Benin Journal of Educational Studies Volume 24 Numbers 1 & 2, 2016, 119-133

Integrated Psycho-socio Scientific Argumentation into Face-to-Face Facilitation and its Effect on Physics Performance of Open and Distance Learners

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Abstract

The study adopted an Ex-post facto Experimental research design to investigate the integrated psycho-socio scientific argumentation into face-to-face facilitation and its effect on Physics performance of open and distance learners. The sample size consisted of randomly selected 28 learners of an open and distance institution. The instrument for data collection was Physics Performance Test administered following the two modes of facilitations. The research instrument was validated with face and content validity and a test re-test administered after three weeks. The obtained alpha value was 0.71. t – test statistical method at 0.05 level of significance was used to analyse the grade scores obtained in Physics Performance Test. The results showed that the performance of learners who were facilitated with the integrated psycho-socio scientific argumentation into face-to-face facilitation performed significantly from those facilitated with ordinary face-to-face facilitation (t =3.85 > 0.002). The study recommends that psycho-socio scientific argumentation integrated with face-to-face facilitation be used as a mode of facilitation for Physics distance learners in open and distance university education.

Key words: Psycho-social, Scientific Argumentation, Physics Performance, Distance learners and NOUN.

Introduction

Face-to-face facilitation is one of the modes of delivering learning contents in the National Open University of Nigeria. This mode is similar to other universities' open and distance learning institutions across the globe (Ipaye, 2007). Face-to-face facilitation in distance learning is mostly conducted on learners'

request and it is expected to facilitate dialogues between the facilitator and the learners (Okopi, 2010). The interactions in a distance learning face-to-face classroom is different from the normal conventional lecture method practised in most conventional universities. Face-to-face facilitation in open and distance learning is scheduled mainly on the basis of learners' needs and meetings are conducted based on the complexities of the study material (Ipaye, 2007). In the National Open University of Nigeria, for example, the direct face-to-face facilitation is practised at a lower degree and only for courses or programmes that have more than fifty students at a given time. This is different from the On-line facilitation that accommodates all categories of learners (without limit to number), requests by learners or distance in time and space (NOUN: Registry, 2014). To Okopi (2010) and Col (2001), face-to-face is a support service which may or may not be used by the learners.

Following the current practice, a critical look at the way face-to-face facilitation is conducted particularly by the part time facilitators of the National Open University of Nigeria who are mostly from the conventional universities, it was observed that adequate attention is not given to the intrinsic and extrinsic psycho-social factors of the learners. Prominent among these factors are learning styles adopted by the learner, methods used to impart knowledge, nature of content to be learnt, intelligence level of the learner, group dialogues and methods to be used in controlling proactive and retroactive factors (Okopi, 2010). These psycho-social factors have a significant influence on learner's academic performance and achievement but are not being adequately provided for. In teaching and learning Physics, being a science course and supported by many learning theorists, integrating some basic contents of scientific argumentation that considered distance learners' psycho-social factors may be a better option for effecting a change ((Williams, 2013). Scientific argumentation is conceived as a discursive practice through which scientific knowledge and claims are justified or evaluated based on empirical or theoretical evidence (Plato and Aristotle cited in Saka, 2006). Jimenez-Aleixandre & Erduran (2008) and Osborne, Erduran, Simon & Mork (2001) said that scientific argumentation is a knowledge building and validating practice in which individuals propose, support, critique and refine ideas in an effort to make sense of the natural world. Duschl & Osborne (2002) and Kelly & Takao (2002) affirmed that scientific argumentation is a form of logical discourse whose goal is to tease out the relationship between ideas and evidence. The use of scientific argumentation in imparting knowledge is described as a dialogic teaching that harnesses the power of talks to stimulate and extend learners' thinking and advance their learning and understanding. Scientific

argumentation, to Kelly & Takao (2002), helps the teacher more precisely to diagnose pupils' needs, frame their learning tasks and assess their progress. In teaching/learning processes, the term argument refers to the artifacts that a student or a group of students creates when asked to articulate and justify claims or explanation while the term argumentation refers to the processes of constructing these artifacts (Simon, Erduran & Osbome, 2006). Previous works on developing the skill of argumentation in teaching science subjects to learners showed that it is possible for teachers to transform their pedagogy to one that is more dialogic through using materials and strategies that promote argumentation, and adopting roles that scaffold the processes of argumentation (Von Aufschnaiter, Erduran, Osborne, & Simon, 2008).

