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Assessment for Enhancement of the Do-It-Yourself (DIY) Physics Equipment and Laboratory Activity: Basis for the Development of a Physics Laboratory Activity Kit

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Abstract

This study aimed to assess the enhancement of the Do-It-Yourself (DIY) Physics equipment and laboratory activity as the basis for the development of the physics laboratory activity kit to be used in physics classes of high school students. This study used mixed methods. The researcher did the modification on the original DIY Physics equipment constructed by the DepEd-NSTIC to improve the workability of the equipment. We used rating sheets to assess the workability of the improvised DIY Physics equipment and laboratory activity. Rating sheets were designed by the pre-service general science teachers. Enhancements were made to improve the workability of the improvised DIY Physics equipment and laboratory activity and produce enhanced DIY Physics equipment. Results revealed that the improved DIY Physics equipment was workable in its physical feature, ease of manipulation efficiency, accuracy, safety, and appropriateness. The enhanced laboratory activity for the DIY Physics equipment was also workable in terms of its title, introduction, objectives, materials, procedure, questions, layout, spelling and grammar, and time allotment. Therefore, the enhanced DIY Physics equipment and laboratory activity could be used for the development of a Physics laboratory activity kit.

Keywords: Do-It-Yourself (DIY) Physics equipment, Laboratory activity, Assessment, Enhancement

INTRODUCTION

Physics remains the least popular science subject among students despite its importance. Compared to other science subjects, only a few students study physics, and subsequently, at higher degrees (Erinosho, 2013). Physics as a discipline requires students to employ various methods of understanding and translate from one to other words, table of numbers, graphs, equations, diagrams, maps (Ornek et al., 2008). It has become quite a challenge for physics teachers to create efficient strategies in attracting the interest of secondary students to physics and teach them effectively. According to Bernardo (2004), the poor performance of the learners in the primary science curriculum is due to the inadequate science curriculum and poor preparation of science teachers. Moreover, the scarcity of instructional materials has also contributed to the low performance of Filipino science learners (Tupas & Matsuura, 2011).

Metante (2012) conducted a study in which he modified the DIY differential radio scope to be utilized as a tool for teaching radiant energy regardless of weather conditions. Based on the result of his study, the apparatus has improved and met the aim of its modification. Buot (2010) developed and evaluated a laboratory apparatus that would help teach several topics in magnetism by using the improvised laboratory device. The study revealed that the improvised machine was very acceptable in terms of (a) constructional appearance and economy, (b)

convenience and scientific rigor, and (c) performance output.

The mission of DepEd-NSTIC is to provide schools and learning centers with affordable quality science instructional equipment, materials, and services in the country. DepEd-NSTIC has continually supported Philippine education in addressing the need to improve the country's science education by developing low-cost science gadgets known as the "Do-It-Yourself (DIY) science equipment." These are pieces of equipment essential at the introductory level of learning science so that the students can later use their developing knowledge and conceptual understanding to dig more deeply into the key ideas of science. These pieces of equipment can be used in laboratory classes in Biology, Physics, and Chemistry. However, there is no laboratory activity designed that involves DIY Physics equipment. This could cause the in-service teachers to limit the use of these gadgets in their Physics classes.

This study was conducted based on objectives including; modifying the original DIY Physics equipment assess the improvised DIY Physics equipment by the pre-service general science teachers and pre-service physics teachers. The goals of this study are also to assess the designed laboratory activity by pre-service general science teachers and pre-service physics teachers. Enhance the improvised DIY Physics equipment based on the assessment. Enhance the designed laboratory activity based on the assessment.

METHOD

This study used a mixed-method that employed a quantitative method because it used a mathematically based method to analyze numerical data gathered from the thorough assessment of the workability of the DIY Physics equipment and laboratory activity. It employed the qualitative method because the researcher sought to conduct an in-depth analysis of the data by deciphering the context of the results or findings of the assessment, collecting detailed views of the participants, and using inductive reasoning in interpreting the process and the outcomes.

A rating sheet was used to assess the workability of the improvised DIY Physics equipment. The rating sheet was based on the rubric made by Jarantilla (2008). The improvised Physics equipment was assessed in terms of its physical feature, ease of manipulation, efficiency, accuracy, safety, and appropriateness. Accuracy was included to ensure that the equipment could yield correct measurements and provide a consistent standard.

