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Interactive Instructional Material in Teaching Atomic Structure: Development and Validation

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Abstract

This study was conducted to develop and validate an interactive instructional material in teaching atomic structure for Grade 8 learners. The study used research and development cycle (R & D) to come up with an interactive material in science instruction. The interactive instructional material was evaluated by Science and Information Technology experts, respectively. The interactive instructional material was excellent in terms of relevance, adequacy, appropriateness, and instructional characteristics. Likewise, the interactive instructional material was very satisfactory in terms of usability, functionality, and user interface. All indicators showed that the interactive instructional material is highly acceptable. Statistics showed no significant difference between the pretest means scores of the control and experimental groups. Both traditional method and the use of interactive instructional material were effective in improving learners' performance. However, the use of interactive instructional material was more effective than the traditional method after comparing the mean scores of the posttest of the control and experimental groups (d = 0.05). It is recommended that the interactive instructional material be used as a supplement in teaching atomic structure in Chemistry.

Keywords: atomic structure, chemistry, development and validation, instructional material

Introduction

The majority of educators frequently employ the lecture method, which does not always promote effective learning. According to studies, teachers prefer the aforementioned teaching technique to merely using additional visual elements to support oral instruction (Angadi & Ganihar, 2015).

Nowadays, it is reported that learners acquire little to no Chemistry knowledge in school as it tends to be too by-the-book, being methodical, and being regarded as simply difficult. Learners are being immersed in a lot of mental stimuli; these being music, computer games, and other technological fields. A large number of educators view these as being lost pursuits, when in fact, these may be utilized to further acquire learners' participation in learning (Ajileye, 2006).

Course-aligned text books play a pivotal role in the framework of the teaching-learning process in school as it is known to be the backbone of education. However, they are not the only resources in learning able to be used (Mahmood, 2010).

Instructional materials have been a staple in the teaching-learning process. It is then recommended for educators to use these resources and materials to make teaching more engaging and promote active class participation (Laxamana, 2012).

Bessong, Ejue and Ojong (2016) pointed out that the use of Information and Communication Technology (ICT) in teaching and learning greatly affects the learners' ability to retain what has been taught, as it encourages their interests.

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Good instruction requires the use of methods that cater to a group or an individual's needs accordingly to enable them to cope properly with what is being taught (Kennedy et al., 2008).

Most Science-related concepts are difficult to grasp as they are theoretical or incapable of being observed in depth in normal interactions. Junior high school learners have a difficult time understanding ideas and concepts being taught in science, particularly in Chemistry, causing the subject area to be viewed as a difficult one. This is because of the lack of visual representation that the various concepts in Chemistry have, being limited to the standard textbook lecture (Yaron et al., 2010).

The teaching-learning process in the classroom is dependent on the methods of instruction used by the teacher, seeing as how professional competence is viewed to be a vital part of the overall teaching process (Baumert & Kunter, 2006). Proper training is among the most crucial components of the development of the public (Županec, Miljanović, & Pribićević, 2013). With this, and as progressing changes in the current generation, adjustments must be made to the proper training and conditioning of educators to effectively modernize the learning materials essential in presenting data and information in a visual manner.

In keeping with the principle of using instructional materials to ease the understanding of scientific concepts, the present work intended to develop an interactive, computer-based teaching tool for the concept of atomic structure. It is intended that the development and eventual deployment of interactive instructional materials will make teaching science to Filipino students more rewarding and productive, in line with the requirements of the K–12 Curriculum.

Didactic Objectives

This study aimed to develop and validate an interactive instructional material in teaching atomic structure among Grade Eight learners.

More specifically, the study sought to achieve the following objectives:

1. to develop an interactive instructional material in teaching atomic structure.
2. to validate the interactive instructional material in teaching atomic structure by:
   - 2.1 Science experts in terms of:
     - 2.1.1 content;
     - 2.1.2 adequacy of the scope;
     - 2.1.3 appropriateness of the procedure; and
     - 2.1.4 instructional characteristics.
   - 2.2 Information Technology (IT) experts in terms of:
     - 2.2.1 usability;
     - 2.2.2 functionality; and
     - 2.2.3 user interface.
   - 2.3 effectiveness to users
3. to derive implications to science education.

