Development and Validation of Infographics Based on the Least Mastered Competencies in Physics

Cynthia G. Quiambao, Jayson Y. Punzalan

ABSTRACT--- The roles of the teacher inside the classroom include, syllabus preparation, classroom management, selection of appropriate methodology, selection and utilization of instructional materials, evaluation of students performance etc. Teacher's effectiveness inside the classroom is always measured in terms of the knowledge acquisition of its students. The higher the passing rate, the more effective the teacher is. Teachers should always look for different avenues to ensure effective and meaningful teaching and learning. In this regard, this study was conceptualized to develop and validate infographics based on the least mastered competencies of students in physics subject and to determine its effectiveness to the students in terms of knowledge acquisition as an input to science education. The developed infographics are based on the least mastered competencies of students in Physics subject: acceleration, force, friction, energy, free fall, work, momentum and impulse, laws of motion, projectile, speed and velocity, heat, phase change ad thermal expansion. The acceptance was rated based on that which could be strongly agreeable, with specific parameters under investigation being clarity and evaluation, adaptability, learning activities, design characteristics, content, and objectives. The developed infographics promoted students' performance in content-knowledge acquisition. The infographics would serve as an instructional materials and teaching aid in teaching science concepts particularly in physics to promote higher students' performance in content knowledge acquisition. It can also be a tool to promote science literacy in different schools because it is a visual electronic type of material that 'millennial/21st' learners can relate with.

Keywords: Development, Validation, Infographics, Physics, Science Education, Knowledge Acquisition.

I. INTRODUCTION

In education, teacher is considered as the manager of the classroom doing different educational task to ensure quality learning as directed through the prescribe curriculum. The significant of Science Education in the Philippines is informed by inventions and innovations, as well as technological discoveries related to science; with the latter aiding in the description and understanding of the environment in which humans live and operate. Concisely if Science subjects were handled by competent and highly skilled teachers, acquisition of necessary skills and knowledge will be promoted that gives student something to think about.

Some of the challenges accruing form the aspect of globalization entail the linking of science ideas, new technologies, and knowledge economy development. However, it is worth noting that globalization is a threat on the one hand, but it poses positive outcomes in relation to growth and development in the processes of teaching and learning; p[roving beneficial. In particular, it is notable that through globalization, there emerges a wealth of information for both learners and teachers. The eventuality is that the globalization phenomenon yields a notable increase in the medium term, proving an invaluable learning resource. For teachers, it remains notable that there is a need to gain knowledge regarding how they could use, adapt, and select appropriate resources that are tailored towards and targeted to their knowledge provision process. Indeed, the dilemma accounts for challenges with which globalization is associated (UNESCO, 2009).

Conventional teaching style in the past trails a design such that an instructor sees himself/herself as a single authority, consequently teaching is seen as telling and learning suggests passive "listening" (Ibrahim, 2014). Current knowledge regarding humans and their environment traces its roots to the earlier periods. Up to date, there have been significant developments and changes that come in the form of discovery and investigation, deviating from the initial trial-and-error approach (Silva 1982).

The implication is that for learners in higher institutions of learning to gain adequate and relevant knowledge, it is essential gain knowledge about the perceptions of scientists of the 20th century. As such, it is predicted that the efficient and effective learning of science requires a teaching approach that incorporates appropriate methodologies and strategies characterized by the use of the right assessment and evaluation techniques, the selection of relevant teaching and learning materials, and a consideration of pedagogy; besides the selection of appropriate instructional/learning materials and using the right evaluation and assessment techniques. (Ibrahim, 2014)

A lot of classroom materials are needed in teaching and learning for affecting or motivating the interest of the students for realizing learning experience, retention and knowledge acquisition. In situations, where the learning or knowledge acquisition process is insufficient, there is likely to be a decline in academic performance among learners (Nwosu, 2002). With the latter translating into problems in the education process, even instructors who might have mastered the subject matter are likely to experience significant challenges; especially regarding the acquisition of adequate and relevant or appropriate materials (Ogunniyi, 1978).