Another sheet was used to assess the workability of the laboratory activity. This rating sheet was also based on the rubric made by Jarantilla (2008). Assessment on the laboratory activity was done in terms of its title, introduction, objectives, materials, procedure, questions, layout, spelling and grammar, and time allotment.

The Do-It-Yourself (DIY) Equipment Construction Manual developed by the DepEd-

National Science Instrumentation Center (NSTIC) for MSU-Iligan Institute of Technology, the sub-center, provided several for Biology, Chemistry, and Physics and procedure so that teachers will be guided systematically on how to assemble every science equipment. The researcher and the panelists chose the Looping Track because of the versatility of the equipment in terms of concept, and its appropriateness with key stage standards of the enhanced K-12 basic education curriculum.

The original DIY Physics equipment, the Looping Track, provided by the Dep-Ed NSTIC was modified by the researcher in terms of its physical feature, ease of manipulation, efficiency, accuracy, safety, and appropriateness to improve its workability. Observations that were based on the researcher and students' experience in using the equipment in the class were carefully documented. Suggestions on the DIY Physics equipment modification were properly solicited from the students and experts to improve the DIY equipment. The modified DIY Physics equipment became the model for the pre-service general science teachers in making their improvised DIY Physics equipment.

The researcher presented the modified DIY Physics equipment to the pre-service general science teachers during his class. The researcher challenged the 25 pre-service general science teachers to construct their own design of DIY Physics equipment. Since the DepEd-NSTIC manual provided no designed laboratory activity, the researcher also enjoined the participants to make a laboratory activity for their DIY Physics equipment. The participants were grouped by four (4) to form six (6) groups, so there were six (6) different DIY equipment constructed and six (6) various laboratory activities. The format of the laboratory activity was adopted from Jarantilla (2008) to have a uniform design. Their designed laboratory activity was also presented to check during the presentation of their improvised DIY Physics equipment if the laboratory activity supports the workability of their improvised DIY equipment.

The researcher ascertained that teamwork and camaraderie were fostered in the group and a fair male-to-female ratio was observed. The researcher considered the pre-service general science teachers as inventors of their improvised DIY Physics equipment as a show of respect and appreciation to the uniqueness of the equipment constructed.

The pre-service general science teachers and pre-service physics teachers assessed their improvised DIY equipment based on its physical feature, ease of manipulation, efficiency, accuracy, safety, and appropriateness using a rating sheet. Another rating sheet was used to assess the designed laboratory activities in terms of its title, introduction, objectives, materials, procedure, questions, layout, spelling and grammar, and time allotment.

This study was conducted to answer the questions:

1. What modification can be done to improve the workability of the original DIY Physics equipment?
2. What is the assessment on the improvised DIY Physics equipment by the pre-service general science teachers and pre-service physics teachers?
3. What is the assessment on the designed laboratory activity by the pre-service general science teachers and pre-service physics teachers?
4. What enhancement can be done to improve the workability of the improvised DIY Physics equipment based on the assessment by the pre-service general science teachers and pre-service physics teachers?
5. What enhancement can be done to improve the workability of the designed laboratory activity based on the assessment the pre-service general science teachers and pre-service physics teachers?

RESULTS AND DISCUSSION

Modification of the Original DIY Physics Equipment

The researcher modified the original DIY Physics equipment in terms of its physical feature, ease of manipulation efficiency, accuracy, safety, and appropriateness to improve its workability.

Original DIY Equipment **Modified DIY Equipment**

Figure 1. DIY Physics equipment's physical feature

In terms of a physical feature, the original DIY equipment as shown in Figure 1 was made from accessible and affordable materials like PVC pipes and aluminum screen frames. However, the equipment was not highly innovative because the design was simple in which there was one (1) loop as part of the track. The equipment was not well built because the loop was not attached to the PVC tee. It was observed that the marble could not sometimes complete the trip due to this construction error.

As shown in Figure 1, the modified DIY equipment was still made from accessible and affordable materials like PVC pipes and aluminum screen frames. The equipment had the same

design as the original equipment, but the modified equipment was already well built because the loop was already attached to the PVC tee using flat metal screws. The metal screws were properly installed to ensure continuous motion of the marble during the demonstration.