Scholars have supported the efficacy of scientific argumentation in teaching and learning. For instance, Driver, Newton & Osborne (2000) claimed that argumentation plays a vital role in learning science subjects and it should be reinforced in science classrooms It was discovered that scientific argumentation is one of the perspectives from which researchers have investigated the role of argumentative discourse in science teaching, and the effectiveness of argumentation on students' conceptual understanding of scientific concepts (Duschl & Osborne, 2002). Another study asserted that students can construct better arguments in terms of content and justification on their own after collaborating with others even when they have minimal prior formal experience in the practice of scientific argumentation (Duschl & Osborne 2002).

For a successful use of scientific argumentation in teaching, factors such as positive interdependence, individual accountability, interpersonal skills, and face-to-face interaction, among others, were recommended (Duschl & Osborne, 2002). These factors are traced to the theories of Constructivism by Dewey (1904), Piaget (1920), Toulmin argumentation pattern (1958), Brunner (1973) and Vygotsky (1978). The development of argumentation in school science subjects needs a partnership between researchers and teachers. The researchers provided both the theoretical ideas and practical resources to stimulate a change in teachers' practice while the teachers implement them in their teaching (Cross, Taasobshirazi, Hendricks & Hickey, 2008). Duschl & Osborne (2002) further asserted that working collaboratively with teachers to develop argumentation activities and teaching strategies through analysing teachers' teaching activities can only take place in the classroom. This will also give insights that would inform subsequent curriculum initiatives aimed at a wider audience of practitioners (Cross, Taasobshirazi, Hendricks & Hickey, 2008). Different researchers claimed that the use of scientific argumentation in classrooms promoted the concept of independent thinking, the importance of dialogic

discourse in science education teaching, and the relevance of cooperative and collaborative group work in pedagogical activities (Von Aufschnaiter, Erduran, Osborne & Simon, 2008).

After different literature reviews such as Von Aufschnaiter, Erduran, Osborne, & Simon (2008), Kuhn (1992), Cross, Taasobshirazi, Hendricks & Hickey (2008) and Duschl & Osborne (2002), the following five stages were suggested for the use of scientific argumentation in teaching but the six stages are the integrated psycho-social factors combined by the writers of this study:

1. **Claim**: This is an assertion that is presented publicly (during class presentation) for general acceptance.
2. **Data**: This refers to the specific facts that are presented to support an established claim.
3. **Backings**: These are generalizations making explicit the body of experience relied on to establish the trustworthiness of the ways of arguing applied in any particular case.
4. **Warrant**: This provides a link between data and claim.
5. **Rebuttals**: These are the extraordinary or exceptional circumstances that might undermine the force of supporting an argument.
6. **Learners' psycho-social factors**: These factors integrated into the scientific argumentation consisted and considered learners' level of education, formation of groups and interaction, and the learner's personal feeling and dialogic approach to the evaluation of evidence in addition to social avenues for the learner in which his and other learners' ideas were proved. Also, there is psychological rehearse, that is, a conclusive summary presented by the facilitator to harmonize all the claims, data and backings in the light of established scientific knowledge.

In the use of integrated psycho-socio scientific argumentation, psychological rehearse becomes necessary to prevent any form of misconception that may arise in the process of argumentation. One of the studies reviewed concluded that many children and adults are very poor at coordinating and constructing a relationship between evidence (data) and theory (claim) which is very important to valid arguments and a successful use of argumentation (Kuhn, 1992 and Kuhn, 1992). Therefore, the integration of psychological and social factors into instructional designs which this study seeks to test permitted students to work in groups of choice; thereby eliminating conflicts belonging to the same level of study; thereby having similar interests and educational level; thereby equating knowledge background with the formation of a control group interaction; and thereby giving the facilitator a chance to maintain orderliness in

discourses and moderating individual learner's feeling, thinking and a dialogic approach to the evaluation of evidence. The addition of psycho-social factors to the scientific argumentation integrated into face-to-face mode of facilitation and used to facilitate Physics students of the National Open University of Nigeria is termed in this study as 'Integrated psycho-socio-scientific argumentation into face-to-face facilitation". Before the addition of psycho-social factors and scientific argumentation, the face-to-face facilitation used to facilitate the learners in NOUN is referred to as ordinary face-to-face facilitation.

