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Development and Evaluation of Discovery Approach-Based Instructional Materials for High School Science

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ABSTRACT

The traditional method of science teaching in the province of Abra, Philippines is still prevalent. This leads to poor academic outcomes due to poor understanding and comprehension of students on the different theories in science. Hence, the study was conducted to develop and evaluate instructional materials aligned to discovery approach and to determine the level of appropriateness, acceptability, and usability of the developed instructional materials for science teaching. The study used the Students and Teacher Collaborative Instructional Materials Development Model (STCIMD) to develop and evaluate instructional materials exclusively for Physics, Chemistry, and Biology. Students from Fourth Year, Third Year, and Second Year of ASIST Laboratory High School and subject teachers served as the evaluators of the prepared instructional materials. Majority of the instructional materials developed were evaluated by the teachers as Strongly Appropriate (SA), Acceptable (A), and Usable (U). The students evaluated the instructional materials as Appropriate (A), Acceptable (A), and Usable (U). Results showed that the instructional materials captured their interest and curiosity in discovering the scientific principle behind the activity. Accordingly, these instructional materials that were aligned to discovery approach were proven

valuable in achieving meaningful learning. Thus, these materials should be utilized during the lesson presentation to facilitate learning.

Keywords – Education, instructional materials, discovery approach, science teaching, descriptive design, Abra, Philippines

INTRODUCTION

Throughout history, the education and training of each person, group, and society have continuously acted as a valuable role for development. It caters in providing valuable human resources for the advancement of all areas in society. Many places conduct researches about new teaching techniques, new teaching tools and new curriculum in developing their country's educational system (Huy, 2013). However, the transfer and development of knowledge will always depend on the teaching strategy employed by the teachers which will motivate the learner and guide him in his own understanding with regards to the application of scientific principles.

The most common method employed in teaching is known as the traditional approach. To distinguish the difference between traditional from other teaching strategies, we could say that traditional teaching focuses with the teacher being the manipulator of the learning environment. Authority and accountability are assumed by the teacher and performs the part of a mentor (through class discussion) and evaluator (in respect to curriculum content and specific outcomes). The traditional method believes that teachers are the reason for knowledge to transpire (Novak, 1998). The subject matter and the traditional teaching technique are believed to be highly valuable in conveying information to learners using constant memorization or repetition of the lesson (D. Johnson & R. Johnson, 1991; Theroux, 2001).

One of the disadvantages of old-fashioned teaching is that it intentionally gives importance to customary practices, does not promote decisive reasoning ability, and does not improve proficiency to keenly utilize knowledge learned through actual practice and understanding. It highly stresses the part of educators as source of wisdom and learners as knowledge receptacles. This type of education does not permit the learners' hidden stage of comprehension needed for difficult ideas and lasting knowledge. It also emphasizes passing tests, whether or not students understand the content of the testing material. The development of knowledge is thus, hindered, and learners are discouraged to learn the procedures,

means and approaches to solve problems. Instead of concentrating on a wider scope and focusing on the learner's perspective as what constructivism does, conventional teaching instead concentrates on rudimentary abilities to slowly develop a learner. Though this makes education easier, it gives only a small background or information to students. Conventional teaching concentrates on each learner's activity and work but fails to instill group dynamics. This form of education fails to train learners the essence of unity and cooperation in achieving wisdom and knowledge (Smerdon, Burkam & Lee, 1999).

The traditional method of science teaching in the province of Abra is still considered prevalent which leads to poor academic outcomes due to poor understanding and comprehension of students on the different theories in science. To provide remedy to this problem, the integration of other forms of teaching strategy should be considered such as discovery approach. Discovery learning aims to let learners find solutions on their own, as well as analyze data and formulate inquiries. Its main objective is to let learners come up with their own answers to problems that were not clear to them before. Apparently, once questions are made, they can gain new ideas that will further motivate them to explore new areas (Marzano, 2011). An effective way of utilizing new teaching strategies such as discovery learning is through the development of related instructional materials.