Original DIY Equipment **Modified DIY Equipment**

Figure 2. DIY Physics equipment's ease of manipulation

In terms of ease of manipulation, the original DIY equipment, as shown in Figure 2, was portable and easy to assemble. Still, there were few construction errors, especially on the aluminum screen frame, which served as the marble path. It was also observed that some parts of the original equipment were loose, especially the PVC pipes which were utilized to form the body and framework of the equipment. The modified DIY equipment was still portable and easy to assemble, but minimal construction errors. The loose parts, especially the diameter of the PVC pipes, were adjusted to fit perfectly.

In terms of its efficiency, the modified DIY equipment was ascertained to be functional to provide opportunities to develop a fundamental understanding of key Physics concepts, enable students to develop process skills and provide opportunities for interactive student participation.

In terms of the equipment's accuracy, based on the researcher's experience in using the equipment in his class, the original DIY equipment could yield the correct measurement. Still, it cannot provide consistent standards all the time due to construction errors. The modified DIY equipment could yield correct measurement and could already provide a consistent standard.

In terms of safety, there were sharp edges on the aluminum screen frame of the original DIY equipment that may cause injury though the equipment was not so defective. The metal screw was not properly screwed. There were already no sharp edges on the aluminum screen frame in the modified DIY equipment that may cause injury because the aluminum screen frame was already polished. The metal screw was already properly screwed.

Figure 3. Modified DIY Physics equipment marble receptacle

The modified DIY equipment had an additional part: the marble receptacle that served as storage for the marbles after the activity. As shown in Figure 3, the receptacle was cut from a plastic bottle and was attached to the PVC pipe body.

Figure 4 shows the whole feature of the original DIY Physics equipment and modified DIY Physics equipment.

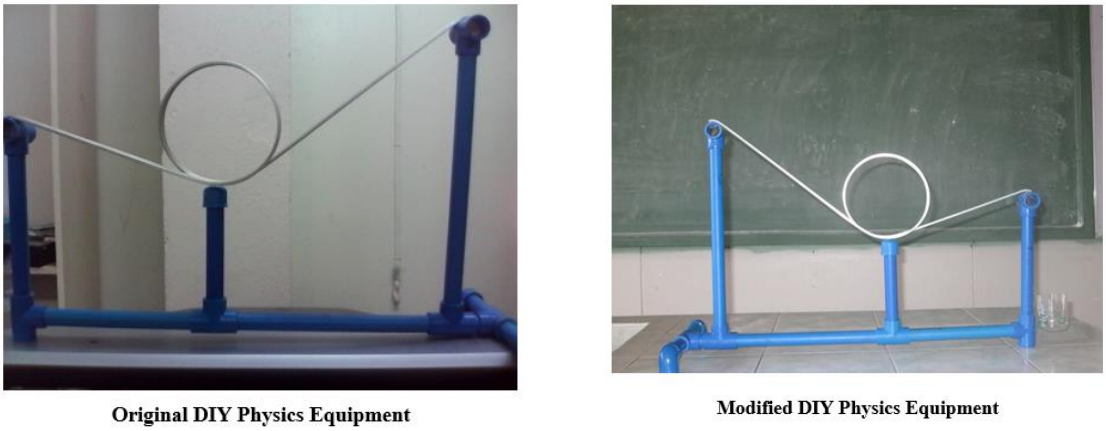


Figure 4. Original and modified DIY Physics equipment

Assessment of the Improvised DIY Physics Equipment

Table 1. Overall Assessment on the Improvised DIY Physics Equipment by the Pre-Service General Science and Pre-Service Physics Teachers

Improvised DIY Physics Equipment	Pre-Service General Science		Pre-Service Physics		Overall		Rank
	Mean Rating	Interpretation	Mean Rating	Interpretation	Mean Rating	Interpretation	
1	3.34	Very Good	3.20	Good	3.27	Very Good	4
2	3.00	Good	3.25	Good	3.13	Good	5
3	3.50	Very Good	3.52	Very Good	3.51	Very Good	2
4	2.94	Good	3.02	Good	2.98	Good	6

Improvised DIY Physics Equipment	Pre-Service General Science		Pre-Service Physics		Overall		Rank
	Mean Rating	Interpretation	Mean Rating	Interpretation	Mean Rating	Interpretation	
5	3.57	Very Good	3.47	Very Good	3.52	Very Good	1
6	3.31	Very Good	3.45	Very Good	3.38	Very Good	3

Table 1 reveals that based on the assessment done by the pre-service general science teachers, the DIY equipment 1, 3, 5, and 6 had a mean rating of "very good"; DIY equipment 2 and 4 had a mean rating of "good". Among the six (6) improvised DIY equipment, 5 had the highest mean rating, so it was considered the best improvised DIY equipment.

