these rapid changes, the education systems need to be modified in such a way that learning is geared towards the ways of reaching knowledge, to improve skills of decision-making and to solve problems (Ince-Aka, GÜven, & Aydogdu, 2010). This calls for equipping students especially at the tertiary institutions with better thinking skills and learning abilities.

Curriculum should be reformed to create classroom in which students are challenged to think creatively about subjects by discovering, understanding, analyzing and applying knowledge in new situations. Indeed one of the widest purposes of the paradigm shift in science education teaching and learning is to train up students with increased creativity, academic achievement and who are interested in science actively (Lorsbach & Tobin, 1992; and Rutherford, 1990).

The strength of a nation is usually assessed in terms of her achievement in science and technology (Olarinoye, 2001; Otuka, 2006; Wasagu, 2007). To attain this strength, educational institutions are mandated by government policies to emphasize the teaching of science and technology courses in all institutions of learning. To back up this stride,

researchers worldwide in general and Nigeria in particular (Walker & Lofton, 2003; Chin & Chia, 2004; Usman, 2000; and Eze, 2001) opined that it is important for students to be prepared for the future by facing real problems in their learning environment and producing appropriate solutions to these problems through the use of activity-based instructional strategies. For the students to be adequately prepared for this, they need to be guided by the teacher through appropriate methodologies and approaches to science teaching and learning.

A number of studies recommended that teachers should be encouraged to use methodologies that promote creative thinking and students to be innovative and come up with creative products(Ali, Akhter, & Khan, 2010; Ince-Aka *et al*., 2010). Students can be encouraged to participate in this process by enabling them to become aware of the ways in which they think, learn and problem-solve. The way of thinking will also attempt to involve students in the teaching learning process through evaluations of what is taking place during learning and can provide a window into the student's thinking processes. Despite this, several studies have shown the dominance of the traditional methods of teaching in the science classroom (Danjuma, 2005) and more pronounced in science teacher training institutions (Auwal, 2011) which results in abysmal performance by teacher trainees. This will invariably be reflected in their overall achievement.

The low performance have been attributed chiefly to poor method of teaching in relation to the nature of the concept to be taught (Galadima, 2001; Mahmud, 2009; Auwal, 2011; Jibrin & Zayum, 2012). A typical scene was exemplified by Auwal, (2011) that the academic achievement of learners in the biological sciences still dwindles at the NCE level. Table 1 shows the summary of grades distribution and percentages in genetics at NCE level in one of the colleges of education (Auwal, 2011).

Table 1.

Grade Distributions and Percentages in Genetics at NCE Level

Grades	2008		2009		2010	
	No	%	No	%	No	%
A	16	5.1	23	6.3	12	3.5
B	20	6.3	25	6.9	35	10.5
C	30	9.0	28	7.7	19	5.6
D	56	17.7	61	16.8	57	17.4
E	83	26.4	130	35.7	80	24.6
F	111	35.5	97	26.6.	120	38.4
	316	100%	364	100%	323	100%

Source: Auwal (2011)

From Table 1, the number of students with lower grades E and F in the period under review is more than those in upper grades A and B. This may eventually affect the productivity of this category of students, which could, in turn, deprive them from gaining admission for higher studies.

As earlier mentioned, better achievement and skills can be enhanced when learners are exposed to teaching/learning approaches that prepare learners for future challenges as well as provide them with alternative thinking skills for finding solutions to problems thereby enhancing their performance. One of these methods is the problem-solving method.

Problem solving refers to a learning process where individuals confront and solve problems related to a variety of contexts. They are step-by-step instructional processes where learners are allowed to construct their knowledge, while the teacher serves as a facilitator (Kaptan & Korkmaz, 2002). In the learning process, students learn how to analyze the problem given among the students and sharing classroom knowledge into practice. Further,

through this course's emphasis on problem-based learning, students acquire creative thinking skills and professional skills as they tackle complex, interdisciplinary and real-situation problems. Problem solving can be classified by the type of problem which must be solved (Kaufmann, 1988). Described as well-structured when the problems are clearly formulated, solved by specific procedure and the solution evaluated against agreed-upon standard. It can also take the form of an ill-structured problem; which is complex with few clues to solution procedures having less definite criteria for measuring solution. Finally, a problem may be based on issues; that is ill-structured and arouses strong feelings which drive people into opposing camps as to the nature of and solution to the problem.

