The Acquisition of Environmental Knowledge through the Development of Games in a Higher Degree Course in Nigeria

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Abstract: This paper reports a study carried out amongst 15 graduate students enrolled for a post-graduate degree in educational technology in one of the Nigerian Universities. In one of the courses the students took-(design and production of instructional media) they were expected to identify educational, instructional or learning problems in their areas of specialization, that is, the subject they teach in school and they were to design instructional packages to solve the problem/s. While trying to do this, the class stumbled on an area of knowledge most of the class members did not know much about and which they desired to learn about. The topic was an environmental issue, which is ozone layer depletion (causes, effects, and solutions etc). This author who was teaching the course therefore challenged them, in addition to what other areas they were to work on to also do a joint project on the ozone layer. The author designed a program for the project. The program included amongst other things-sessions on how to design simple games, playing and interacting with existing games, searching for information on the ozone layer, discussing and clarifying information collected and so on. The end result of the 10week program was a board game on the causes, effects and existing solutions to the ozone layer depletion problem. The program, the learning experience of the students and the knowledge they gained are reported in this paper. In addition the game is described and process of playing presented.

Keywords: Games

Introduction

THE USE OF games to teach, instruct and motivate has been studied by various researchers (Kamii and Devries 1980, Kamii and DeClark 1985, Jensen 1996, Oldfield 1991, Pulos and Sneider 1994, Sugar and Sugar 2002). Positive results/reports on the effectiveness of most games have been attributed to factors such as the motivational attribute of games, increase in levels of cognitive activity and development of reasoning and logical thinking skills as the games are played (Ernest 1986,Magney 1990, Kamii 2003, Wolfe 2001). Furthermore, it has been discovered that when games are invented, designed or created, by learners, it promotes reasoning, because the learners invent, create, co-operate, problem-solve, confront conflicting ideas etc. (Castle 1990). It has also helped sustain the interest of learners in subject-content and this sustained interest provided connections to other areas of information (Surbeck and Glover 1992).

The choice of games to play and children playing the games that interest them have also been explained to bring about higher levels of cognitive activity. (Kamii and DeClark, 1985, Leigh 2005). Wolfe (2001) contended that the effectiveness of games is enhanced if students participate in the design or construction of the game. The basis for all these claims can be traced to Piaget's constructivism which Kamii (2003) explained thus-children develop their ability to think logico- mathematically by reasoning actively. The process of developing and playing of games afford the learners to reason actively, therefore opportunities for cognitive activities were provided which enhances logico mathematical knowledge of the students. Surbeck and Glover (1992) working on these assertions introduced their ecology class to the design/invention of games. They claimed that, what benefited the children most was not that they had to glean information (which in itself was impressive) but also that the content they gleaned was incorporated into the process of inventing – this created rich opportunities for learning.

If all these positive results can be achieved with children in the process of their creating games, the researcher felt that at the post-graduate level also, there should be a lot of benefits. The benefit would not only be with respect to acquisition of knowledge about a relatively unknown environmental concept but also that the students would acquire game development skills. This belief is posited on the fact that if we examine learning across the lifespan, the variables of culture, ethnicity, personality and political ethos assumes far greater significance in explaining how learning occurs and is experienced than does the variable of chronological age. (Brookfield 1995).

There are however differences in how children and adults learn (Lieb 1991, Mihall and Belletti 1991). Whereas, according to Milhall and Belletti (1991) children rely on others to decide what is important to be learned, adults decide for themselves what is important to be learned. They also expressed

some other differences which include the fact that children are dependent on teacher and they enjoy the dependence however, adults expect and enjoy independence. All these and other differences imply that adult learners are self directed, goal oriented, relevancy oriented and practical. Further more, they have accumulated life experience and require respect. Therefore according to experts in adult learning (Zenke and Zenke 1984) the following amongst others should be considered when designing instruction for adults-

- Adults will need to learn experientially
- It may be best to approach the topic as problem solving.
- Involve the adult in the planning, learning and evaluation.

Furthermore Malcolm Knowles, the 'father' of andragogy (the art and science of helping adults learn) has determined the following as principles of adult learners.

- Adults need to be involved in the planning and evaluation of their instructions. (in this study, though the suggestion came from the researcher, the students were eager to join in planning what they needed to do to achieve the results)
- Experiences (including mistakes) provide the basis for learning.
- Adults are most interested in learning subjects that have immediate relevance to their job or personal life.
- Adult learning is problem-centered rather than content-oriented. (http://www.ettc.net/tech/adultlearning/index.htm)

In the design of this study, all these basic points where put into consideration as would be seen. For this research work, most of these principles actually guided the design and the process of conducting the research.