The need for the designers of information to establish optimal solutions that are relevant to the needs of users is worth emphasizing, especially due to the predicted increase

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in the amount of knowledge in the world; including teaching-learning situations. Particularly, it is imperative to ensure that graphics and texts are blended in such a way that communication processes are enhanced. However, it is worth noting that this process requires a consideration of the correlation between the decision to blend graphics with text and the ability to enhance communication (Kendler 2004).

Indeed, infographics, which reflect a combination of graphics and information, constitute graphic visual representations that present the knowledge, data and information through which clear and quick information presentation can be achieved. Indeed, infographics aid in cognition improvement whereby they exploit graphics towards the enhancement of the ability of human visual systems to discern or establish trends and patterns.

Since, mathematics is the language of physics, which requires skills in computation makes most learners find physics difficult to comprehend. Some of the reasons attributed to this trend include the learners' misunderstandings and misconceptions, especially due to a lack of clarification of certain concepts in the subject. Therefore, it is predicted that instructional materials might enable learners to understand the concepts better; coming in the wake of a lack of adequate monitoring of individual differences in large classrooms (Ornek.et al, 2008).

From the documentation by some of the past scholarly investigations, the majority of Filipino students fail to achieve practical literacy, yet the latter is crucial for addressing challenges that face the current, fast-growing world. Some of the factors contributing to the teaching-learning process in this context include poor teacher training, lack of adequate and quality instructional materials, a compromised teaching-learning process, and a lack of a science culture (Batomalaque 2010).

Hence, the central purpose of this study was to establish and validate some of the infographics that target some of the competencies that are least mastered by most of the students. The motivation was to steer improvements in the target students' knowledge acquisition; hence improvements in their academic performance.

For that reason,this study aimed to develop and validate infographics based on the least mastered competencies of students to increase student's classroom performance in terms of information acquisition.

II. STATEMENT OF OBJECTIVES

The main goal of the study was to establish and validate infographics in relation to some of the competencies that are least mastered by students taking Physics as a subject.

Specifically, the study aimed to achieve the following objectives:

1. To validate and establish infographics relative to some of the competencies that Physics students had mastered
2. To validate the infographics as perceived by Science Education Experts, Graphic Artists and Students in terms of its:
   2.1. objectives
   2.2. content,
   2.3. design
   2.4. characteristics
   2.5. adaptability
   2.6. and clarity
3. To validate the infographics in its effectiveness to the students in terms of knowledge acquisition
4. To generate input to science education

Null Hypotheses

The following are the hypotheses of the study:

1. In the experimental group, the posttest and the pretest do not exhibit a significant difference
2. In both the experimental and control groups, the pretest does not exhibit a significant difference
3. In both the experimental and control groups, the posttest does not exhibit a significant difference

