International Journal of Education and Information Technology
Vol. 1, No. 2, 2015, pp. 55-60
http://www.aiscience.org/journal/ijeit

Adopting an Incentive-Based Problem Solving Strategy in Computer Science

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Abstract

It is a known fact that as long as there is life, there will always be problems that demand solutions. In other words, problems are part of human experiences. The investigation of the impact of *Problem Solving* as a University Course led to the conclusion that learning is enhanced to a great degree, especially while engaging the students in group participation, frequent interaction and feedback. In addition, the enhancement of the learner's group and individual abilities in problem solving and decision making is recognized as an important issue in education, industry, and government. It is therefore important to actively engage students to interact with the learning environment through positive reinforcement. This has been experienced in the course of teaching CSC 102 *(Introduction to Problem Solving)* in FUNAI. The students were assigned to 26 groups to deliberate on topics in Computer Science within a time frame. An incentive-based or reinforcement price of $10 was proposed to the best performed group. The criteria for evaluation were clearly defined, which roused the enthusiasm of the students to research and write a report. The results suggested that the application of incentive based problem solving in learning activities more efficiently engages the students, and facilitates the intended learning objectives. This research demonstrated the fact that there is a relationship between methods of instruction, attitude, and achievement. It is therefore possible to predict achievement when problem solving strategy is incentive-based.

Keywords

Problem Solving, FUNAI, Computer Science, Incentive-Based, Team Work

Received: April 9, 2015 / Accepted: April 25, 2015 / Published online: May 28, 2015

1. Introduction

It is a well known fact that as long as there is life, there will be problems that demand solutions. Every living being gets faced with their own share of problems and the only distinguishing factors in humans all over the world is their attitude towards their problem which results in their ability or inability to solve their problems. Many student and teachers equate problem-solving with determining the answers to story or word problems. Some people view problems as dense, difficult, discouraging, deflating, disturbing, debilitating, disgusting, deadening, demonic or even damnable – to mention but a few of the more polite adjectives (Castellon, 2006), thus, making a mountain out of a mole hill. A problem is an obstacle, impediments, difficulty or challenge, or any situation that invites resolution. Therefore, a problem entails firstly, the lack of an obvious way to find a solution and secondly, an interest in finding the solution. Problems, then, require a thoughtful analysis and, perhaps, an extended effort.

One strange thing about problem is that one's problem cannot be another person's problem but the fact is that there are problems everywhere. With the fast and rapid rate at which problems arise every day, there is an urgent need for clues on how to go about our problems which brings us straight to problem solving. Problem solving consists in using generic or ad hoc methods, in an orderly manner, for finding solutions to problems. This means that problem solving is

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those articulated steps taking for finding a solution to the problem.Problem-solving often involves decision-making. Problem and problem solving can be illustrated diagrammatically (see Figure 1). X, Y, and Z are articulated approach to solving it. Consequently, the hardest part of process is part X and Y but the most important of it all is that there is a way out of every problem, Z. The ultimate goal of problem solving is to overcome obstacles and find a solution that best resolves the issue (Singh et al, 2004). It is a process in which we perceive and resolve a gap between a present situation (X) and a required goal (Z) with the path to the goal blocked by known or unknown obstacles (Y).

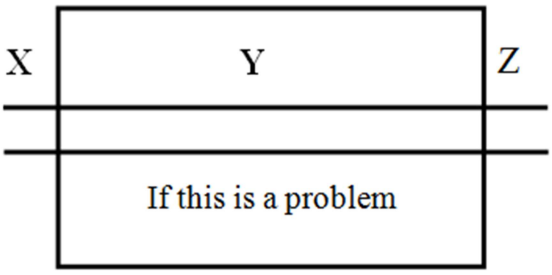

Figure 1. Problem and Problem Solving

Problem and problem solving can also be illustrated using equations as shown below. Problem solving is more or less a mathematical process along with logic and reasoning. Thus,

Problem → "objective" + "obstacle(s)" = Problem

Problem solving →"method" + "answer" = solution

To solve a problem therefore means to find a solution or explanation to the already existing obstacle. Some problems come to us with varying amounts of important and useless information. And at times we are grouped to tackle such problem. Consequently, problem solving collaboration is necessary. Problem solving collaboration is simply the act of coming together of two or more people in order to device a solution to a problem (Meyer, 2004). Let us look at the words "Problem" and "Solve". These two words, like two sides of a coin, have totally different meanings and interpretation. According to the Concise English Dictionary, problem means "an unwelcome or harmful matter needing to be dealt with and overcome". The word "Solve" on the other hand means "to find an answer to, or way of dealing with a problem or mystery". Obviously, the only way to get out of or deal with a problem is finding a solution; this solution, however, must come through the process of solving, which will aid the learning processes.