The choice of designing a game as against any other learning resource, though suggested by the researcher was agreed on by the students. The students having explored the various games that the researcher brought to the classroom were convinced that even for adults learning, games and simulations made learning fun. According to McLean (2006) no matter what your age, games are fun and naturally give people enjoyment and pleasure. Furthermore, McLean (2006) claims that games for adults can improve learner engagement, learner participation and comprehension, retention and more. Games are also seen as relevant especially in experiential learning for adults on sustainability. According to Dieleman and Huisingh (2006), games can contribute to helping learners to effect shifts in their personal paradigms, context and practice that are needed for sustainable development. The value of using games for learning was a great motivation for this group of students such that they decide to embark on creating one.

Nicholas Stern (2006) states that global climate change is the defining issue of our time requiring immediate and decisive action. However, for there to be a much required global change, Muller and Siebenhuner (2007) have explained that transformation must come from the following: individual action, sustainable business strategies, Government regulations and non-governmental organization initiatives. This seems to support the call of environmentalists to act purposively about what is happening in the environment. One of the emerging areas of action especially in Nigeria to cater for this call has been environmental education. Most primary and post primary education curricula have been infused with environmental issues and concerns. Even at the tertiary institution, students are required to take general courses on the Environment. All these measures are to ensure that the populace understands the problems and issues relating to the environment and also to learn how to handle such issues such that they can protect the environment.

This research work is therefore well positioned in that it provides insight into how people especially adults can be educated about the environment. This work also is a guide into how adult learners can be actively engaged in constructive actions to help proffer solutions to an important environmental issue which is ozone layer depletion.

All these aforementioned formed the basis for this research work. The researcher therefore, introduced the idea of development of a game (a group work) to the graduate class of 15 students. These group of students had to take a compulsory course titled-design and development of instructional materials. In past years, the students had to come up with various educational /social issues that would be used as a basis for the design of their instructional materials. Some of the past topics had been-acid rain, malnutrition, refuse management, developing children's interest in reading etc. Having identified the goals of such an instructional material, the target population and the best instructional format to use, the students would go ahead to design a prototype of their instructional material/ product and after validation, they modified and presented the product

The topic which was identified by the group of students whose report is given in this paper is "ozone layer depletion". This is a topic the students themselves expressed little or no knowledge about. The researcher therefore suggested to the students to develop a game on the topic, seeing it as an opportunity to inculcate two things at the same time (that is game

development skills and knowledge about ozone layer depletion)

The Problem

The problem that is therefore discussed in this paper was the design and development of a game that could provide knowledge about ozone layer depletion to a target population of post-basic education students in Nigeria.

Methodology

This study is a case study. However it had distinct guidelines/steps for the preparation of the games and the execution of the project execution. The steps taken are as shown in figure 1.

There was a pre-test and then a post-test. The aim of this was just to ascertain the entry points of the students and then to check if they had retained any knowledge of the concept after they completed the game at the end of the course.