III. CONCEPTUAL FRAMEWORK

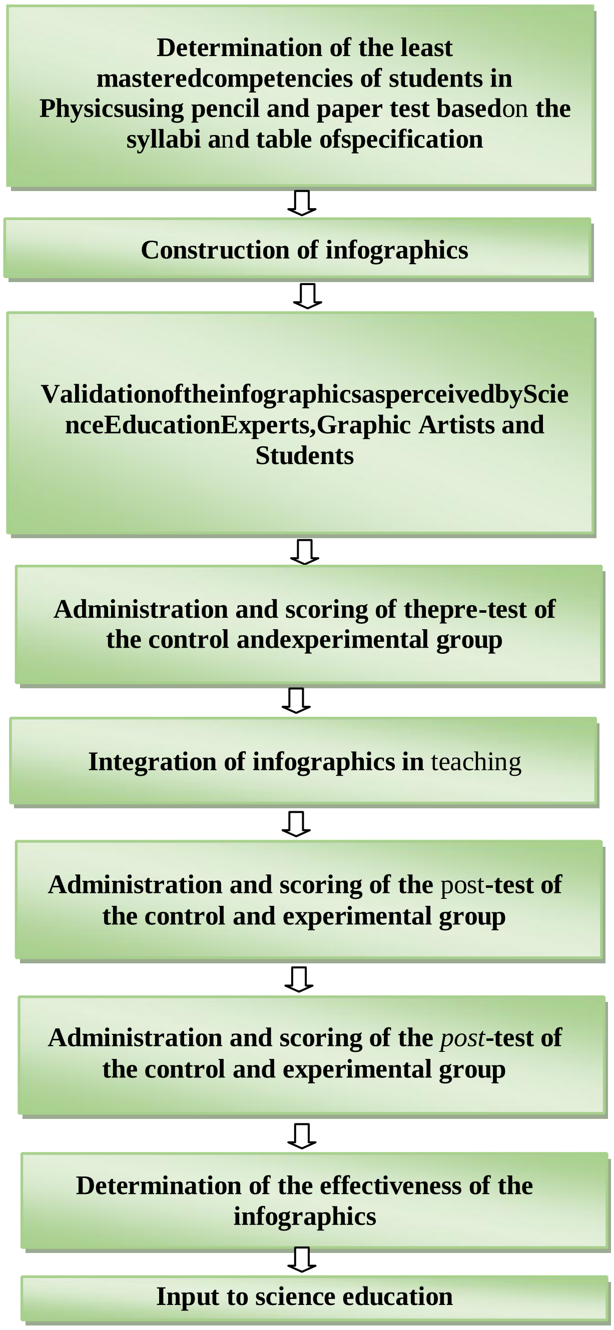

Figure 1: The study's research paradigm

This study's conceptual framework or research paradigm that was adopted is illustrated in Figure 1. The aim of the framework, which was designed and integrated into the study carefully, was to guide the process of establishing and validating infographics relative to competencies that were perceived to be the least mastered among Physics students.

In the figure, test was constructed and given to determine the least mastered competencies of students in Physics as a basis on what infographics were developed. Validation of the infographics in terms of its objectives, content, design characteristics, adaptability was evaluated by science education experts, graphic artists and students. Average mean was computed to get the rating of the evaluators in each criterion.A pre-test was given to the control and experimental group before the integration of infographics inside the classroom.A posttest was also given to the both groups after.Pretest and posttest scores of students in both control and experimental group were tabulated. Effectiveness of the infographics was determined using t-test for correlated samples and t-test for equality of means

IV. METHODOLOGY

In this study, Borg and Gall's (1992" Research and Development (RT&D) concept was used to guide the process of establishing and validating infographics, which represented education products that were targeted.

The construction of test to determine the least mastered competencies of students in Physics was based on the outcomes-based teaching-learning (OBTL) guide or syllabi-stipulated content areas. Indeed, the table of specifications guided the careful selection and validation of these items.

Infographics were designed and develop using photoshop software and MS-Publisher. An evaluation sheet was adapted from the study of Naval 2014 was administered to science education experts, graphic artists and students to evaluate the infographics relative to aspects of clarity, adaptability, design characteristics, content, and objectives. In this stage, suggestions, comments and corrections were elicited for the improvement of the infographics.

The following scale was used in evaluating the infographics

4.01 -5.00perceived to be Very Strongly Acceptable
3.01 -4.00expected to be Strongly Acceptable
2.01 -3.00projected to be Acceptable
1.01 -2.00predicted to be Moderately Acceptable
0.01 -1.00reflected the Least Acceptable

The researchers used Average Mean in determining the acceptability of the infographics based on the evaluation of the science education experts, graphic artists and students.

The respondents of the study were the students of TSU-COED BEEd taking PHYS A: Physics for Health Science subject. The table below shows the distribution of respondents.