The instructional material design following a student-centered approach combined with case-based and collaborative learning produced encouraging result wherein conversations with school children showed that the use of the developed instructional material made the class motivating and thought provoking, aided them to practice computing realistic problems, encouraged teamwork, incorporated geography and history, and encouraged development of their interaction abilities (Godoy & Gravoso, 2010).

A similar study was conducted in Singapore exploring student teachers' intentions and actions in technology integration as a form of instructional material in their classrooms. Results show that student teachers in Singapore are willing to use the instructional material to facilitate student-centered learning when they become full-pledged teachers. (Choy, Wong & Gao, 2009).

Teachers should consider instructional materials that are cost-effective as well as conformant with today's instructional material standards. The instructional materials will further be assessed and evaluated based on the rubrics that are adopted. The goal of the study is to look for a possible practical approach on enhancing learning through the development and use of instructional materials.

FRAMEWORK

Teaching the different fields of science is a complex and painstaking endeavor. Everything that a teacher does should always be exact, precise and accurate to be able to achieve meaningful learning. Science teaching can be best described as a constantly evolving field in educational instruction that undergoes transformation with the changing time.

In the advancement of science and technology, teaching strategies and methods in science teaching is being revolutionized to meet the needs of students. For students to keep up with the changing trends of instruction, teachers must consider methods and strategies along with proper instructional materials. Thus, this research is concerned with the Development and Evaluation of Discovery Approach-based Instructional Materials for High School Science. The instructional materials presented in the study were Simple Electric Motor and Steam Powered Boat for Physics, Kitchen Chemicals and Surface Tension for Chemistry and Audio-Visual Presentation of Human Circulatory System and Human Digestive System for Biology stand as the independent variable in this study. The level of appropriateness, acceptability, and usability of the different discovery approached-based instructional materials developed will be the dependent variable.

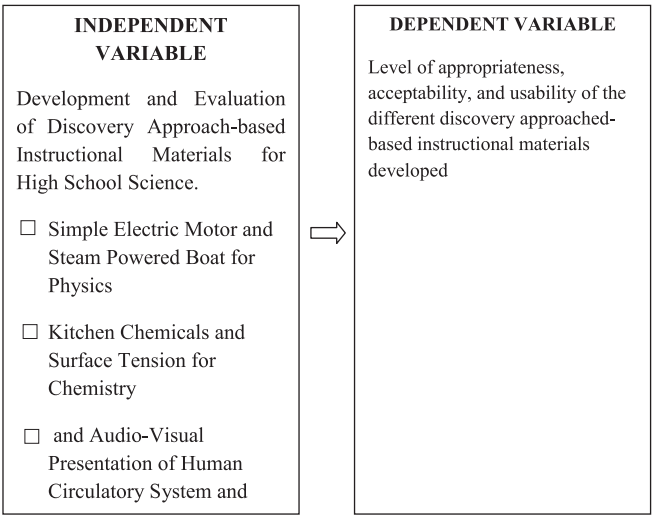

Figure 1. Conceptual paradigm of the study

OBJECTIVE OF THE STUDY

The study aimed to develop and use instructional materials that are relevant based on the principles of human learning and cognition that will also fit current standards and practices for instructional materials design (Greitzer, Merrill, Rice & Curtis, 2004).

METHODOLOGY

Prior to the conduct of the research, necessary permits were obtained as well as strict ethical protocols were observed. The study used the Students and Teacher Collaborative Instructional Materials Development Model to develop and evaluate instructional materials aligned to discovery approach.

Figure 2. The Students and Teacher Collaborative Instructional Materials Development Model

The sources of the study were collected from Second Year, Third Year and Fourth Year High School students who used and evaluated the instructional materials. The study was divided into three fields of science, namely, Biology; Chemistry and Physics in which the instructional materials were used through discovery approach. Both sections of the Fourth Year, Third Year, and Second Year students of ASIST Laboratory School were chosen as assessors, together with corresponding subject teachers. The researchers used the students and teacher collaborative instructional materials development model to develop and evaluate instructional materials. The evaluators were selected through random sampling. The students whose names were odd numbered were given evaluation sheets. The instructional materials were evaluated according to the level of appropriateness, acceptability, and usability. The gathered data were organized and recorded after the administration of the said study.