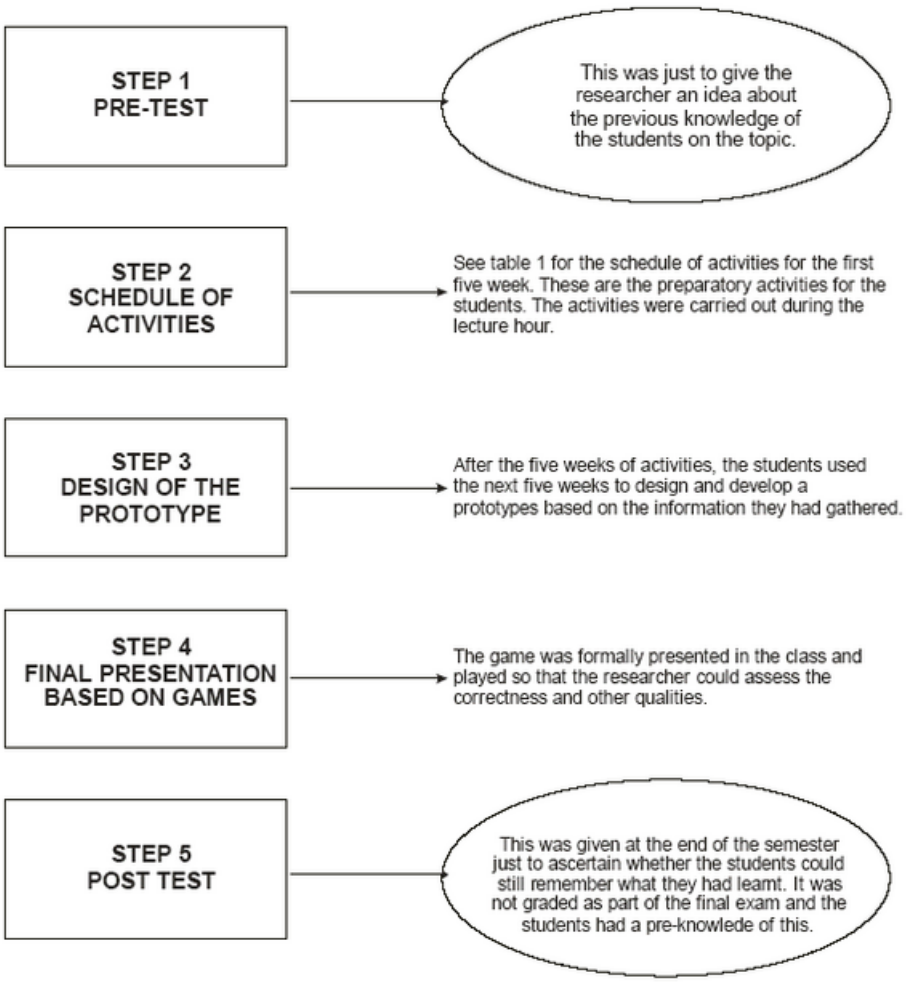

Figure 1: Steps for the execution of the study

Schedule of Activities

During the first 5 weeks of lectures, about 45 minutes to one hour was scheduled to discuss various issues on games- what they are, variety and types of games, how they are played and so on. Issues about ozone layer depletion were also discussed. The researcher facilitated the first five weeks of interactions after which the class met for the next five weeks to discuss and plan and develop the prototype.. Twice, a prototype was presented to the researcher/lecturer and probing questions on rules, level of abstraction, whether all knowledge needed was incorporated etc. where posed to the students, who then went ahead to modify project. The final version of the game produced was played by the members of the class and final modifications where made after which the game was packaged.

Table 1 shows the activities the students went through for the first five weeks.

Week	Activities
1	A) Resources where brought into the class to sensitize the students about games. The resources used where a). Amazing things to do with your computer by Ted Smart. This Resources CD has a section on digital games. Users could actually design a whole collection of exciting digital games using 3 boards, with any of the following themes – under sea world, the jungle, and space world. The students had to use this package to design games b) Speak French (A Dorling Kindersley Language pack) - a language learning activity pack. This had two games • L'alphabet (in the format of snakes and ladders) • Un deux trios (a board game where you move from start to finish trying to go past obstacles). B). Students completed questions of ozone layer/depletion (their names on the question sheet was optional).
2.	A) The students had searched for information on the ozone layer from the internet, these were presented in the class and was the basis of a discussion session on the topic. At this point the Researcher felt many of the students were still confused about causes and effects of ozone layer depletion and they were encouraged to look for more information on the topic. B.) Students played with the games from the following resources. • The Wizard of 0z game book (it has board games with an electronic module) • Let's stay at home games package-this had the following games-snakes & ladders, mini solitaire, picking apples, the fox and the crow.
3	A) The discussion on ozone layer was more eventful because students had gone to search for more information especially in relation to Nigeria as a country. B. The process of integration of the content into game format started. The students analysed, causes and effects of ozone layer depletion and possible solutions to the depletion. There was also a lot of discussion on the game format to use. C. The lecturer gave the class a summarised lecture on ozone, ozone layer/depletion. D. The students were provided with further reading materials on games that has been designed such as in Ortiz (1994), Ludeman and Sevier (1982) Bruni & Silverman (1975, 1976). E. Ideas for a Game board that would reflect the theme under study was discussed.
4	A. More resources where brought to the classroom – there where teacher made games as well as published games, they include – • Tootie footie (a number game with a spinner) • Story telling (step by step) a card game • Junior scrabble • Word search (the game of finding words) • Math magic (the ultimate math challenge). B. At this stage, a lot of ideas was generated and the lecturer was satisfied that the students had enough experience about goals/aims of games, rules, winning strategies etc.
5 – 10	The student met together without the researcher but twice presented a prototype in the class which was critiqued by the lecturer and modifications were made. When the game was finally approved, there was a discussion with the lecturer on what materials to use for various parts of the game, what illustrations would be suitable to reflect the theme and packaging of the game.