Year and Section	Total No. of Respondents
BEEd 2-1	42
BEEd 2-2	36

A one hundred multiple choice Pretest was constructed by the researchers which was basedon the syllabus and a table of specification to assure equal distribution of the topics identified on the list mastered competencies of students.Then, the same test is also given in the post test to determine the acquired knowledge of the students after the infographics were used inside the classroom.

Upon administering the posttest and pretest, they were extended to the study's respondents before determining the correlation between the experimental group's posttest and pretest – via a t-test of the selected samples. The formula is as follows:

$$t = \frac{\Sigma d}{\sqrt{\frac{n\left(\Sigma d^2\right)-\left(\Sigma d\right)^2}{n-1}}}$$

Where:

d= was the posttest and pretest mean difference

Σd^2 = was the total of the squares that were obtained in relation to the difference between the posttest and the pretest

Σd=the sample summation of the difference between the pretest and post-testN=sample size.

To establish a comparison between the experimental and the control group's pretest (as well as a comparison of the experimental and control group's posttest), the study employed a t-test for equality means. The formula is as follows:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2}}}$$

Where:

X1= pretest's mean of the control group
X2= pretest's means of the experimental group
$S^2_{1=}$ pretest's SD of the control group
$S^2_{2=}$ pretest's SD of the experimental group

V. RESULTS AND DISCUSSION

1. Outcomes regarding the establishment of infographics (in relation to competencies that were perceived to be mastered the least among selected Physics students).

Based on the test administered to measure the competencies of the respondents in physics subject,the following topics where determined to be at least:acceleration, force, friction, energy, free fall, work, momentum and impulse, laws of motion, projectile, speed and velocity, heat, phase change and thermal expansion. The topics mentioned were the basis of what infographics were developed and designed.

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Figure 2. **Infographics about Friction**

Figure 2 represents an example of infographics develop using picture editing software. The graphic contains information about the topic friction.

2. Validation theinfographics perceived by:

2.1 Science Education Experts

Table 1. Rating of Science Education Experts

Criteria	Mean	Verbal Description
objectives	4.40	Very Strongly Acceptable
content	4.20	Very Strongly Acceptable
design characteristics	4.00	Strongly Acceptable
adaptability	4.20	VeryStrongly Acceptable
clarity	4.40	VeryStrongly Acceptable
Grand mean	4.24	VeryStrongly Acceptable

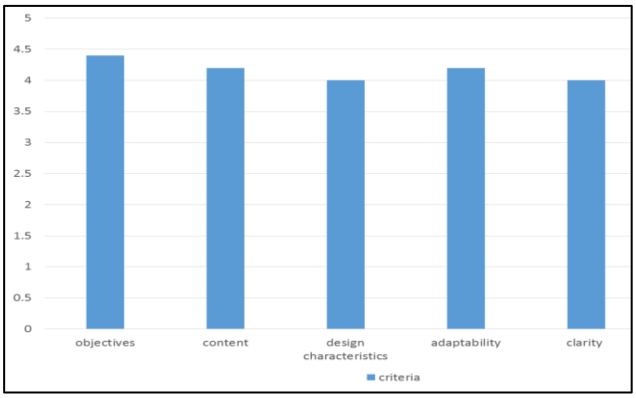

Figure 3. Rating of Science Education Experts

From the results presented in the figure and table above, this study established that a very strong level of acceptance of the infographics that were developed; having gained the information form the perspective of science education experts. However, the study revealed

Based on the table and figure above, the developed infographics are rated ‘ very strongly acceptable’ in all criteria by the science education experts except for design characteristics which was rated ‘strongly acceptable’. The grand mean is 4.24 which is considered very strongly acceptable.