Analysis and Presentation of Data

Development of the Interactive Instructional Material

The process of the development of the interactive instructional material started with the collection of relevant information, materials, and subtopics in atomic structure. After the collection of relevant information and material, the development followed. The subtopics were Models of the Atom; Proton, Electron and Neutron; Atomic Number and Mass Number; Atom vs Ion. The material underwent the following phases: planning, collecting, video-making, sound placing, and burning.

The primary application used was Visual Basic (Visual Studio 2012). Adobe Photoshop CS6 - Create was used to edit images. The audio was downloaded from YouTube. Atube Catcher was used to convert video files from .mp4 to .wav audio files because .wav file is the supported file for Visual Studio 2012. All images were downloaded from google.com. Microsoft windows 10's built-in burning function was used to burn the atomic structure file.

Validation of the Interactive Instructional Material in Atomic Structure

The interactive instructional material was validated by science experts, IT experts, and users in terms of effectiveness.

Validation of the Interactive Instructional Material in Atomic Structure by Science experts

The developed interactive instructional material in atomic structure was validated by Science experts in terms of relevance of content, adequacy of the scope, appropriateness of the procedure, and instructional characteristics.

Validation of the Interactive Instructional Material in Atomic Structure by Science Experts in Terms of Content

The relevance of the content of the interactive instructional material was considered excellent with a total mean of 4.9. It contained significant lessons marked by mean rating of 4.8 – excellent. The interactive instructional material's potential to enhance learning competency of learners was 5.0, excellent. Experts also considered the motivation and adequacy of the interactive instructional material as excellent for having a rating of 4.6. Lastly, the objectives, presentation, and evaluation were evaluated as excellent with a weighted average of 5.0.

Validation of the Interactive Instructional Material in Atomic Structure by Science Experts in Terms of Adequacy of the Scope

The contents and discussions of the interactive intructional material had a mean rating of 4.4, very satisfactory. The test items, lessons, and explanations were all 4.8, excellent; the illustrations received a grand mean of 5.0, with an excellent rating.

The results show a total mean of 4.7 for the adequacy of the scope of the interactive instructional material whichreceived a descriptive rating of excellent.

Validation of the Interactive Instructional Material in Atomic Structure by Science Experts in Terms of Appropriateness of the Procedure

The directions and arrangement of the procedure of the interactive instructional material had a mean rating of 4.8 excellent and 4.4 very satisfactory rating, respectively. The interactive instructional material showed 4.6 excellent rating in self-pacing and exercises. The illustrations have a mean of 4.6, excellent rating from the experts.

The total mean of 4.6 reveals that the appropriateness of the teaching procedures of the interactive instructional material is excellent.

Validation of the Interactive Instructional Material in Atomic Structure by Science Experts in Terms of Instructional Characteristics

In terms of instructional characteristics, the experts evaluated the interactive instructional material with indicators ranging from 4.2 to 5.0 and had a total mean of 4.8, which is interpreted as excellent and implying that the interactive instructional material is highly acceptable.

In sum, the validation of Science experts of the interactive instructional material in terms of relevance of the content, adequacy of the scope, appropriateness of the procedure, and instructional characteristics revealed a grand mean of 4.8 with a descriptive rating of excellent.

Validation of the Interactive Instructional Material in Atomic Structure by IT experts

Three (3) IT experts evaluated the developed interactive instructional material in atomic structure in terms of usability, functionality, and user interface.

Validation of the Interactive Instructional Material in Atomic Structure by IT Experts in Terms of Usability

The IT experts evaluated the usability of the interactive instructional material as very satisfactory with a total mean of 4.3. It was rated very satisfactory (4.3) by experts in terms of understanding of system function. Also, the experts evaluated the interactive instructional material as very satisfactory with a mean rating of 4.3 as to ease in learning to use software and ease in operating the software, respectively.