Statement of Problem

The problem of poor performance of Open and Distance Learners in the sciences, especially Physics, necessitated this study. The researchers were of the view that when facilitators of the National Open University of Nigeria used the face-to-face facilitation that integrated psycho-socio scientific argumentation to teach courses in open and distance learning, science courses may improve learners' academic performance as opposed to the ordinary face-to-face facilitation. In addition, the description of scientific argumentation in teaching as a social, intellectual, verbal activity serving to justify or refute an opinion, consisting of statement directed towards obtaining the approbation of an audience by Von Aufschnaiter, Erduran, Osborne, & Simon (2008) influenced the researchers' opinion to investigate. This is very necessary because Open and Distance Learning circle and learners in science subjects related programmes have many distinct psycho-social characteristics that need to be considered and added to scientific argumentation and thus, integrate into face-to-face facilitation for effectiveness. The ordinary face-to-face facilitation used in the National Open University of Nigeria assumed that all the students of the Institution were the same. For example, differences and nature of programme of study, level of education, group interaction, formation and the individual's psychological traits of feeling and didactic reasoning, and the social avenue for the individual to prove his ideas and other individual ideas are basically lacking. These shortcomings prompted this study. Thus, the study experiments with the integrated approach to facilitate the learning of Physics students' of the National Open University of Nigeria so as to prove its effectiveness when compared with the current mode of ordinary face-to-face facilitation of the Institution. The choice of Physics for this investigation is because a reasonable number of open and distance learners perceive the course as difficult among other science courses offered by NOUN. This is justified by the level of enrolment into the programme.

Research Objective

The objective posed in this study is:

> To find out whether there is a significant difference between Physics performance grade scores of open and distance learners facilitated with integrated psycho-socio scientific argumentation into face-to-face facilitation and those facilitated with ordinary face-to-face facilitation.

Research Question

The research question posed in this study is:

> Is there any significant difference between Physics performance grade scores of open and distance learners facilitated with integrated psycho-socio scientific argumentation into face-to-face facilitation and those facilitated with ordinary face-to-face facilitation?

Research Hypothesis

One research hypothesis was tested in the study.

> There is no significant difference between Physics performance grade scores of open and distance learners facilitated with integrated psycho-socio scientific argumentation into face-to-face facilitation and those facilitated with ordinary face-to-face facilitation.

Methodology

Research Design:

The Ex-post facto experimental research design was used for this study. The design was used in two stages. First, it was used to identify Physics open and distance learners that belonged to the same level of education, programme of study and the same study centre and second, the facilitation with integrated psycho-socio scientific argumentation into face-to-face facilitation and ordinary face-to-face facilitation. The Ex-post Facto experimental design allowed the researchers to investigate the subjects without following the conditions expected in using a pure experimental research design.

Population

The population of the study consisted of all the 32 year one Education Physics and Pure Physics open and distance learners of the National Open University of Nigeria in Lagos Study Centres. This study was limited to only distance learners of the National Open University of Nigeria.

Sample Size and Sampling Technique

The sample size of 28 open and distance learners was determined by the use of table for determining sample size for a research purpose (Krejcie & Morgan, 1970). The samples volunteered to participate in the study. Nineteen (19) males and nine (9) females of one hundred level Education Physics and pure Physics were sampled for the study. The 28 samples were further randomly divided into two groups. Group one consisted of 14 learners (10 males and 4 females) and group two also consisted of 14 learners (9 males and 5 females). Group one was facilitated with the integrated psycho-socio scientific argumentation into face-to-face facilitation and group two with ordinary face-to-face facilitation. The mean age of the samples was 21.5. The sampling technique used was randomization.