2.2 Graphic Artists

Table 2. Rating of Graphic Artists

Criteria	Mean	Verbal Description
objectives	3.67	Strongly Acceptable
content	4.00	Strongly Acceptable
design characteristics	4.33	Very Strongly Acceptable
adaptability	3.33	Strongly Acceptable
clarity	4.00	Strongly Acceptable
Grand mean	3.87	Strongly Acceptable

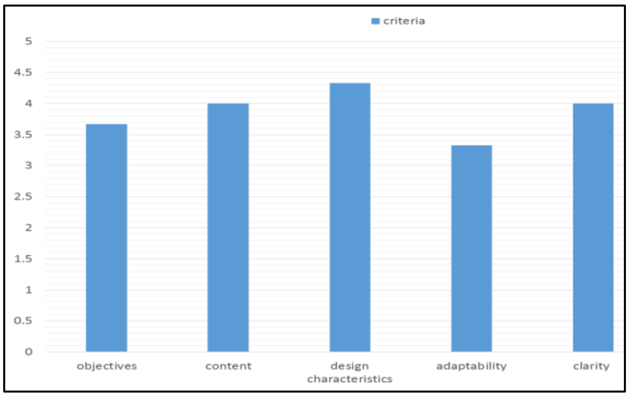

Figure 4. Rating of Graphic Artists

Based on the table and figure above, the developed infographics are rated ‘strongly acceptable’ in all criteria except in design characteristics which wasrated ‘very strongly acceptable’ by the Graphic Artists. The grand mean of is 3.87 which is strongly considered Strongly acceptable.

2.3 Students

Table 3. Rating of Students

Criteria	Mean	Verbal Description
objectives	4.31	VeryStrongly Acceptable
content	4.19	Very Strongly Acceptable
design characteristics	4.29	Very Strongly Acceptable
adaptability	4.43	Very Strongly Acceptable
clarity	3.81	Strongly Acceptable
Grand mean	4.21	VeryStrongly Acceptable

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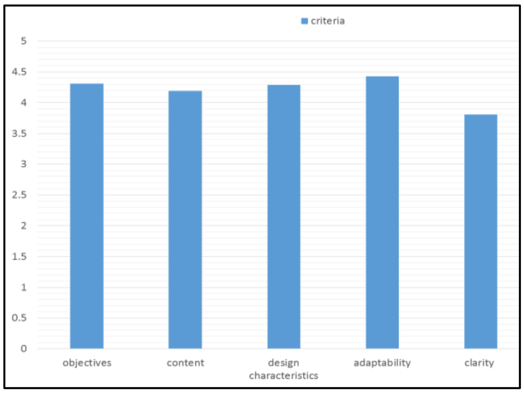

Figure 5: Ratio of Students

Based on the table and figure above, the developed infographics are rated 'very strongly acceptable' in all criteria by the Students except clarity which was rated 'strongly acceptable'. The grand mean is 4.21 which is considered very strongly acceptable.

3. Validation the infographics in its effectiveness to the students in terms of knowledge acquisition.

Table 4. Result of pretest and posttest of experimental and control group

	VAR00003	N	Mean	Std. Deviation	Std. Error Mean
PRETEST	Group 1	36	34.3056	5.39746	.89958
	Group 2	42	32.2143	8.38854	1.29438
POSTTEST	Group 1	36	29.0278	8.62053	1.43675
	Group 2	42	61.3095	12.01521	1.85399

In the table above, the results that are presented reflect insights form the control and experimental groups' posttest and pretest.

Table 5: Comparisons of the outcomes for the posttest and the pre-test experimental group, the pretest of control and experimental groups, and the experimental and control groups' posttest

	t	df	*p*value	Mean difference	Decision
Comparison between pre-test and posttest of experimental group	-14.565	41	0.000	-29.09524	Reject H_o
Comparison between pretest of control and experimental groups	1.285	76	0.203	2.09127	Do not reject H_o
Comparison between post-test of control and experimental groups	-13.763	73.837	0.000	-32.28175	Reject Ho

Based on the results presented in Table 5, it is evident that in the experimental group, this study's posttest and pre-test groups exhibited a significant difference. Particularly, superior results were evident in the post-test – compared to the pretest. Hence, it was inferred that through the development and implementation or use of infographics, there is likely to be a significant improvement in the learners' performance. During the pretest, the study did not establish a significant difference between the experimental and control groups' means. The implication is that the groups exhibited similar basic knowledge in the selected subject (Physics) – prior to the introduction of infographics. Finally, results in Table 5 demonstrate that the experimental and control groups' posttest means did not exhibit a significant difference. The resultant conclusion was that most of the learners are likely to experience better performance when infographics are employed in the teaching-learning process.