By selecting appropriate problems and providing students with needed support and strategies, teachers can use problem solving as a way to actively involve students in their own learning. Problem solving is often seen as an experimental study requiring first-hand student participation and gathering evidence that permits a question posed to be answered. There is the need for students to think creatively forwarding hypotheses, point out ways of solving the problem and carry out a careful analysis of the results (Awang & Ramly, 2008). This model enables the student to learn new knowledge by facing the problems to be solved, instead of burdened contents (Orhan & Ruban, 2007). According to Eze (2001), Bichi (2002), Kirtikar, (2008) and Adesoji (2008) problem-solving asks learners to observe, understand facts, analyse and interpret, find solutions and perform applications that lead to a holistic understanding of concepts.

The importance of the role of problem solving skills in the teaching and studying of science is widely acknowledged by experts in the field (Ali *et al.*, 2010; Awang & Ramly, 2008; Dehaan, 2009; Ince-Aka *et al.*, 2010). Specifically, it has a major role of enhancing creativity of learners forwarding hypotheses, pointing out ways of solving the problem and carrying out a careful analysis of the results thereby improving academic achievement

Creativity can be viewed as a novel and unexpected way of defining or solving a problem and process whereby a person creates something new which can be a product, a solution or a work of art that has some kind of value (Kaufmann, 1988; Akinboye, 1977). It covers a wide range of skills that are required to change concepts and perceptions. Guilford, (1959) described it as a process that has to do with thinking, exploring and discovering new facts and principles, which can be found in science, music and the arts. Creativity is an extensively studied adjunct to problem solving. In most descriptions of problem solving, there is usually a step called *search for alternatives* and creativity is needed in this step (Awang & Ramly, 2008). Creative thinking has very much to do with perception to put forward different views that are not derived from each other but are independently produced. The creative process of an individual are identified by certain traits namely originality, flexibility, fluency and elaboration (Aldous, 2007; Awang & Ramly, 2008; Kaufmann, 1988; Seng, 2000; Behroozi, 2006; and Hirsh & Peterson, 2008)

Creativity can be enhanced in individuals with proper coaching in class with a positive attitude and suitable exercises (Christenson, 1988) through which academic achievement can be predicted (Olorunkooba and Lawal 2007). The teacher's job is to nurture the creative abilities which everyone possesses and to stem any decline in creativity. It is therefore the aim of this paper to test whether the method of problem solving would be effective for improving pre-service teachers' creativity and achievement in a genetics classroom.

Conceptual Framework

This study is based on the conceptual framework of constructivism and creative thinking as they relate to the practice of teaching. Constructivism is a cognitive perspective of learning whose model suggests that what a person knows is not received passively, but actively assembled or constructed by the learner (Vygotsky, 1978; Tobin & Tippins, 1993). That is, in order for information to take on personal meaning, individuals must actively

engage the material they are attempting to learn (O'Shea & Leavy, 2013). We construct knowledge of ideas and experiences which are personal constructions that mediate all further knowledge.

There is nothing as theoretically interesting as good practice. This is particularly true of efforts to relate constructivism and creative thinking as a theory of learning to the practice of instruction and for helping students become more effective problem solvers. In constructivist teaching, the teacher's role is to help students construct their knowledge rather than to reproduce a series of facts. Some early writers (Vinacke, 1952; Russell, 1956) have attempted making conceptual and operational description of the relationships between problem-solving and creativity. Their conclusion related problem solving to learning and thinking, as a type of higher mental process or cognitive process, to which problem solving certainly belongs. Further, much of what is called learning is also creative and pointed out that learning, problem solving and perception appear to be inextricably linked to the individual's creative process. In its characteristics, creativity makes students move sideways to try different perceptions, different concepts and different points of entry. Creativity finds its place within the problem-solving process (steps) known as "search for alternatives". This is where creativity is needed and improved in this step.