Summary of Findings

Before the whole process of design and development started, the researcher prepared a list of questions about the ozone layer depletion for the students. They were encouraged to answer as much as they could anonymously. Only three students were confident enough to put their names on the paper. After the final presentation of the game, (on the last meeting day of the course), the same set of questions was given to the students. A look through the answer

scripts showed that all the students put their names on the paper. This showed to the researcher that they were more confident of what knowledge they had acquired during the design and development process despite the fact that they had submitted the game about 4weeks earlier.

Comparison of Knowledge of Ozone Layer Concepts.

The set of questions that the students were to respond to can be grouped into the following-

1. what ozone, ozone layer, ozone layer depletion were, where the layer was located and the importance of the layer.
2. What the effects of ozone layer depletion was
3. What causes the depletion
4. What measures should be adopted to control/stop the depletion
5. Questions on other related concepts – such as global warning, greenhouse effects, UV radiation.

An attempt is made following to compare the responses of the students during the pre-test and the post test.

a) what ozone, ozone layer, ozone layer depletion were, where the layer was located and the importance of the layer Before the game design, only one student had a close answer about what ozone was however after the design, 10 of the students were able to correctly state that ozone was a gas and they went on to discuss the ozone layer itself which shows they had acquired the knowledge Furthermore the 10 where able to state correctly the molecular formula of ozone. 12 of the students were able to state precisely where the ozone layer was found. The question on the importance of ozone layer to the earth was also answered correctly after the game, all the students were able to say the protective functions of the layer.

b) Effects of ozone Layer Depletion An analysis of the answers given before the design showed that the students who answered the question gave general answers such as "increase in heat or temperature". However, responses after yielded specific effects like "diseases caused to human beings, effects on marine life, effect on animals and atmosphere".

c) Causes of ozone Layer Depletion None of the students could state the chemicals that cause the depletion and other causes before the game design however after- everyone was able to mention the role of the CFC's and mention household equipment that contained the CFC.

d) Measures to Control Depletion Before the design of the game, the students gave answers like "planting trees, reducing pollution" to the question on how ozone layer depletion could be controlled. However after the design, it was worthy of note that all the students did not just give brief answers but actually wrote short essays on how they felt the control could be carried out. This showed that not only did they acquire knowledge; the knowledge acquired affected their attitude and made them more concerned about what is happening to the environment. Most of them further showed a commitment to seeing the problem of the depletion solved.

e) Other Related Concepts The answers after the game was designed showed that all the students were able to differentiate the concepts related to ozone layer depletion (such as global warning and greenhouse effect) from ozone layer depletion itself. The answers showed that eleven (11) of the students did not mix up the two concepts and were able to differentiate them.

The result of this post test not only shows that students can acquire knowledge through game design and development but also prove that adult learners learn effectively if elements (motivation, reinforcement, retention, transference) as propounded by Malcolm Knowles are incorporated in their instruction.

Motivation for this group of adult learners came by the fact that there was a friendly and open atmosphere for learning. They played games and discussed about what they would do. Further more, there was adequate feedback as they trial tested the games many times. The relevance of a game to address an environmental concern was also quite understood throughout the process by the students.

Reinforcement was provided by the researcher in form of encouraging words and at times sitting with the students during the trial testing sessions. Retention, which is another element, was acquired through the design process. The students had to process and use the facts about the ozone layer over and over as they designed the board, the cards and the rules for the game. No wonder the post test showed appreciable understanding of ozone layer depletion and other the related concepts.

The last element, transference, which describes the ability to transfer or apply learning as a result of training, was observed in the process of the design and the development of the game. The students were able to associate facts about ozone layer depletion with real life situations. That is, what happens

everyday formed the context of the game and the game cards.

The fact that all these elements where present obviously led to the increased understanding and commitment of the students to solving the environmental issue – ozone layer depletion as reflected in their post test.

Conclusion

The process of the development of the game on ozone layer depletion (an environmental hazard) has shown that students can actually acquire knowledge of environmental education concepts when they are involved in the process of developing a game around the concept. This has been vividly demonstrated in this study/report.

Despite the fact that the number of students was not large and the fact that the researcher was avidly committed to the success of the project, it can still be concluded that an application of the steps discussed in this study (if adapted to the development of games) would increase the knowledge and understanding of students about the concepts involved in the design. It is therefore suggested that other environmental concepts should be used as the basis for other game developments.

One missing part in this study is a documentation of the student's attitudes towards the concept before and after the design of the game (this would have included their enthusiasm, level of motivation and interest). Furthermore a study needs to be conducted using the game designed and finding it's effectiveness on students learning outcomes. This would help ascertain/ verify the claims made in this research.