2. Literature Review

Problem solving is a new trouble faced by the individual. Adesoji (2008) carried out a study designed to clarify the claim by several authors that methods of instruction could change students' attitude positively towards science. The findings in his study showed that students in the experimental group developed more positive attitude towards Chemistry. Helping student to improve the problems solving skills by science teacher trainees has been discussed by Dogru (2008).Problem solving skills can be improved with exercising and training as demonstrated by Nadeem et al (2012).Since large classes are most common in the first year of study at university, teaching large classes requires a combination of skills and strategies; therefore we use the idea proposed by Lynn et al (2009) for crowd control in large groups by grouping the students in groups. Sabourin et al (2011) discussed the guided inquiry-based learning which has been proposed as a promising approach to science education. In it, they examine students' inquiry behaviors within a game-based learning environment, as well as inquiry behaviors' relationships with problem solving and learning. Furthermore, students were encouraged to gather information, use this information to iteratively formulate and test hypotheses, draw conclusions, and report their findings. There is further evidence that providing guidance about appropriate inquiry behaviors can improve students' future inquiry skills (Ketelhut, 2007).The purpose of a case study in general is to study a single or several individuals as part of an in-depth analysis of a bounded system (e.g. a group) to gain insight, to discover and to interpret (Creswell, 2008; Merriam, 1998) their experiences. In the context of this study the case study was on several individuals (289) grouped into 26 groups.

3. Methodology

Large classes are most common in the first year of study at university as mentioned above, which have the responsibility of supporting first year students through the transition to university, while also introducing them to learning in the university context. This led us to exploit this unique opportunity in carrying out research work.

Subjects and Procedure: Two hundred and eighty-nine (289) fresh undergraduate in their first year of study were all selected from Federal University Ndufu Alike-Ikwo, (FUNAI), Abakaliki, Ebonyi State of Nigeria, of 2012-2013 Academic Session. The students were taken from all existing department in FUNAI as shown in Table 1. As a result of large classes, these students were divided into twenty-six (26) groups from different departments (see Table 1) for effective group participation by each student. The 26 groups were each given a problem on selected topics to deliberate on. Students were expected to research and report on topics that relates to their group. Each group was given a period of three weeks to

complete the task, that is Thursday. 11th April to Thursday, 2nd May 2013.The 26 groups had the liberty to consult online materials, magazines, journals, lecturers as well as fellow student for ideas, concerning their allocated topics. Students were also encouraged to interact with other students from different group to exchange ideas. This action was not a threat to the research since each group was given a unique problem topic which is a condition that makes group learning efforts to be more productive than competitive and individualistic. They brainstorm to explore the problem. A problem shared is a problem half-solved. As a result of this they were given three weeks for the completion of the task and with a score scale of 20. The three weeks given was done to make the students to be active, interact and have time to think on the topic given. Information gathering behaviors prior to problem solving does lead to better learning gains. This increases their attitude towards problem solving and increases their scores (grades) to be obtained in Mid Semester Examine (MSE) tests.

Caution: Students were cautioned on the following three points to ensure that when student work in groups they work cooperatively:

a) Firstly, the members of a group must notice that they will all have a common goal and score;

b) Secondly, group members must realize that the problem they are going to solve is a group problem and the success or failure of the group will be shared by all the members of the group;

c) Thirdly, to carry out the group's goal, all the students must talk and discuss with one another.

Table 1. List of 26 Groups, Departments, Problem Solving Topics and Number of Students