Specifically, a model that of problem-solving approach that describes this relationship is Search, Solve, Create and Share model (SSCS). This model was first developed by Pizzini, Shepardson and Abell in (1988) on the subjects of science. This model for science instruction was developed on the premise that for a problem to be meaningful to a student, it needs to be identified and defined by the student and that student meaningfully learn problem-solving skills and science concepts. This model consists of four phases; search, solve, create and share as shown in Figure 1

When we encounter something new, we have to reconcile it with our previous ideas and experiences for effective learning (Jibrin & Zayum, 2012). Based on the above, the

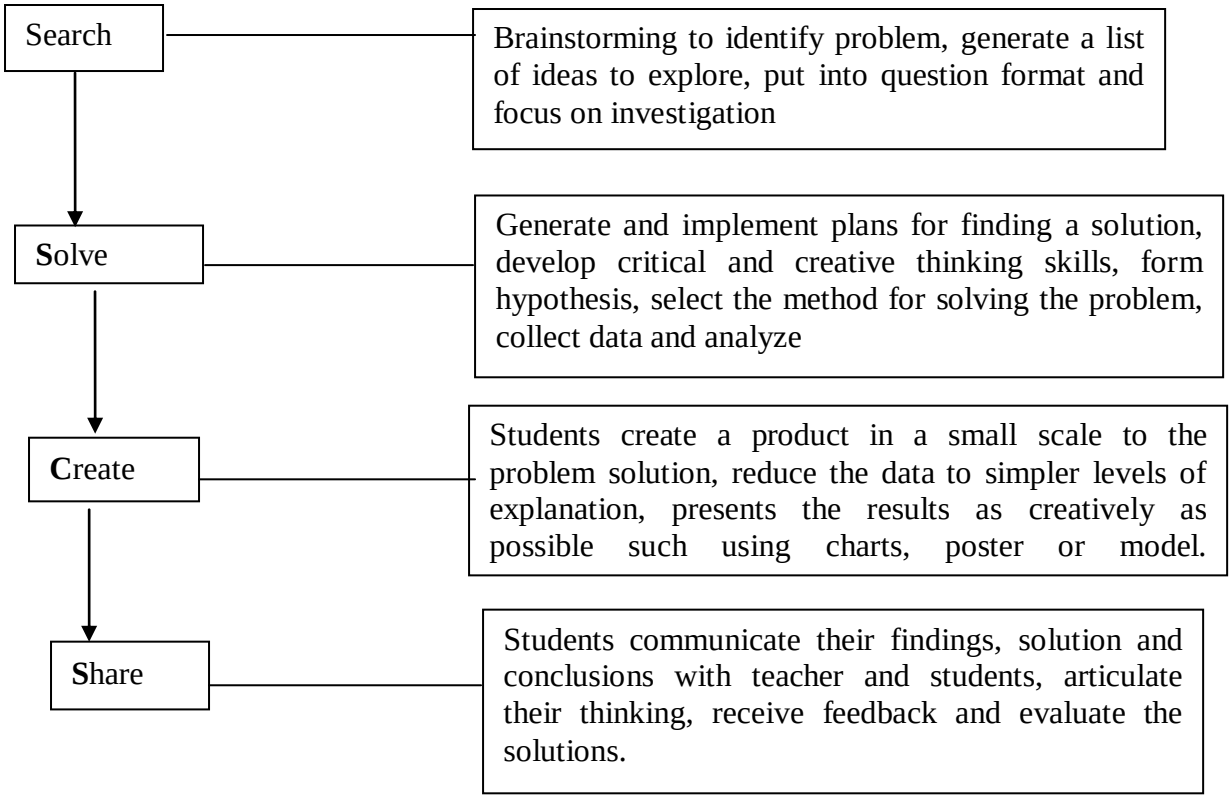

Fig. 1. The SSCS Model (Pizzini, *et al*, 1989)

constructivist classroom is all about encouraging students to use active techniques (experiments, real-world problem solving) to create more knowledge and then to reflect on, and talk about what they are doing and how their understanding is changing. Studies (Ali et al., 2010; Awang & Ramly, 2008; Ince-Aka et al., 2010; Kaptan & Korkmaz, 2002; Kirtikar, 2008) have indicated that problem-solving method which is a constructivist instructional strategy increased students' creative skill, reduced rote learning and eliminate poor academic practices, which in turn enhanced academic achievement.