The instructional materials presented in the study were Simple Electric Motor and Steam Powered Boat for Physics, Kitchen Chemicals and Surface Tension for Chemistry and Audio-Visual Presentation of Human Circulatory System and Human Digestive System for Biology.

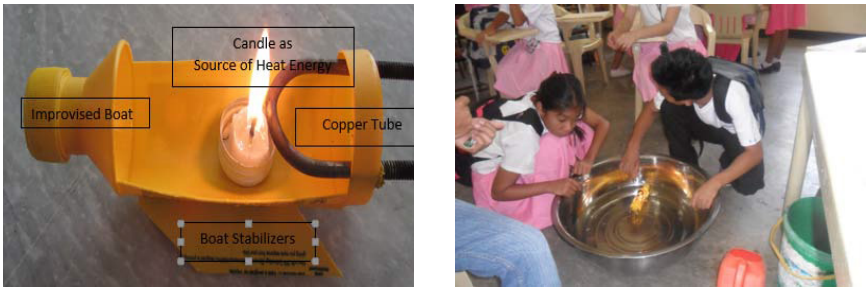

Figure 3. Fourth year students performing the activity in Thermodynamics using the Steam Power Boat Model

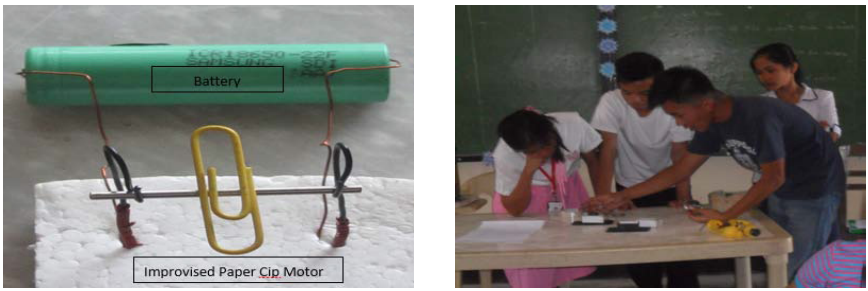

Figure 4. Fourth year students performing the activity in Electromagnetism using the Improvised Electric Motor Model

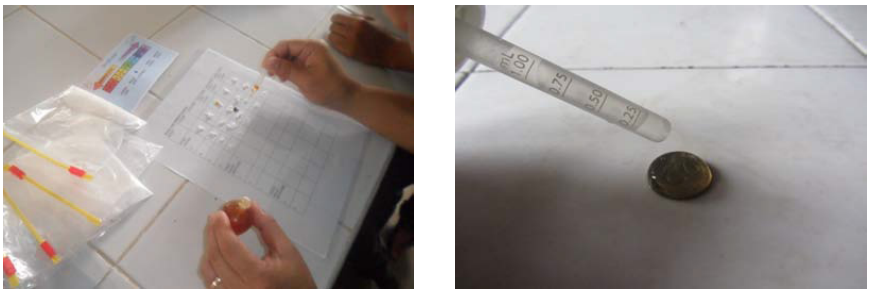

Figure 5. Chemistry Teachers evaluates the developed instructional material in microchemistry using household chemicals in explaining chemical reactions and surface tension.