Based on the assessment done by the pre-service physics teachers, the DIY Equipment 3, 5, and 6 had a mean rating of "very good"; DIY equipment 1, 2, and 4 had a mean rating of "good". Among the six (6) improvised equipment, the DIY equipment constructed by Group 3 had the highest mean rating, so it was considered the best improvised DIY equipment.

The overall assessment reveals that the DIY equipment 1, 3, 5, and 6 had a mean rating of "very good"; DIY equipment 2 and 4 had a mean rating of "good". Among the six (6) improvised equipment, DIY equipment 5 had the highest overall mean rating, which was considered the best. DIY equipment five was proclaimed as the best DIY equipment in terms of a physical feature, ease of manipulation, efficiency, accuracy, safety, and appropriateness.

Assessment of the Designed Laboratory Activity

Table 2. Overall Assessment on the Designed Laboratory Activity by the Pre-Service General Science and Pre-Service Physics Teachers

Laboratory Activity	Pre-Service General Science		Pre-Service Physics		Overall		Rank
	Mean Rating	Interpretation	Mean Rating	Interpretation	Mean Rating	Interpretation	
1	3.50	Very good	3.51	Very Good	3.51	Very Good	2
2	3.48	Very good	3.36	Very Good	3.42	Very Good	4
3	3.53	Very good	3.53	Very Good	3.53	Very Good	1
4	3.28	Very good	3.08	Good	3.18	Good	6
5	3.59	Very good	3.32	Very Good	3.46	Very Good	3
6	3.40	Very good	3.23	Good	3.32	Very Good	5

Table 2 reveals that based on the assessment done by the pre-service general science teachers, laboratory activities 1, 2, 3, 4, 5, and 6 had a mean rating of "very good". Among the six (6) laboratory activities, laboratory activity 5 had the highest mean rating, so it was considered as the best laboratory activity.

Based on the assessment done by the pre-service physics teachers, the laboratory activities 1, 2, 3, and 5 had a mean rating of "very good"; laboratory activities 4 and 6 had a mean rating of "good". Among the six (6) laboratory activities, the laboratory activity

constructed by Group 3 had the highest mean rating so it was considered as the best laboratory activity.

The overall assessment reveals that laboratory activities 1, 2, 3, 5, and 6 had a mean rating of "very good"; laboratory activity 4 had a mean rating of "good". Among the six (6) laboratory activities, laboratory activity 3 had the highest overall mean rating, so it was considered the best laboratory activity. Though laboratory activity 3 had the highest mean rating among the six (6) laboratory activities, the researcher considered laboratory activity 5 to match the improvised DIY equipment 5. The consent of the adviser and panel members was sought for approval.

Enhancement of the Improvised DIY Physics Equipment

Upon selecting the best DIY Physics equipment, the researcher considered the concerns that could be improved. The different criteria observed during the assessment to enhance the workability of the improvised DIY Physics equipment were considered.

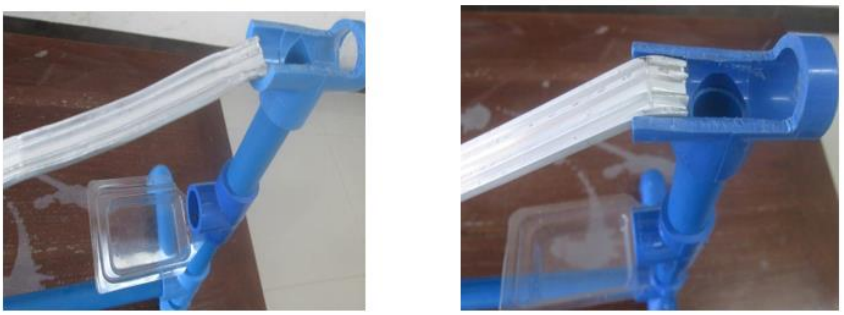
The ideas and suggestions of the fifth group of pre-service general science teachers, whose improvised DIY equipment was identified as best, were solicited to contribute to the development of more improvised DIY Physics equipment, the enhanced DIY equipment.