Statement of the Problem

Several studies such as Danjuma (2005), Gaigher (2005), Kelly (2006), Mahmud (2009) and Tolga (2010) were conducted to determine the effect of instructional strategy on academic achievement of students in the sciences. Reports, show consistent poor academic

achievement in genetics at the college of education level (Mahmud, 2009; Auwal, 2011) and attribute this to students' poor manipulative skills, poor method of teaching employed, poor reasoning and creative ability, mathematical manipulation involved, and abstract nature of the genetic concepts. There is the need to use an instructional strategy that could assist the students to increase their creative thinking in solving genetics problems and may likely improve their academic achievement.

Objectives of the Study

The main purpose of the study was to determine whether problem-solving instructional strategy could improve the academic achievement and creativity of Nigerian college of education students in genetics course.

Specifically, the study was designed to:

i. Determine the effects of problem-solving instructional strategy on the academic achievement of Nigerian college of education students in genetics.
ii. Find out whether problem-solving instructional strategy could improve the creativity of Nigerian college of education students in genetics.

Research Hypotheses

Based on the research questions, the following null hypotheses were formulated to guide the guide the researchers and tested at $p \leq .05$ level of significance.

H_1: There is a significant difference in the academic achievement of college of education students taught genetics concepts using problem-solving instructional strategy and those taught using conventional method

H_2: There is a significant difference in the creativity of college of education students taught genetics concepts using problem-solving instructional strategy and those taught using conventional method

Methodology

The study uses a quasi-experimental design which adopted the pretest-posttest experimental control group's design. The design is represented diagrammatically as follows:

Groups	**Pre-test**	**Research Conditions**	**Post-Test**
Experimental Group	O_1	Treatment (X_1)	O_2
Control Group	O_1	Control (X_0)	O_2

Key:

O_1 = Pretest

O_2 = Posttest

X_1= Treatment (Teaching using Problem-solving Instructional Strategy)

C= Control

The population for the study comprised all the 200 level biology students in Federal Colleges of Education in the North-West Geo-Political Zone. Two Federal Colleges of Education were randomly selected and assigned as the experimental and control groups. Fifty students from each of the colleges were selected randomly using Table of Random Numbers. This is in line with Ibrahim (2012) who states that 30 subjects are sufficient for the experimental study of this nature.

The instruments for data collection were;

i) Genetics Achievement Test (GAT) developed based on the topics in genetics that were identified to be difficult to the students, it measure students' academic achievement in genetics. The GAT with corresponding marking scheme was validated by two Senior Lecturers in Department of Science Education, ABU Zaria and Two Chief Lecturers from the college of education. Test-retest method was used to determine the reliability of the instruments. Pearson Product-Moment Correlation Coefficient statistics was used for the analysis. The reliability coefficient of GAT was found to be r = .79.

ii) Ibadan Creativity Assessment Scale (ICAS), adopted from Wakili (2007) with reliability co-efficient of r = .73, was employed for this study. It was developed to measure creativity and creative attributes or traits, which are, flexibility, fluency, originality and motivation (Akinboye, 1977). The respondent is to use a ten-point scale to rate himself on the items listed. He is to rate items most descriptive of him high in the increasing order of magnitude (6, 7, 8 and 9) and to rate items least descriptive of him low in decreasing number of magnitude (4,3, 2, 1 and 0) Zero will be his rating for an item that is totally unlike him while 5 is neutral.

The scale looks like this:

0 1 2 3 4 5 6 7 8 9

(Totally Unlike me) (Very much like me)

Fig 2 Scales for measuring creativity

The instruments were administered by the researchers after a teaching period of six weeks. The data collected were analyzed using t-test statistics at $p \leq .05$ level of significance.