Instruments for Data Collection

A One hundred-item objective test named Physics Performance Test (PPT) was designed for measuring Physics concept of temperature, types of thermometer, heat measurements and gas law. This was administered at the post-test stage to the two groups of distance learners so as to measure their performance grade scores after facilitation. The content coverage of the One hundred-item objective tests were: 1). Concept of temperature, 15%. 2). Types of thermometer, 35%. 3). Gas law, 25% and 4). Heat measurements, 25%. These gave a total of 100%. The cognitive domain covered 30% of the items, psychomotive domain covered 40% and affective domain covered 30% of the items (Bloom's Taxonomy in Adeloye, Masha, Aliyu, Nagee, & Maiyanchi, 2009). The scoring format for the objective tests was one mark for each correct response and zero mark for each incorrect response. The total grade scores expected were 100. Score grades of 01 to 39 are considered fail and score grades of 40 and above are considered pass.

Validation of the Instrument

The methods used in validating the instruments were face and

content validities. For face validity, four experts in Physics, Test and Measurement and Education Psychology determined at face value the appropriateness of the One hundred-item objective tests in measuring up what was studied. The experts also ascertained if the instruments contained the appropriate items that could actually elicit the intended responses. Expert judgments were also used to determine the content validity by checking the extent to which the items were representatives of the content and the behaviours specified by the theoretical concepts being measured.

A reliability test (Test re-test) was conducted on 17 students that were in 200 level Education Physics and Pure Physics and were taught the contents being measured when they were in one hundred level of the programme. The reliability coefficient of 0.71 was obtained three weeks after the first administration. This made the instruments to be considered adequate and adjudged appropriate for the study.

Administration of the Instrument

The researchers personally collected the data for the study. The facilitation with the integrated psycho-socio scientific argumentation into face-to-face facilitation and ordinary face-to-face facilitation were performed by the Physics specialist among the researchers.

Treatment Procedures: The treatments spread into two stages, that is, Integrated Psycho-socio Scientific Argumentation into face-to-face facilitation and ordinary face-to-face facilitation:

Treatment A. Integrated psycho-socio scientific argumentation into face-to-face facilitation:

Stage 1: The group for integrated psycho-socio scientific argumentation into face-to-face facilitation was formed. It consisted of fourteen members. **Stage 2**: The group was further randomly divided into two groups of seven people each. This was done to enable the groups to cover the four Physics learning contents that formed the contents being facilitated. These contents determined the roles that the learners played in the facilitation processes. Each of the group was given an identification name that tallied with some of the foremost Physics scientists. For example, group one was identified as 'Albert Einstein group. **Stage 3**: The group members were asked to extensively study the recommended course materials on the concept of temperature, types of

thermometer, heat measurement and gas law on their own. **Stage 4**: Rules of engagement for group interaction were read out to include respect for individual's opinion towards proving his group and other individual ideas, non-interruption of individuals when expressing ideas, proving his and other individual ideas, strict focus on subject matter (s), non-comment on personality appearance or affiliation, respect for individual attempt (s), appointment of group representatives, complete audience when a representative of a group presents group's thoughts, ideas or opinions, and regard for the facilitators. Finally, a summary based on valid and established facts. **Stage 5**: The group members appointed a representative to present the findings and thoughts of their group while the other group members created rebuttals. **Stage 6**: Each group made a presentation on the assigned content extracted from module one of Heat and Properties of Matter (course material prepared for the students of the National Open University of Nigeria.) **Stage 7**: The representative of the group introduced the identification name of the group as Albert Einstein. The representative of the group introduced the group title of presentation to be concept of temperature. For example, one of the group presentations of contents started with Claims as follows:

1. It has been scientifically established that the term "Heat" is different from the term "Temperature". Heat measurement is usually referred to as calorimetric while temperature measurement is referred to as Thermometry. Heat is capable of effecting several actions as it was during the industrial revolution. Temperature is a measurement of heat and cannot effect any action. Heat causes an increase in the hotness of a body. If a body receives heat, it becomes warm and cold when it loses heat. Temperature therefore, is the degree of hotness or coldness of a body. Heat flows from a body whose degree of hotness (temperature) is higher or greater than the body of lower degree of hotness. 2. Rebuttals: A member of Galileo Group raised this rebuttal: Some people argued that this type of definition of temperature is qualitative and very subjective. Hotness or coldness is a perception that differs from one person to another. Quantitative measure of temperature will be preferred. How will you react to this argument? Response: The measure of degree of hotness or coldness is done with the use of an instrument called a thermometer. A thermometer gives a quantitative measure of degree of hotness or coldness and not qualitative measure. When we say 35^{o}C, it is a quantitative account and not subjective. 2. Another important scientific claim in this concept is the principle of thermal equilibrium. Thermal equilibrium exists between two bodies when they are in contact with each other and there is no net flow of heat between them. Two bodies may be at different temperatures - one hot and the other cold. The hot one is said to possess more heat energy than the colder

