

Development and Evaluation of an Instructional Package for the Topic Cellular Respiration in Biology for Grade 12 Science, Technology, Engineering and Mathematics (STEM) Track

Ma. Socorro G. Leong-on¹, Bibiana Espina²

¹Biology Department, College of Liberal Arts, Science and Education, University of San Agustin, Iloilo City, 5000, Philippines

²West Visayas State University, Iloilo City, 5000 Philippines

Abstract: Cellular respiration is one of the difficult topics to learn in Biology. This situation calls for a development of an instructional package for this topic. This study was conducted to design and develop an instructional package for the topic cellular respiration and to evaluate it. The instructional package made use of the 5E's model. The evaluation form for both print and non-print of the Learning Resources Management and Development System (LRMDS) of the Dept. of Education, 2009, of the Philippines were used by the experts in the field for evaluation. Result showed that the print part of the instructional package was rated by the evaluators excellent in format, presentation and organization and accuracy and up to datedness of information. The content was rated very good. The print part of the instructional package covered all the development of desirable values and traits among Filipino students. The top values perceived by the evaluators on the instructional package were enhancement of the scientific attitude and reasoning, desire for excellence, helpfulness/ teamwork/cooperation, ability to tell the right and wrong and critical and creative thinking. While the videos (non-print material) were rated excellent in all areas of evaluation such as content, instructional, technical qualities and other findings. The instructional package that was developed can be used to teach grade 12 students in their Biology subject under STEM track based on the evaluation of the experts. It conforms to the standards of the Learning Resources Management and Development System (LRMDS) of the Dept. of Education, 2009, of the Philippines.

Keywords: instructional material/package, cellular respiration, biology, STEM track

1. Introduction

1.1 Background of the Study

The search for efficient and effective delivery of instruction to students has always been a major concern of science educators [1], especially now with the implementation of the K-12 program. Due to this concern, educators develop instructional package/materials that can help students to attain the 21st century higher order thinking skills. Instructional materials are print and non-print items that are rested to impact information to students in the educational process [2].

Study showed that pupils taught using instructional package performed significantly better. This could be explained by giving the students a chance to interact or participate effectively in the teaching learning process through the use of instructional materials [3]. It was found out also that teaching using instructional materials improved the performance of learners in various learning activities [4].

In Biology, there are several topics that are considered by the students to be difficult. These are matter cycles, endocrine system and hormones, aerobic/cellular respiration, cell division, and genes and chromosomes [5]. A need for the development of instructional package, module or whatever learning material was recommended to be solution to these difficult topics. A study revealed that there is a positive

achievement in students taught by highly qualified biology teachers and those exposed to instructional materials during the lessons [2].

Whatever the form of the instructional materials, either print or non-print, improvised or imported, the most important effect of these materials is to assist in achieving the stated behavioural objectives when evaluation is carried at the end of a lesson or programme [1].

1.2 Rationale of the Study

Since there are topics in Biology that are difficult to learn like the cellular respiration, therefore there is a need to develop an instructional package and to evaluate such package.

1.3 Objectives of the study

This study was conducted to design and develop an instructional package for the topic cellular respiration and to evaluate the instructional package.

1.4 Significance of the Study

The instructional package that was developed can be used to teach grade 12 students in their Biology subject under STEM track based on the evaluation of the experts. It conforms to the standards of the Learning Resources Management and Development System (LRMDS) of the Dept. of Education,

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2009, of the Philippines.

2. Materials and Methods

2.1 Design and Development of Instructional Package

An instructional model for constructivism made use of 5Es Model. This model consists of activities that enhance students' interest towards investigation, meet their expectations and have active usage of knowledge and abilities [7]. The 5Es model served as the pattern in making the instructional package for the topic cellular respiration intended to the grade 12 STEM track students.

The 5E's model consists of five steps: enter/engage, explore, explain, elaborate and evaluate.