H_{01}: There is no significant difference in the academic achievement of NCE students taught genetics concepts using problem-solving instructional strategy and those taught using conventional method.

The stated hypotheses were tested using t-test statistical tool. The summary is presented in Tables 2 and 3. Table 2 indicates the t-value of 7.468 with a p-value of 0.0001and the df of 98. The p-value is less than the stated level of significance set at $p \leq .05$. This indicates that there was significant difference in the academic achievement of the experimental and the control groups in favour of the experimental group. Thus, the null hypothesis was rejected.

Table 2: Summary of t-test between Experimental and Control Groups on Academic Achievement

Group	n	$\bar{X}$	SD	Std. Error	df	t-Value	p <.	Remark
Experimental	50	18.18	3.72	0.53				
					98	7.468	.0001	Sig.
Control	50	13.50	2.27	0.32				

Problem solving method was more effective than traditional teaching methods. This situation may have been appeared to show that problem solving method is activity-based and student centered which develops student's self-reliance, cognitive learning and scientific learning (Saban, 2000; Aksoy, 2002). This requires intellectual activities that are known to promote cognitive gains and self-regulation. Self-regulation, according to Zimmerman (2001), is a learner's self-generated thoughts, feelings and actions which are systematically oriented towards achieving a set goal using self-regulatory strategies. According to Zimmerman and Martinez-pons (1986) that problem-solving instructional strategy allows learners construct their knowledge through self-regulatory strategies like self-evaluation, goal setting and planning, seeking information, seeking peer assistance and adult assistance. The finding of the study was in agreement with Jensen and Finley (1996) who found paired problem-solving instructional strategy to be more effective in teaching Darwinian Evolution Concepts, while Mahmud (2009) indicated that college of education students exposed to genetics using discovery method of instructions performed better than those exposed to using lecture method.

H_{02}: There is no significant difference in the creativity of NCE students taught genetics concepts using problem-solving instructional strategy and those taught using conventional method

Table 3

Summary of t-test between Experimental and Control Groups on Creativity

Group	n	$\bar{X}$	SD	Std. Error	df	t-value	p<.	Remark
Experimental	50	49.84	14.01	1.98				
					98	4.857	.022	Sig.
Control	50	38.72	8.11	1.15				

The result in Table 3 reveals the t-value of 4.856 with a p-value of .022 and the df of 98.The p-value is less than the stated level of significance set at $p \leq .05$, inferring that there was a significant difference in the creativity of the experimental and control groups in favour of the experimental group. Thus, the null hypothesis was rejected.

The result indicates that college of education students taught genetics using problem-solving instructional strategy performed better in the creativity test than those taught the same course using traditional lecture method in creativity at P=0.05 level of significance. Meaning that problem-solving had significant effect on creativity. Problem-solving instructional strategy has been seen to develop self confidence, manipulative skills, creative thinking, clarity in thinking and logical reasoning of the learners. Debroux (2007) observes that self-regulated learning improves the creativity of biology students at university level. It was not surprising that college of education students exposed to genetics using problem-solving instructional strategy performed better than those taught using lecture method in creativity test as shown in the present study. This result is in agreement with Kaptan and Korkmaz (2002), and Sambo (2002) who reports that brainstorming technique is effective in fostering the creativity potentials of secondary school students.

Conclusion

Based on the findings from this study, it was concluded that problem-solving instructional strategy has improved the academic achievement and creativity of college of education students in genetics. Learners were guided to take much more responsibility for their own learning; they have become independent learners who can continue to learn in their whole lifetime. This method turns the student from passive recipient of information to the active one, free self learner and problem solver and it slides the emphasis of educational programmes from teaching to learning

Recommendations

Based on the findings from this study, it is recommended that:-

1. Colleges of Education lecturers should be encouraged to employ problem-solving instructional strategies which are activity-based in teaching genetics concepts.
2. The basic learning which pre-service (NCE Students) achieve from this study can be used as a basis for grooming them for extensive application of problem solving skills in the later education life as teachers.

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