Validation of the Interactive Instructional Material in Atomic Structure by IT Experts in Terms of Functionality

The appropriateness of system function and accuracy of the system output were both rated very satisfactory with a mean rating of 4.0. The IT experts rated the interactive instructional material as very satisfactory in terms of its functionality.

Validation of the Interactive Instructional Material in Atomic Structure by IT Experts in Terms of Effectiveness to Users

The experts found the user interface of the interactive instructional material as very satisfactory, and gained a total mean of 4.0. The interactive instructional material was rated very satisfactory in terms of its visually appealing user interface, use of menu bar, and software design; all with mean rating of 4.0.

In sum, the experts evaluated the interactive instructional material as very satisfactory (grand mean of 4.1) with a descriptive rating of very acceptable.

Validation of the Interactive Instructional Material in Atomic Structure in terms of Effectiveness to Users

The developed interactive instructional material in atomic structure was validated through pretest/posttest results of the experimental and control groups using t-test. There were 20 subjects for each group, having a total of 40 subjects in both experimental and control groups. The pretest and posttest results of the experimental and control groups were scored, tabulated, and their means were compared and tested at 0.05 level of significance.

Comparison of the Pretest for the Control Group and Experimental Group

T-test results were computed to show the significant difference between results of the pretest of the experimental and control group.

The mean of the control group is 8.55 while the experimental group is 7.00. The mean difference of the two groups is 1.55. The computed t-stat is 1.636, lower than the critical t-value of 2.024 at 0.05 level of significance. The null hypothesis was accepted. Hence, there is no significant difference between the mean rating of the pretest scores of the control and experimental groups.

Comparison of the Pretest and Posttest of the Control Group

The control group posted a mean in the posttest statistically higher than the mean computed in the pretest, with a mean difference of 6.40. The computed t-stat was 7.419 is a value higher than the critical value of 2.093; the null hypothesis was rejected. Thus, the results show that there is a significant difference between the pretest and posttest of the control group.

Comparison of the Pretest and Posttest of the Experimental Group

The t-statistics for the pretest and the posttest is 10.609 which is statistically higher than the critical t-value 2.093 at 0.5 level of significance. As such, the null hypothesis was rejected.

The results show that there is a significant difference between the pretest and the posttest of the experimental group.

Comparison of the Posttest for the Control Group and Experimental Group

The mean of the control group is 14.95 while the experimental group is 18.70. The mean difference of the two groups is 3.75. The computed t-stat is 2.55, higher than the critical t-value of 2.024 at 0.05 level of significance. The null hypothesis was rejected; therefore, there is a significant dereference between the mean rating of the posttest scores of the control and experimental groups.

Implications to Science Education

In this study, the interactive instructional material was found to be an effective method of teaching and could be used as an alternative method in motivating learners' learning. In connection to the study of Buckshaw and Lyon (2011) emphasized that incorporating technology in teaching Chemistry shows improved learner achievement. More specifically, the use of an interactive instructional material to teach concepts in Chemistry could lead to ways in bringing together the idea of an effective Science instruction and productive learning on the part of the learners. Moreover, Sangodoyin (2010) studied the academic achievement of Nigerian secondary school learners using computer animation as instructional tool. His findings show that there was a significant effect on learners' achievement, where computer animation was effective in improving learners' achievement. Thus, the interactive instructional material had a significant influence on the learners' performance. It encourages the said learners to think for themselves, without having to be solely dependent on the teacher, and be logically assessed by the presented games. There is a given creative aspect to the experimental group that separates it from the traditional classroom discussion learners are often subjected in. It keeps the learners hooked on the lesson while giving them the enjoyment of learning, which is the basic objective of any educator for their learners.

Since the results reveal that learners achieved higher understanding towards atomic structure when the interactive instructional material was used, then the implementation of the method was successful. Having the said results, this study may be adapted by other teachers in the field to improve their teaching methodology. It could also suit some characteristics of 21st Century learners like being visual-manipulative learners, critical thinkers and curiosity-driven individuals. As a whole, this study would support interactive instructional material to science teaching in the classroom and such method should be taken into full consideration.

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