- **Enter/Engage Phase:** It helps students to identify what they have known about the subject in order to distinguish their old ideas. In this phase, the lesson is started by an entertaining and attractive presentation, and some questions about the reasons for the event are asked. Here, it isn't important to find the correct response, but to encourage students to put forward different ideas by questioning.
- **Explore Phase:** Students produce new ideas to solve the problem by studying together, conducting experiments and studying using computers, videos or in a library environment. These ideas are turned into abilities and solutions to solve the problem after filtering by the teacher. This is a phase where students are most active.
- **Explain Phase:** In this phase, the teacher helps students to substitute new and correct ideas for old and inadequate ones. This is the most teacher-centered phase of the model. The teacher makes formal descriptions and scientific explanations.
- **Elaborate Phase:** Students apply their newly gained information and problem solving approach into new events and problems. They learn new concepts that didn't exist in their minds before.
- **Evaluate Phase:** This is the phase in which the teacher observes students while they are solving problems and asks them open-ended questions. This is also the phase where students evaluate their own development in learning new concepts and abilities. In this last phase, students form a conclusion by evaluating their new knowledge and abilities.

The instructional package on cellular respiration had the following parts:

- a) **Introduction:** Contains the engagement part of the 5Es model, a brief description of the main topic, target audience, expected outcome after using the instructional package and the key questions
- b) **Pretest:** Measures the initial knowledge of the grade 12 students on cellular respiration based on the competencies listed in the Biology STEM tract, part of engagement
- c) **Objectives:** Lists the competencies of the topic based on the K-12 Education Curriculum of the STEM track.
- d) **Activity:** The exploration part of the 5E's, includes:
 - Objectives – presents the outcome of the activity

- Materials - list the materials needed
 - Procedure – lists the step by step to be done
 - Results – where students illustrate the result of the activity and the questions to be answered
- e) **Topic:** The subject matter to be discussed with video as the support technology, the explanation part of 5E's model.
 - f) **Assignment:** The elaboration part of 5Es model, provides the students the opportunity to learn more.
 - g) **Glossary:** Contain terms needed to be defined/described for clearer understanding.
 - h) **Summary:** Presents the main thought of the topic
 - i) **Posttest:** Provides the evaluation of the 5E's
 - j) **References:** List the resources used in the making of the module.
 - k) **Answer key:** Answer to the pretest and posttest, this is intended for the teachers who will use the instructional package.

For technology support, videos were downloaded from youtube.com. for the topic cellular respiration.

2.2 Validation/Evaluation

The draft of the instructional package was submitted to five experts for evaluation using the evaluation rating sheet for print and non-print resources from the standards of the Learning Resources Management and Development System (LRMDS) of the Dept. of Education, 2009. For print resources, the basis of evaluation were content, format, presentation and organization. The non-print materials (videos) were evaluated based on the content quality, instructional quality, technical evaluation, and other findings.

3. Results and Discussion

3.1 Design and Development of the Instructional Package on Cellular Respiration

An instructional package was made to cater the need of the learners to help solve the problem on the difficulty in teaching the topic cellular respiration in biology among grade 12 STEM.

The instructional package cellular respiration was patterned to the 5Es constructivists' approach. This was used to answer the need to make cellular respiration interesting to learn. The 5Es constructivist instructional strategy was more effective in facilitating students' interest in like genetics in both urban and rural schools. The study recommended that the 5Es constructivist instructional strategy be adopted in the school system for teaching biology, especially in genetics [8]. This approach was also used because it has a significant effect on both the achievement and interest of students like in Senior Secondary Science physics students [9]. The 5E's model consists of activities that enhance students' interest towards investigation, meet their expectations and have active usage of knowledge and abilities [7].

There were five topics that the students had the most difficulties in learning: matter cycles, endocrine system and

hormones, aerobic respiration (cellular respiration), cell division, and genes and chromosomes [5]. The study was made among the 207 11th grade students in the district of Rize, Turkey. Furthermore, another study found out also that the topic cellular respiration was difficult to students [10].

The students perceived cellular respiration to be difficult to learn because of the nature of the topic, students' learning ability, students' studying habits, students' negative feelings and attitudes toward the topic and lack of resources. The students identified the possible solutions to make cellular respiration not a difficult topic to learn. The top solutions suggested were the use of instructional materials and making the topic interesting [5], [11]. Another reason why students may find some topics difficult could be due to the persistent use of lecture method for teaching Biology as against the recommended discovery/inquiry approaches which are student-activity centered. It was also noted that when students are always exposed to practical lesson with good quality teachers and quality teaching methods, they will obviously find most of these concepts in Biology less difficult [12]. It was affirmed also that the use of instructional materials in teaching and learning like in Mathematics, makes students to learn more. They can retain better what they have been taught and that it also promotes and sustains students' interest [13]. It also allows the learners to discover themselves and their abilities. Students learn more when they see what they are being taught [3]. A study recommended that policy makers should promote programmes and provide facilities that could be used in teaching Biology that would help remove the dreaded difficult areas in Biology [14]. This no doubt would help stimulate students' interest in Biology. There was also recommendation that government should make available to schools the basic instructional materials as this will enhance an effective teaching and learning process [2]. This is based on the result of findings that there is a positive achievement in students taught by highly qualified biology teachers and those exposed to instructional materials during lessons.