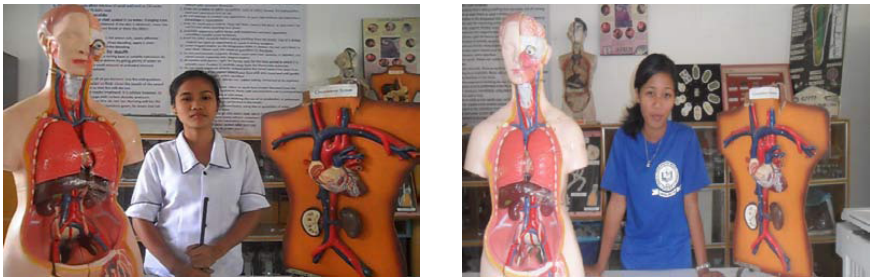

Figure 6. Audio-visual Presentation as part of the instructional material in Biology

The levels of usability, acceptability and appropriateness of the developed Instructional Materials were evaluated and described following the norms:

	Appropriateness	Acceptability	Usability
Range Interval		Descriptive Rating	
3.50 - 4.00	Strongly Appropriate (SA)	Strongly Acceptable (SA)	Strongly Usable (SU)
2.50 - 3.49	Appropriate (A)	Acceptable (A)	Usable (U)
1.50 - 2.49	Fairly Appropriate (FA)	Fairly Acceptable (FA)	Fairly Usable (FU)
1.00 – 1.49	Not Appropriate (NA)	Not Acceptable (NA)	Not Usable (NU)

Usability - it is the usefulness of the instructional materials.

Acceptability - it is to determine whether instructional materials are worth the cost in materials, effort and time involved.

Appropriateness - it is the suitability of the instructional materials to students and teachers.

RESULTS AND DISCUSSION

The findings were based on the table of statistical analysis on the level of appropriateness, acceptability, and usability of instructional materials.

Table 1. Level of appropriateness, acceptability, and usability of the audio-visual presentation used in teaching Human Circulatory System for Biology

Instructional Material Component	Teacher		Students	
	$\bar{x}$	Adjectival Description	$\bar{x}$	Adjectival Description
Appropriateness	3.67	SA	3.45	A
Acceptability	4.00	SA	3.58	SA
Usability	3.00	U	3.39	U

It has been observed that the subject teacher and students in the study found the audio-visual lessons appropriate, acceptable, and usable. They enjoyed during its demonstration as "an enjoyable learning setup is a prerequisite to fruitful teaching". It is likewise promising that the students realized that the materials are relevant and valuable. This is because appropriate and applicable tools enable students to achieve specific expertise, intelligence, and manners (Ghee & Heng, 2008).

Table 2. Level of appropriateness, acceptability, and usability of the audio-visual presentation used in teaching Human Digestive System for Biology

Instructional Material Component	Teacher		Students	
	$\bar{x}$	Adjectival Description	$\bar{x}$	Adjectival Description
Appropriateness	4.00	SA	3.46	A
Acceptability	4.00	SA	3.53	SA
Usability	3.67	SU	3.47	U

Wetzel, Radtke, and Stern (1994) found in their research that audiovisual materials enhance learners' attention in the topic, as well as it acts as a driving force to learn. Students find audiovisual materials appealing, and it leads to higher degree of acceptance among students (Kearney & Treagust, 2001; Piotrow, Khan, Lozare, & Khan, 2000). Likewise, a similar result shows the affirmative effects of interactive audiovisual material on both learning outcomes and learner satisfaction in e-learning (Zhang, Zhou, Briggs & Nunamaker, 2006).

Table 3. Level of appropriateness, acceptability, and usability of the kitchen chemicals used in teaching Chemistry

Instructional Material Component	Teacher		Students	
	$\bar{x}$	Adjectival Description	$\bar{x}$	Adjectival Description
Appropriateness	4.00	SA	3.34	A
Acceptability	3.00	A	3.16	A
Usability	4.00	SU	3.17	U

According to the Ministry of Education (1995), in using instructional technologies, the teacher can explain concepts that would be difficult to elaborate orally. Students can easily understand concepts when they see the material, its mechanism, and its function.