body. If the two bodies are now in contact with each other, heat energy flows from the hot to the cold body until the temperature of the two bodies becomes the same. The two bodies are said to be in a state of thermal equilibrium. It is the temperature of a body that determines the direction of flow of heat from that body to another. 3. Rebuttals: This rebuttal is posed by a member of Isaac Newton's group: How will you explain thermal equilibrium when ice is mixed with warm water? Will you say that heat flows from the ice if the entire water is still cold at the end of the mixture? Response: The amount of heat needed to convert ice to hot or warm water will be more than you have described. In thermodynamics, thermal equilibrium is better explained when the two bodies are in direct contact or separated by two types of walls: the adiabatic and the diathermic. If liquid of different temperature is however, mixed together as you have described, there must be a common resultant temperature. In any case, thermal equilibrium will be maintained as you cannot experience two different temperatures within a system or container of a liquid. The argument continues within the framework of scientific facts on each topic presented. 4. At the end, the facilitator came up with a clear submission on the subject matter

For example, the facilitator used the psychological rehearse to explain the Zeroth law of thermodynamics that states that "when two thermodynamic systems A and B are separately in thermal equilibrium with a third system C, and then the systems A and B are in thermal equilibrium with each other.' It must be first of all noted that Zeroth law is used in establishing the temperature of a body quantitatively and objectively. In thermodynamics, bodies are brought into contact in order to establish a common temperature. The two bodies may be in direct contact or they may be separated by two types of wall: adiabatic and diathermic. Adiabatic (insulators such as wood, plastic or fibre gears) are those through which heat cannot be transmitted while diathermic (such as a copper wire) will allow heat to be transmitted. These two words are used to describe thermal equilibrium. For clearer a explanation on Zeroth law of thermodynamic, the concept of a diathermic or adiabatic wall will be considered to enhance thermal equilibrium which is the major word in the law. Even with this illustration, rebuttal was raised. Rebuttal: What does the term "Zeroth" mean and what is the practical application of the law? Response: From my understanding and in accordance with the course materials, the term Zeroth was used to recognize the fact that there are existing laws and principles called the 1^{st}, 2^{nd}, and 3^{rd} laws of thermodynamics. Hence the Zeroth law which is foundational was placed

before other existing laws on number zero. The Zeroth law was used to further explain thermal equilibrium using the adiabatic and diathermic walls. These stages were repeated on the three other Physics contents, that is, types of temperature, gas law and heat measurement. The facilitation day was every Saturday of the week for four weeks at an average of one hour, twenty-five minutes for each meeting day.

Treatment B: Ordinary face-to-face facilitation

Stage 1: The second experimental group consisted of fourteen members without further divisions. They were facilitated with the Ordinary face-to-face facilitation practised by NOUN. **Stage 2**: The facilitator assumed that the group members had read the four Physics contents: concept of temperature, type of thermometer, gas law and heat measurement extensively which made them to request for facilitation because the practice is that under the Ordinary face-to-face facilitation approach, the open and distance learners' request for facilitation is not compulsory. But to ensure a balance between the two groups under investigation, the facilitator asked the group members to read the four Physics content since they were aware of the experiment. **Stage 3**: Facilitator allowed them to interact with one another and asked questions on areas they had difficulty in or found difficult when they read. They shared their thoughts and knowledge with the facilitator.

The facilitation days for Ordinary face-to-face facilitation group were Saturdays. This lasted for two weeks at an average of one hour by meeting. At the end of the two facilitation modes, the groups were tested on One hundred-items objective Physics Performance Test (PPT) design based on the Physics contents that the two groups were exposed to. The testing duration was two hours.

Data Analysis Techniques

The grade scores of the groups in Physics Performance Test (PPT) were analysed with the use of t-test for independent samples. SPSS version 20.0 was utilized.

