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Development and Validation of Historical Physics Vignettes For Physics 2 Course of Senior High School

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Abstract: Despite this significance of science to every man's life, a considerable number of the population lacks understanding of scientific operations. Nature of science (NOS) teaching is viewed to complete the puzzle of scientific literacy and science learning. NOS refers to values and assumptions inherent to scientific knowledge and the development of scientific knowledge. Teaching nature of science to students develops awareness of the relevance of science in society which might help remove the disconnection of science to students as it stimulating their interests by showing science practicality. Historical Physics Vignettes were developed to serve as instructional material to teach NOS in senior high school. The material was validated by experts in terms of historical narratives, featured aspects of NOS, guide questions, language, overall presentation, illustrations, and additional activities through a researcher developed criterion based reference evaluation tool. The developed instructional material featuring eight vignettes was rated as "Highly Acceptable" (4.66) by the validators. The value of average inter-rater reliability coefficient kappa of the ratings of the evaluators is interpreted as "Substantial Agreement" (0.63).

Key Words: historical vignettes; nature of science; history and philosophy of science

1. INTRODUCTION

Majority of students are disinterested in their studies of science and at worse dislike it. They are unable to see the social importance of the subject as they characterized it to be more of transmission of facts of little relevance and difficult to comprehend (Linder, Ostman, and Wickman, 2007). Specifically, physics suffers from bad disposition coming from students, thinking that it is difficult (Ornek et. al, 2008). This fact is supported by different studies, pointing out different causes (Angell et. al, 2004,; Redish, 1994).

Teaching nature of science to students develops awareness of the relevance of science in society (Driver, Leach, Millar, and Scott, 1996). Relevance removes the disconnection of science to students by stimulating their interests by showing its practicality (Za`rour, 2001). Students' interest and relevance are in the same picture in science education (Holbrook and Rannikmae, 2009). These point that teaching nature of science can traverse students' current disinterest in studies of science (Lederman, 1999; Meyling, 1997). Moreover, this hints that NOS teaching is promising to boost students' just sufficient positive attitudes, beliefs, and motivation, towards learning science/physics.

Science curricula worldwide are recently adjusting to explicitly include nature of science as an important part of scientific literacy. Science education leaders are quick to develop different basic approaches in properly teaching NOS like the use of inquiry activities, contemporary cases, and historical cases (Allchin, 2014). Historical cases is mostly used considering the number of researches present and given the present trend of teaching history of science. Studies suggest that historical entries reveal the true nature of science making it a good direct avenue to learn NOS (Nur and Fitnat, 2015). This initiative can be considered established in terms of concepts, and our focus now should be turned to developing extensive resources and quality instructional materials (Allchin, 2011; Dolphin, 2009).

Crafting historical materials into effective instructional materials for NOS teaching is an arduous task (Nur and Fitnat, 2015). Historical vignette and anecdotal as sidebars to science textbooks are previous plain attempts to humanize science to students. In recent studies, these historical materials are developed to serve as the main context for NOS lessons. An effective historical vignette arises to the seamless discussion of NOS and science content with highly interested students (Wandersee, 1992).

This study generally aimed to develop historical physics vignettes which will be an instructional material that will explicitly teach nature of science to senior high school students.

2. METHODOLOGY

2.1 Instruments

Evaluation Tool for Validating HPV. The instrument for validation of the developed historical physics vignettes is a criterion-based reference evaluation tool developed by the researcher. This instrument assessed the developed historical physics vignettes in terms of historical narratives, featured aspects of NOS, guide questions, language, overall presentation, illustrations, and additional activities

2.2 Procedure

Initial Preparation. The researcher examined the general physics 2 curriculum for grade 12 STEM students. Then, historical narratives related to general physics 2 content (electricity and magnetism, light and optics, and modern and nuclear physics) were gathered. An intensive examination on STEM general physics 2 curriculum and content and a comprehensive reading on HPS was conducted to properly match nature of science, physics content, and historical narratives. Inquiry approach was set

Table 1: List of Historical Physics Vignettes

Title	NOS Aspect	Physics Topic	Inquiry Activity to Discover NOS
The Conflict with Frog Legs: The First Look at a Complete Circuit	Objectivity/ Subjectivity	Electrostatics	Pair Picture Interpretation
Next Man Up: Combining Efforts to Establish Electromagnetic Induction	Empirical Evidence	Electromagnetic Induction	Venn Diagram
From One Great Mind to Another: The Elaborateness of Relaying Electromagnetism	Scientific Laws and Theories	Electromagnetism	Paintings: Different Styles Same Subject
As Light Travels through Time: The Journey of Light to Become What It is Now	Tentativeness	Introduction to Light	Development of Conception of Light – Concept Map
Experimentum Crucis: The Ingenious Experiment that Dissected Light	Creativity	Refraction	Biome Survival Activity
Before Big Bang: Sitting Under the Desk to Laying Theory of General Relativity	Scientific Method	General Relativity	Steps of Scientific Method
The Outer World and the Inner Space: Seeing More than the Perceived World	Observation and Inference	Atomic Phenomena	Context Clues Passage
Sourcing Money for Science: Keeping a Physics Laboratory in Contention	Social/Cultural Embeddedness	Nuclear Phenomena	Allocating the Philippine Budget