Table 4. Level of Appropriateness, Acceptability, and Usability of the Instructional Material Used In Teaching Surface Tension for Chemistry

Instructional Material Component	Teacher		Students	
	$\bar{x}$	Adjectival Description	$\bar{x}$	Adjectival Description
Appropriateness	3.33	A	3.23	A
Acceptability	3.50	SA	3.21	A
Usability	3.00	U	3.30	U

In terms of *Appropriateness*, the evaluated instructional material was based according to the significance of the material to students, and styles or designs of the material. The computed mean of the teacher is 3.33 while the students obtained a mean of 3.23. Although, the evaluation of the teacher is lower compared to the students, both agreed that the material is Appropriate (A).

The use of the instructional material has an impact on students' content acquisition and adds to class performance (Baylor & Ritchie, 2002). However, research has shown that it is not only the technology that is important, but also how it is used that improves learning and increases pupils' interest (Beggs, 2000).

Table 5. Level of appropriateness, acceptability, and usability of the instructional material used in teaching electric motor for Physics

Instructional Material Component	Teacher		Students	
	$\bar{x}$	Adjectival Description	$\bar{x}$	Adjectival Description
Appropriateness	4.00	SA	3.23	A
Acceptability	3.25	A	3.14	A
Usability	3.67	SU	3.21	U

A research study conducted in the Division of Pateros and Taguig for C.Y 2003-2004 shows very poor performance of Fourth Year students in Physics. Changes were made in their Science curriculum, but still low results were obtained. This prompted school administrators to implement discovery approach-based instructional materials. Result shows that the instructional materials effectively increased the performance level of the students. All instructional materials were also evaluated as highly acceptable with regard to its usability, adequacy, clarity, and relevance (Naval, 2014).

Table 6. Level of appropriateness, acceptability, and usability of the instructional material used in teaching using steam powered boat for Physics

Instructional Material Component	Teacher		Students	
	$\bar{x}$	Adjectival Description	$\bar{x}$	Adjectival Description
Appropriateness	4.00	SA	3.13	A
Acceptability	3.25	A	3.13	A
Usability	3.67	SU	3.10	U

Physics is one of the science subjects that is considered to be difficult and hard to understand due to its mathematical equations that further increases the complexity of the subject matter.

Most high school students find physics difficult to understand. This may be accounted to the use of mathematics as its language which requires skills in computation. If not properly explained it will lead to erroneous beliefs or misconceptions on the part of the students. The introduction of instructional material will aid students to comprehend the lesson better, especially when it involves a great number of learners (IJESE from Australia, 2008).

CONCLUSIONS

Instructional materials aligned to discovery approach in science teaching enhances students' participation and learning in Biology, Chemistry, and Physics. Based on the findings of the study, most of the instructional materials developed were Strongly Appropriate (SA), Acceptable (A), and Usable (U) for classroom instruction as perceived by the teachers. The findings of this study imply that there is a need for the improvement of instructional materials in Science and Technology in Abra.

On the other hand, the students evaluated the developed instructional materials as Appropriate (A), Acceptable (A), and Usable (U). This implies that instructional materials associated to discovery approach can better improve learning outcomes as well as enhance their understanding of concepts and ideas on the different fields of science. Therefore, maintaining students' interest in Science and Technology can be attained by the implementation of discovery approach in teaching which, if well planned, can inspire and encourage the learner to perform and observe the scientific knowledge learned to life situations by making use of the process and skills in science. This could also lead to the attainment and advancement of knowledge in the country. Through discovery approach, learners will be able to foster more optimistic point of view towards learning skills and also, it will improve learning results through hands-on and minds-on activities.

TRANSLATIONAL RESEARCH

The researcher regards this study as a catalyst of change in improving the learning outcomes of students in the province of Abra. From the result of the study, teachers would be given ideas on how to create instructional materials in science that is well suited for discovery approach. Instructional materials that were developed from this study will undergo further enhancement and then be distributed to participating schools in the province for further verification and validation as to its effectiveness. Once it passed all criteria as an instructional material on discovery approach, it will then be converted into kits that will be readily available to all schools in the province. Hence, this will hopefully increase the inquisitiveness and attainment of knowledge of students in Abra.

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