Results

The following consist of Physics performance grade scores of learners facilitated with the Integrated Psycho-socio scientific argumentation into face-to-face facilitation and Ordinary face-to-face facilitation.

Table 1: **Obtained Grade Scores in Physics Performance Test of the Integrated psycho-socio scientific argumentation into face-to-face facilitated group and Ordinary face-to-face facilitated group (N=28)**

S/N	Integrated psycho-socio scientific argumentation into face-to-face facilitated group	Ordinary face-to-face facilitated group
1.	44	46
2.	40	49
3.	43	41
4.	59	43
5.	57	42
6.	44	41
7.	66	41
8.	57	41
9.	77	44
10.	66	43
11.	49	41
12.	50	41
13.	67	44
14.	47	41

Table 1: This description showed that the mean of Physics distance learners facilitated with the integrated psycho-socio scientific argumentation into face-to-face facilitation statistical mean (54.71) was higher than those distance learners' statistical mean (42.71) facilitated with Ordinary face-to-face facilitation.

Hypothesis: There is no significant difference between Physics performance grade scores of open and distance learners facilitated with integrated psycho-socio scientific argumentation into face-to-face facilitation and those facilitated with ordinary face-to-face facilitation.

Table 2: t –test Analysis of Physics Performance Test Grade Scores of Integrated Psycho-socio scientific argumentation into face-to-face facilitated and Ordinary face-to-face Facilitated Groups (N=28)

Measures	Mean	Sds	t-cal.	t-crit
Integrated psycho-socio scientific argumentation Into face-to-face facilitated group	54.71	11.19	3.85	0.002
Ordinary face-to-face facilitated group	42.71	2.999		

Note: t >0.05, t > 3.85

Table 2: Following the analysis, the result indicated t >0.05, t > 3.85, that is, a significant Physics performance grade scores of open and distance learners facilitated with the Integrated psycho-socio scientific argumentation into face-to-face facilitation after being compared with those open and distance learners facilitated with the Ordinary face-to-face facilitation.

Discussion

The research findings indicated that the performance grade scores in Physics Performance Test of open and distance learners facilitated with the integrated psycho-socio scientific argumentation into face-to-face facilitation significantly differed from the performance grade scores of open and distance learners facilitated with the ordinary face-to-face facilitation, as can be seen in table 2. The result was expected on the basis that psycho-social factors assumed to be the limitation of scientific argumentation were considered and added to the scientific argumentation process and then integrated with the ordinary face-to-face facilitation. This supports the claim that argumentation plays a vital role in the teaching and learning of science subjects among learners, and therefore, is reinforced in science subject classrooms (Driver, Newton, & Osborne, 2000). The findings also support the study that stated that a scientific argumentation is one of the perspectives from which researchers have investigated the role of argumentative discourse in science subjects' education, and the effectiveness of argumentation on learners' conceptual understanding of scientific concepts (Duschl & Osborne, 2002). The result of the study was also in line with the findings that learners can construct better arguments in terms of content and justification on their own after collaborating with others even though they had minimal prior formal experience in the practice of scientific argumentation processes (Simon, Erduran & Osborne, 2006). The psycho-social factors that were considered into the scientific argumentation approach were in agreement

with outlined factors that are relevant in the practice of scientific argumentation to include positive interdependence, individual accountability, interpersonal skills and face-to-face interaction (Duschl & Osborne, 2002). The study's result also supported the opinion that the development of argumentation in schools' science subjects involved a partnership between researchers and teachers (Simon, Erduran & Osborne, 2006).

Recommendation

The study recommends that the integrated psycho-socio scientific argumentation into face-to-face facilitation can be used as a mode of facilitation for Physics distance learners of the National Open University of Nigeria and possibly distance learners that have similar characteristics. Teachers or facilitators can also consider the psycho-social factors whenever they apply scientific argumentation or when they discover a problem in the way they apply the scientific argumentation technique or the ordinary face-to-face facilitation.

Conclusion

The researchers concluded that the integrated psycho-socio scientific argumentation into face-to-face facilitation proved helpful in enhancing the academic performance of Physics distance learners under investigation. Further studies that will investigate the integrated psycho-socio scientific argumentation into face-to-face facilitation on large classes of open and distance learners should be conducted.

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