It was further recommended that Biology teachers should adopt the innovative teaching strategies such as concept mapping in teaching some of the difficult topics in Biology [14]. Biology teachers should present the difficult concepts in clearer terms starting from simple to complex. Teachers in rural and urban centers should be given incentives for them to do their best. This is because teachers' effectiveness plays a major role in students' academic achievement.

3.2 Evaluation of the Instructional Package

Result showed that the print part of the instructional package was rated excellent in all areas and very good in content. (table 1).

Table 1: Evaluation/validation of the instructional package (print part)

Areas of Evaluation	Scores Given by Evaluators (mean)	Description
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	score and percentage)	
content (28 pts)	25 (89.29%)	very good
Format (72 pts)	69 (95.80%)	excellent
presentation & organization (20 pts)	18 (90%)	excellent
accuracy and up to datedness of information (24 pts)	24 (100%)	excellent

$M = 93.77$ %, $SD = 5.08$

Note: *Passing percentage is 75%. The means were interpreted as follows: 90-100 = excellent; 85-89= very good, 80-84 = good; 75-79= fair; below 75 =poor

This implies that the content, format, presentation and organization and accuracy and up-datedness conform with the standards of the Learning Resources Management and Development System (LRMDS) of the Dept. of Education 2009 as perceived by the evaluators. The top values perceived by the evaluators were enhancement of the scientific attitude and reasoning, desire for excellence, helpfulness/teamwork/cooperation, ability to tell the right and wrong and critical and creative thinking (table 2). This implies that evaluators perceived these values as being shown in the instructional package.

Table 2: Results of evaluation of the enhancement of the desirable values and traits of the instructional package under the content (N=5)

Values	Frequency
pride in being a Filipino	3
scientific attitude and reasoning	5
desire for excellence	5
love for country	3
helpfulness/teamwork/cooperation	5
Unity	3
honesty and trustworthiness	4
ability to know right and wrong	5
Respect	3
critical and creative thinking	5
productive work	4

Result of the evaluation of the videos is presented in table 3. The videos were rated excellent in all areas that were evaluated. The evaluators perceived that the videos complies the required standards of the Learning Resources Management and Development System (LRMDS) of the Dept. of Education 2009.

Table 3: Evaluation of videos (non-print) used in the explanation and assignment parts of the instructional package on cellular respiration

Areas of Evaluation	Scores Given by the Evaluators (mean score and percentage)	Description
Content Quality (40 pts)	39 (97.50)	excellent
Instructional Quality (40pts)	39 (97.50%)	excellent
Technical Quality (52 pts)	51 (98.00%)	excellent
Other findings/ Information(16 pts)	16 (100%)	excellent

$M = 98.25$ %, $SD = 1.19$

Note: *Passing percentage is 75%. The means were interpreted as follows: 90-100 = excellent; 85-89= very good, 80-84 = good; 75-79= fair; below 75 =poor

5. Conclusion

An instructional package on the topic cellular respiration was made since students find this topic difficult to learn. The package followed the 5Es model. The instructional package got an excellent rating in all areas of evaluation such as format and presentation and organization and in accuracy and up-datedness of information and very good in. It covered all the values listed in the evaluation sheet for print with the top values of enhancement of scientific attitude and reasoning, desire for excellence, helpfulness/teamwork/cooperation, ability to tell right and wrong and critical and creative thinking. The videos (non-print material) were also rated excellent in all areas of evaluation. The study developed an instructional package that was recommended by the expert for use because it conformed the required standards of the Learning Resources Management and Development System (LRMDS) of the Dept. of Education.

6. Recommendations

It is highly recommended to do pilot testing (implementation) and evaluation of the impact of the instructional package to the students' learning among grade 12 STEM track students in their Biology subject. Readability of the package is also recommended.