4. Input to science education

The findings of this study will serve as a springboard for future studies on the development of infographics in physic and other science subject. As a visual aid and the same time an instructional infographics is proven to help in improving student's understanding of scientific concepts and principles. This suggests that physics teachers should explore effective materials and modern methods in teaching to help students in comprehending difficult concepts. The results provide justification for curriculum developer and science teachers to promote the development and utilization of infographics in physics classes to facilitate meaningful learning.

VI. CONCLUSIONS

1. The developed infographics are based on the least mastered competencies of students in Physics subject: acceleration, force, friction, energy, free fall, work, momentum and impulse, laws of motion, projectile, speed and velocity, heat, phase change ad thermal expansion.
2. From the infographics that the study developed, responses were rated based on their degree of acceptability. With target populations being students, graphic artists and science education experts, some of the parameters that were analysed included clarity and evaluation, adaptability, learning activities, design characteristics, the nature of the content, and objectives.
3. The developed infographics promoted students' performance in content-knowledge acquisition.
4. The developed infographics would serve as an instructional materials and teaching aid in teaching science concepts particularly in physics to promote higher students' performance in content-knowledge acquisition. It can also be a tool to promote science literacy in different schools because it is a visual electronic type of material that 'millennial/21st' learners can relate with.

VII. RECOMMENDATIONS

1. Teachers are encouraged to develop their own infographics according to their students' need. Moreover, collaboration among physics teachers in preparing the infographics covering all the competencies is highly recommended.
2. Physics teachers are suggested to utilized instructional materials that enhance scientific ability of the students.
3. The Tarlac State University should continually provide seminars, trainings and workshop I conceptualizing, developing and further validating instructional materials not only in physics but also in other fields of study to improve quality education.

VIII. ACKNOWLEDGMENT

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IX. RESEARCHERS' PROFILE

Lead Researcher

DR. CYNTHIA G. QUIAMBAO was the lead researcher. The researcher has atta9ined a master's degree in Administration and Supervision. Also, the researcher has competed a Master's of Arts in Education's academic requirements, specializing in physical sciences. At the undergraduate level, the researcher pursued a Bachelor's degree in secondary education major, specializing in General Sciences. The researcher has also obtained a Doctor of Education degree, specializing in the field of educational management. The degree was obtained from Tarlac State University. The researcher has also worked as a director of TSU University high school, with the current position being the BEEED Extension program chairperson. Also, Dr Quiambao is one of Pi Lambda Theta's members and plays an additional active role in the Philippine Association of university Women and Philippine Association of Teacher Education. Other previous positions include: the Area head of the MAED Physical Science at the Graduate Studies of TSU-College of Education, a professor of the ECF Project Free of La Salle University, the chair of the Extension and spearheaded successful extension programs in Laungcupang Elementary School, and the current Chair of Experiential Learning in the College of Education of TSU.

Co-Researcher

Emerging as an alumnus of Tarlac State University, Mr. JAYSON Y. PUNZALAN, who was a co-researcher in this study, has attained Master of Arts in Education (MAED) major in Physical Science and a Bachelor of Secondary Education (BSED) major in Physical Science. Currently, he works as an Assistant Editor of the College Faculty Research Journal, as well as a college coordinator at the University's Information Management System (IMS). Also, he is coordinator for CRE 1 of the College of Education and the subject head in BSED Physical Science.

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