Table 2. Overall Rating of the HPV and Evaluation Inter-Rater Reliability

Area	Mean Score	Verbal Interpretation	Kappa Value	Verbal Interpretation
1. Historical Narratives	4.81	Highly Acceptable	0.63	Substantial Agreement
2. Featured Aspect of NOS	4.56	Highly Acceptable	0.46	Moderate Agreement
3. Guide Questions	4.81	Highly Acceptable	0.71	Substantial Agreement
4. Language	4.13	Acceptable	0.75	Substantial Agreement
5. Over-all Presentation	4.94	Highly Acceptable	0.88	Almost Perfect Agreement
6. Illustrations	4.63	Highly Acceptable	0.42	Moderate Agreement
7. Additional Activity	4.75	Highly Acceptable	0.58	Moderate Agreement
Overall Mean Rating	4.66	Highly Acceptable	0.63	Substantial Agreement

Highest Score - 5

as mode of delivery of NOS thus limiting the qualified historical scenario to embed NOS teaching. It took a lot of deliberation to arrive with the correct perspective in looking in a historical account to create with a vignette that gives accurate history and teaches NOS at the same time. As the plot of a vignette becomes clear, review on the physics content were necessary to keep it accurate and clear as the vignette is narrated. Every story was reduced to two or three pages length to make it short enough for students. The vignettes often featured a condensed highly technical science experiment limited to the level of language and physics understanding of the intended senior high school students. After the eight vignettes were completed, guide questions were structured for each to lead students' reflections to nature of science understanding. Lastly, inquiry activity was designed, together with a lesson plan, for classroom use to aid the explicit – reflective approach of NOS teaching. The final vignettes are listed in Table 1. The developed HPV was initially validated by four experts, a physical science expert, a science education expert (who also teaches History and Philosophy of Science for several years), and master teachers from senior high school and junior high school. Then, the HPV was revised according to the experts' comments and suggestions. The revised material was returned to the initial validators for final rating using a researcher developed criterion-based reference evaluation tool.

3. RESULTS AND DISCUSSION

Table 2 shows the final evaluation of the evaluators the HPV. Mean score and corresponding kappa value for each area of evaluation is presented with the appropriate verbal interpretation.

The 4.66 overall mean rating shows that the prepared HPV is highly acceptable for use as instructional material to teach NOS in General Physics 2 course.

The high mean score for Historical Narrative (4.81) indicates that the historical accounts in the HPV are clearly narrated, accurate, basic idea of certain aspect of NOS after its use. This can be realized through the use of Guide Questions (4.81) that are properly structured, after some revisions based from comments, for this purpose.

The validators initially agreed upon that the Language (4.13) used in the HPV featured significant

3.1 HPV Validation

and correct. Readers are expected to have a clear impression of the depicted scenario through the different point of view that the vignettes offer.

In addition, the high evaluation for Featured Aspect of NOS shows that different facets of nature of science are properly integrated and well matched to each historical accounts. Though, one of the validators have uncertainties upon the approach of delivery of two NOS aspects (scientific laws and theories and scientific method). This was reflected in the raters' "moderate agreement" (0.46) for this area. Still, the HPV is viewed to at least provide reader the number of technical terms and words which are not common to Filipino students. This concern was addressed through the suggestion of one validator to provide definition for difficult words. As the validator commented:

"Can a glossary be added before each story to help student understand better the story?"

On a different note, the Over-all Presentation (4.94) of the HPV received the highest evaluation. This was attained through a lot of changes made upon the comments of the validators upon the initial validation. A validator commented:

"Improve the lay out and the margin design, remember you will be giving this to SHS students not to primary students. Make it more simple yet elegant."

The Illustrations (4.63) which was made specifically for each story also got high mean score but with "moderate agreement" (0.42). One comment from a validator:

"Be consistent in using what kind of illustrations you will be using [animated or actual]..."

Validators have a slight gap in perspective if the main illustration (animated vector) is appropriate for SHS students to realize its purpose.

Lastly, the Additional Activities (4.75) got a high mean score. These additional inquiry activities is viewed to assist facilitating explicit-reflective approach in teaching NOS.

4. CONCLUSIONS

The developed HPV is "Highly Acceptable" on the different aspects of validation. From the high mean scores on Historical Narratives, Featured Aspect of NOS, Guide Questions, Language, Over-all Presentation, Illustration and Additional Activities facets of the developed material, it can be concluded that it is ready for use as instructional material to teach NOS in physics 2 courses. Teaching NOS using explicit method often involves activities that illustrate certain NOS aspect but of have little reference to science content Thus, students find NOS learning as non-authentic while teachers view teaching NOS on a context out of the curriculum content as time consuming "add-ons". With this, the develop HPV might be the answer to call for materials that meaningfully interweave NOS and science content. Through this material, teachers might be encouraged to teach NOS.

The activities developed are validated for its many features. First, the different historical narratives will help students have a clear picture of different period in our history on where scientific concepts are actually developed. This might help students overcome their troubles in sorting out history and science and bringing them together. The eight featured aspects of NOS that is integrated to eight different historical narratives will help fill the dearth in the available materials for NOS teaching which is suited for our curriculum. Guide questions and additional activities will also assist teachers with low pedagogical content knowledge in teaching NOS to facilitate NOS learning. It is viewed that the developed HPV will play a role in promoting and realizing the integration of NOS teaching to the current curriculum.

This initial effort in including NOS teaching in the country's science curriculum seek that more researchers develop more materials. Though, it is more urgent to try the vignettes inside the classroom.

5. ACKNOWLEDGMENTS

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