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Author Profile

MA.SOCORRO GONZAGA-LEONG-ON, PhD, College of Liberal Arts, Sciences and Education, University of San Agustin,

Iloilo City, 5000 Philippines. Ma. Socorro G. Leong-on is a holder of Doctor of Philosophy in Science Education major in Biology from West Visayas State University. She graduated with highest distinction. She was a recipient of a scholarship grants from the Department of Science and Technology (DOST)-Science Education Institute (SEI), and University of San Agustin, Iloilo Faculty Development. She also holds a Master of Science in Biology from University of the Philippines in the Visayas as a scholar of St. Paul University, Iloilo and got DOST fundings for her thesis. She obtained her BS Biology from the University of San Agustin, as cum laude, awardee in community service, and awardee in cooperation. She was a P.D. 451, Alumni-Chicago, Illinois Chapter, and University of San Agustin academic scholar. Dr. Leong-on was the first placer during the search for best thesis and dissertation in Region 6, in 2005 with her study "Bioactivity Screening of Selected Ethnobotanicals for their Potential Uses in Reproduction and Fertility Management" a DOST funded study. She was also the 2012 Gregor Mendel Professorial Awardee on the study "Anti-arthritis Activity of the Ethanolic Extracts of Calamansi (*Citrus microcarpa*), Pomelo (*Citrus maxima*) and Pagatpat (*Sonneratia alba*) Leaves in White Mice (*Mus Musculus*). She is also a 2015 winner in the International Conference on Inquiry-Based Science and NOSTE Biennial Convention with her study "Antihyperglycemic Activity of the Ethanolic Extracts of *Artocarpus heterophyllus* (langka) unripe fruit in White Mice (*Mus Musculus*). She was also a 2017 winner, International Conference on Inquiry-Based Science and NOSTE Biennial Convention with her study "Genotoxicity Screening of the Crude Ethanolic Extracts of *Artocarpus heterophyllus* (langka) unripe fruit." Her dissertation "Competencies of Junior High School Science Teachers on Selected Biology Laboratory Procedures: Inputs to Instructional Material Development" (DOST and University of San Agustin funded study) won first place – Best Oral Presenter Award during the National Organization of Science Teachers' Educators (NOSTE) 2018 National Research Conference & Training Workshop. She has published her researches in national and international journals. She is a research presenter in regional, national and international research fora. She is also a consultant in various biological researches, and since then produced many winners in science investigatory projects and researches among college students. She serves as judge in regional and national research presentations. She also serves as resource person in many speaking engagement like in DOST 6- Health Research Consortium on Screening of Plant Extracts for Medicinal Uses. A speaker also on Instructional Material Development Research and Topics on Science Investigatory Project. She was also a research reviewer, National Medical Admission Test and Licensure Examination for Teachers' reviewer of West Visayas State University. She is a committee member of the Human Resource and Development, Western Visayas Health Research Development Consortium – Department of Science and Technology, Region 6. She is the former Chairman – University of San Agustin Institutional Animal Care and Use Committee of the University of San Agustin. She served as the board of director, auditor and recording secretary, treasurer of the Philippine Society for Microbiology. She is also a member of the Philippine Association of Laboratory Animal Science and Biology Teachers' Association. She has attended various seminars and trainings. Her area of research is on bioactivity screening of plant extracts. She acquired skills on procedures in testing plant extracts using mice in the following studies: pre-coital or anti-ovulatory (antifertility), post-coital antifertility, abortifacient, and teratogenicity testing. She has also skill on, mutagenicity, analgesic, antihyperglycemic, anti-arthritis, anti-diarrheal, anti-inflammatory, and anti-depressant testing. She has been performing studies on cytotoxicity testing using brine shrimp, antimicrobial testing, genotoxicity, larvicidal assay, anti-pediculocidal assay, molluscicidal testing phytochemical analysis and instructional material development. She has a training on animal handling by the Philippine Association of Laboratory

Animal Science, communicating researches to stakeholders by DOST, writing scientific papers for publication by DOST, and completing the 3rd Course on Transforming Philippine Plants into Quality Herbal Medicines for a Healthier Nation by University of the Philippines - Manila and Institute of Herbal Medicine. Dr. Leong-on was a former faculty member and the team leader of the Science Department of St. Paul University Iloilo. Currently, she is a faculty member of the University of San Agustin. She is married to Rey N. Leong-on, and blessed with three children, Rae Marie, Rae Angelique and Rae Danielle.