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APPENDIX

OZONE GAME

How to Play
Number of players: 2 to 4
Needed
A game board. (Photo 1)
Game cards (photo 2a-2d)
Play money (photo 3)
Dice
How to start the game:

Players must toss 6 on the die and stay on the starting point. Subsequent tosses would determine the movement of each player's seed. Every player must be given an initial capital at N500.
Play moves clockwise from the person who is the first to throw a six. Each player throws the die and moves the number of spaces indicated on the die. The seed could either land on any of the spaces on the game board including the following

- A space with a question mark
  

This stands for question. Players pick a question card .Players that cannot answer the question will miss a turn.

- A space tapered with a blackline: Players pick corresponding cards. This stands for the effects of the ozone layer depletion. Any player that falls on it will pay a specified amount of money either for: (i)treatment at the hospital or (ii) relocation
- A space tapered with a Red line: This stands for the causes of ozone layer depletion. Any player that falls on it faces a penalty of either.
- moving some steps backward
- going to prison and missing two turns

1. paying a specific amount as fine to the treasury.
2. A space tapered with a Green line: This stands for remedies.

Any player that lands on it is commended by receiving a specific amount of money from the treasury.

- A space tapered with a Yellow line: This stands for immunity. Any player that falls on it is immune for the next five moves even if the players' seed lands on the red tapered space.

The players have to pick corresponding cards to where they land on the board. The cards are marked accordingly on one side and the action to be taken is on the other side.

Determination of the winner: The first person to get to the end of the game receives a sum of N1000 from each of the other players.

The capital left with individual is calculated and whoever has the highest amount is declared the winner whether he gets to the end of the game first or not

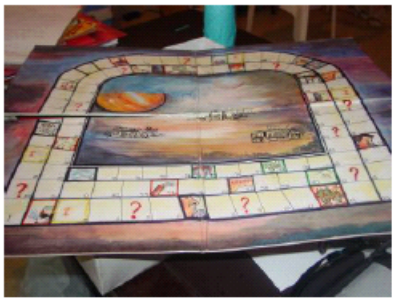

Photo 1: Game Board

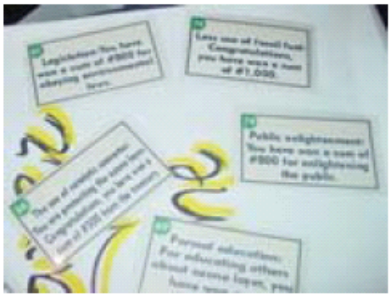

Photo 2a: Game Cards 1

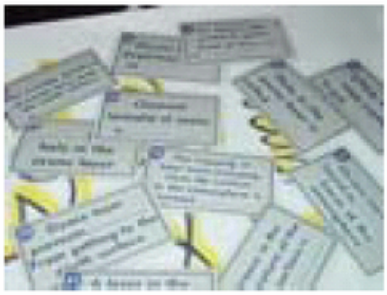

Photo2c: Game Cards 1

Photo 2b: Game Cards

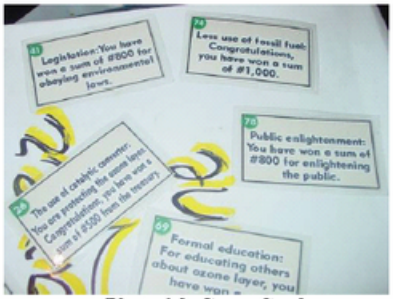

Photo 2d: Game Cards

Photo 3: Money Cards 1

About the Author

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41 year old and female Nigerian, I obtained a first degree in Electrical and Electronics Engineering and taught for 10 years at the Faculties of Technical Education at 2 higher institutions in my Country. I choose to teach rather than work in the industry because I had loved to teach my mates while I was in high school. I used to enjoy teaching them mathematics. I decided to follow this my line of interest by taking an M;Ed in Educational Technology after obtaining a Higher Diploma in Education. My areas of specialisation were mathematics education and educational Technology. With an interest in developing resources for teaching Mathematics, I decided to take a Ph.D degree in Educational Technology. For the research work, I designed and developed games to teach primary school children aspects of Geometry. Currently I am lecturing at the Educational Technology unit of The University of Ibadan, Ibadan, Nigeria where I also carry out researches. My main areas of research interest are design of games and other resources for teaching primary children mathematics and science, sustaining the interest of girls in Mathematics and use of toys for total development of children. I have published 18 articles in journals and books in these areas and some others.