Improvised DIY Equipment **Enhanced DIY Equipment**

Figure 5. DIY Physics equipment's physical feature, ease of manipulation and accuracy

As shown in Figure 5, the enhanced DIY equipment was still made from accessible and affordable materials like PVC pipes and an aluminum screen frame. Just like the improvised DIY equipment, the enhanced DIY equipment was also well built. The enhanced DIY equipment had the same design as the improvised DIY equipment, but since one of the concerns was the size of the equipment as far as ease of manipulation was concerned, the parts of the equipment had been adjusted for the enhanced DIY equipment, including the two (2) loops. The distance between the two loops was minimized in the enhanced DIY equipment. The loops were carefully formed and properly attached to the PVC tees to ensure the equipment's stability and the marble's continuous motion. It was made sure that the enhanced equipment could yield

correct measurement while providing a consistent standard.



Improvised DIY Equipment **Enhanced DIY Equipment**

Figure 6. DIY Physics equipment's physical feature, ease of manipulation and safety

As shown in Figure 6, the improvised DIY equipment had irregularities in the construction of its aluminum screen, especially near the lowest point of release of the marble, so it was reconstructed for the enhanced DIY equipment to ensure continuous motion of the marble. The aluminum screen frame for the enhanced DIY equipment was thoroughly polished to eradicate sharp edges that may cause injury.

Improvised DIY Equipment **Enhanced DIY Equipment**

Figure 7. DIY Physics equipment's ease of manipulation

The highest point of release for the marble was also enhanced to prove the ease of manipulation of the enhanced DIY equipment. As shown in Figure 7, the improvised DIY equipment had an extension on the aluminum screen frame track. The extension was removed for the enhanced DIY equipment to minimize the size of the equipment.

The enhancements that were done on the improvised DIY equipment were necessary to ensure that the enhanced equipment would be workable, which was the study's main goal so that the enhanced DIY equipment would then be used for the development of a laboratory activity kit. The results of this study would agree with the findings of Metante (2012); he mentioned in his study that the apparatus has improved and met the aim of its modification. Also, Buot (2010) revealed in her study that the improvised apparatus was acceptable in terms

of (a) constructional appearance and economy, (b) convenience and scientific rigor, and (c) performance output.

Enhancement of the Designed Laboratory Activity

The title of the designed laboratory activity of Group 5 was not so appropriate for the activity though it was brief and concise. For this reason, the researcher enhanced it into something that is appropriate, brief, and concise. The introduction of the designed laboratory activity was brief, but it did not give a general overview of the concept because it only differentiated between potential and kinetic energy. For this reason, the researcher enhanced it to give a general overview of the concept of energy transformation. The objectives of the designed laboratory were not measurable and did not require a high level of difficulty. For this reason, the researcher enhanced them to become SMART (specific, measurable, attainable, reliable, and time-bounded), require a high level of difficulty, and involve two or more skills.

The materials included in the designed and enhanced laboratory activities were already simple and easy to use, appropriate, readily available, completely itemized, and safe to use. The designed and enhanced laboratory activities had clearly stated that one class period was enough for the activity. The procedure in the designed laboratory activity was brief and concise, simple but not so clearly stated, logically sequenced but not so easy to follow. The precaution was correct and was emphasized in bold texts. The researcher still enhanced the procedure to make the steps more workable, and the points of release of the marble were clearly stated.

The questions in the designed laboratory activity were clearly stated relevant to the topic. Still, they did not promote higher-order thinking skills (HOTS) and were not arranged in ascending order of difficulty. The researcher enhanced them to promote HOTS, arrange them in ascending order of difficulty and lead to the attainment of the objectives.

CONCLUSION

The enhanced DIY Physics equipment was workable in its physical feature, ease of manipulation, efficiency, accuracy, safety, and appropriateness. The enhanced laboratory activity for the DIY Physics equipment was also workable in terms of its title, introduction, objectives, materials, procedure, questions, layout, spelling and grammar, and time allotment. Therefore, the enhanced DIY Physics equipment and laboratory activity could be used for the development of a Physics laboratory activity kit.

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