Group/ Department	Topic Description	No. of Students/289
Group 01/ Sociology	Problem Solving and Decision Making: A Proper Treatment for Child and Parent Relationship	08
Group 02/ Sociology	Classroom Problem Solving Is Equal To Teaching Surgery Without A Patient	09
Group 03/ Visual Art	Using Problem Solving Strategies to Ruin A Perfectly Good Teamwork	07
Group 04/ Economics	The Relationship Between Problem Solving Inside and Outside Lecture Environment	10
Group 05/ Economics	Student Attitudes Toward various Aspects of a General Purpose 6-Step Strategy	10
Group 06/ Accountancy & Business Adm.	Using Problem Solving Steps to Solve Financial Problems	10
Group 07/ Accountancy & Business Adm.	The effects of Problem Solving on Learning	11
Group 08/ Political Science	Using Problem Solving Steps to Solve Family Problems	15
Group 09/ Political Science	Problem Solving in Political Science	14
Group 10/ Computer Science	Bringing a University, a state and a Region into Problem Solving to Confront National Security Threats.	12
Group 11/ Computer Science	What Everyone should Know About Problem Solving!	15
Group 12/ Biochemistry, Chemistry, Molecular Biology	Face-to-Face with introduction to Problem Solving Course.	13
Group 13/ Biochemistry, Chemistry, Molecular Biology	Using Problem Solving Steps to Solve Medical Problems	13
Group 14/ Biochemistry, Chemistry, Molecular Biology	Decision Making and Problem Solving: Parental Guidance Suggested	13
Group 15/ Anatomy, Physiology and Medical Biochemistry	Problem Solving: Effects of Small-group learning on undergraduates in Anatomy, Physiology and Medical Biochemistry	10
Group 16/ Anatomy, Physiology and Medical Biochemistry	Problem Solving in Anatomy, Physiology and Medical Biochemistry	12
Group 17/ Geology and Geophysics	Teaching Children Problem Solving for Managing Challenging Behaviors	09
Group 18/ History and Strategic Studies	The Power of CSC 102: Introduction to Problem Solving.	10
Group 19/ History and Strategic Studies	Collaboration in Problem Solving is needed for "lifelong learning"	11
Group 20/ Physics	Gender Differences in Applying Problem Solving Strategies in Real Life	02
Group 21/ English	Problem Solving Collaborative Foster Collaborative Learning.	12
Group 22/ English	Decision Marking in Problem Solving: There's more to life than Marking Decision	13
Group 23/ Microbiology	Introduction to Problem Solving: Learning outcomes and their effects.	13
Group 24/ Microbiology	Benefits of problem solving Strategies in University Courses.	12
Group 25/ Microbiology	Decision Making versus Problem Solving: Which is more effective for learning?	13
Group 26/ Microbiology	Student and Instructor Perceptions of the efficacy of Problem Solving lectures in Undergraduate University Courses	12

4. Results and Discussion

After a careful Analysis we found out that most students worked together as they all coveted the inducement ($10) and were determined to win it. Not minding the inducement, few groups failed to work in group living the task to few for instance group 26 that scored 06 (see Table 2). In our investigation, we limit our analyses to these respective subsets of students from same department to enable the student have easy access to group member. Of the 289 students in the corpus, 159 students were able to perform positively in their academic success level in the second SME test, while 29 students did averagely and 101 students were unable to score above average. This was after the incentive based strategy was administered. Meanwhile prior to the inducement, in the first SME test out of the 289 students in the corpus, 106 students perform positively in their academic success level, while 24 students did averagely and 159 students were unable to score above average. Thus, there was a remarkable improvement among the student, that is, 54 students performed better after the inducement.

In our findings, we found out that for a problem to be well solved most students tackle the problem or meets an adviser or if possible form study groups to help tackle the problem. These findings suggest that students who do not participate in group work effectively in learning environments cannot experience distinct impacts on their academic success level.

Table 2. Performance Analysis

Group	Group scores/20	1st MSE % Pass	2ndMSE % Pass	Difference in Pass Rate	D or I Performance	No. of Students/289
Group 01	15	63%	25%	38%	D	08
Group 02	10	44%	34%	11%	D	09
Group 03	14	71%	29%	42%	D	07
Group 04	14	40%	70%	30%	I	10
Group 05	14	30%	40%	10%	I	10
Group 06	18	40%	90%	50%	I	10
Group 07	16	45%	45%	00%	Stable	11
Group 08	12	40%	33%	07%	D	15
Group 09	14	36%	57%	21%	I	14
Group 10	10	17%	58%	41%	I	12
Group 11	16	27%	80%	53%	I	15
Group 12	14	38%	62%	24%	I	13
Group 13	10	23%	38%	15%	I	13
Group 14	13	54%	46%	08%	D	13
Group 15	15	40%	70%	30%	I	10
Group 16	13	25%	42%	17%	I	12
Group 17	17	04%	100%	96%	I	09
Group 18	15	40%	60%	20%	I	10
Group 19	14	36%	45%	09%	I	11
Group 20	10	00%	50%	50%	I	02
Group 21	15	75%	83%	08%	I	12
Group 22	14	15%	54%	39%	I	13
Group 23	14	54%	46%	08%	I	13
Group 24	15	25%	33%	08%	I	12
Group 25	11	38%	46%	08%	I	13
Group 26	06	25%	50%	25%	I	12

4.1. Results from Team Work

A key feature of small group work is that interaction should take place among all present. When students participate in group, they are able to learn better and understand thus applying what they have learnt to real life situations. When problems are shared in groups, many ideas as well as many solutions are gotten from the group. When faced with a difficult problem students in an incentive-based environment will not assume they know the answer at the start. Rather they will stop for a second and take the time to understand what the problem is truly about with their group members before applying a solution. In a group each problem piece becomes manageable. Deep learning (reflection) is enhanced when students gain understanding of a problem and its related concepts and processes by talking about the problem as a group. Consequently, teachers are also advised to give students group work to build up a better relationship between the students. The best performed group that won the price was group 06, followed by group 17 and then groups 07 and 11. However, some students were lazy especially those in group 26, where it was observed that they never worked as a group. Other groups that showed a low level of cooperation include groups 02, 10, 13, 20 and 25 which affected their scores (see Table 2).

The sole aim of interacting is to get ideas from people of different discipline and levels in other to enhance ones

understanding and expand ones knowledge. These will enable students overcome the basic problems they encounter while learning in the university. We believe that if the steps and strategies emphasize here are implemented students will soon have better results without inducement in their daily studies.

4.2. Result from Group Learning

Learning outcomes have played a very important role in the life of both students and teachers within and outside the globe. Learning outcomes are concerned with the achievement of the learner rather than the intentions of the teacher. Students are faced with many problems, challenges and obstacles in their academic or social life which most times affect them positively or negatively. Outcomes of learning are difficult to measure in this type of incentive-based learning environment because they are affected by different variables or parameters, such as the type of problem task (or topics), learning task, and students' cognitive learning outcomes. What matters is that the group shows three characteristics: active participation, a specific task, and reflection. Small group learning is the learning that takes place when students work together usually in groups of 10 such as in groups 04, 05, 06, 15 and 18 or less as in groups 01, 02, 03, 17 and 20. Some groups may work effectively with a larger number of participants such as groups 07, 09, 11, 12, 13, 14, 16, 19, 21, 22, 23, 24 and 25.The experimental group (2^{nd} MSE) was exposed to the incentive treatment while the control (1^{st} MSE) was not. The results were compared at the end of semester (see Table 2).

Students who took active roles in solving problems, communicating effectively, analyzing information and designing solution have skills that go far beyond academic environment. Due to different interest and background preparation, individual student may also face the choice between personal learning objectives and learn to convince, respect, support, negotiate and compromise with other members. Other outcomes of group learning skills include self respect, self confidence communication, conflict resolution and persuasion which are important in finding solutions to problems involving people.

4.3. Result from Feedback

The researchers were responsible for generating problems and making them available to the students (see Table 1). The students establish the learning needs raised by the problem according to their group participation. The students then undertake self-directed study and a critique of the problem tasks. In follow-up sessions the group meets to discuss and studied the problem task, to summarize and integrate the group learning. The primary purpose of this research was to ensure that problems are tackled in better and effective ways via an incentive-based strategy and also to ensure that students life were made better by learning outcomes resulting from their participation in group work.

Feedback can enhance learning for instance, when an assignment or project is given to a student, after researching and brainstorming and other problem solving strategies that may have been applied and the student did not find any useful information, he can always go back to the lecturer and complain to him the challenges he is encountering while trying to tackle the problem and the lecturer on other hand would direct him toward the right direction on how to solve that particular problem. Each group was given their results and their scripts with comments on some. The positive feedback from the lecturer encouraged the student to endeavor to take other courses more seriously so as to increase their academic success level. The researches show that the student success is deeply related with the attitude of the student towards the incentive.

5. Conclusion

Problem solving is a vital part of human life in the sense that it provides room for useful analysis, brainstorming, and decision making. The importance of problem solving both for academic and professional purposes cannot be overemphasized especially in the context of our current economic malaise, academic decadence and learning lives. Consequently, the ability of a student to tackle that problem positively makes him/her a perfect problem solver. Working in groups helps students get to know their peers. This mitigates the stress of the university environment and helps them build a network of friends and colleagues. There are many influences on students today among them are; parents, family, school, religious organizations and media. Furthermore, teachers can actively and permanently affective their students' life by inducement. The academic success has increased more in the experiment group (2^{nd} SME) in this study as a result of the bonus. The result showed that incentive-based problem solving strategy enhances students learning, communication, negotiation and conflict resolution skills and prepare students for real life situations not only in Computer Science but also in other disciplines as shown by our research.

Recommendations

Based upon the findings of our research study, the following recommendations are proposed:

a) Problem solving course should be taught to students during the first year of undergraduate program to prepare

students for real life situations.

b) Undergraduate courses should be structured in such a way that they compel the students to work in group (team working) and to develop problem solving skills.

c) The study recommends the use of incentive-based learning as a learning method as it promotes the development of critical thinking skills and improves student's academic performance.

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