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Development of Comprehensive Project-Based Learning Packets in Teaching Conservation of Momentum

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Abstract. This study has developed a Project-Based Learning activity in the conservation of momentum using available online simulations. The teaching materials had undergone validation and revisions for further improvement before its implementation. This study pilot tested the Developed Project-Based Learning Activities in teaching Conservation of Momentum and determine the gain of students in terms of their achievement test results. Developed Project-Based Learning Activities for Grade Nine Science class as a form of instruction and assessment in an Online Distance Learning Modality. Sixty-one Grade Nine Students were chosen to answer the Pretest-Posttest Achievement test. Through a Qualitative with quantitative support research design with weighted mean, Dependent/Paired Sample T-test, the comparison of the student's achievement test scores through Normalized Gain, and their perception to the use of the developed learning material. Findings showed that the Developed Project-Based Learning Activities received a Very Good Rating from the evaluators. Based on their Achievement test results, students had a significant difference in their conceptual understanding and from their perception, it indicated that students' value and find relevance in learning the topic specifically road safety. Thus, the use of the Developed Project-Based Learning Activity in online instruction improved the students' conceptual understanding of Conservation of Momentum. It can also be seen that students who experienced PBL activity have a higher interest, motivation level and positive attitude towards momentum with a rating of 5.88 and a descriptive agreement the activities helped them learn the purpose of being careful about road and sports safety. With these findings, it is therefore concluded that self-directed, reflective and project-based learning strategies and teachers' instruction might be effective.

Keywords: Project-based learning, Momentum, Simulation, Develop

INTRODUCTION

One of the aims of education is to let the learners understand different phenomena in their environment and allow them to choose among natural options to aid their daily life challenges and develop life-long skills that will carry them throughout their existence.

This ultimate goal can be attained when abstract lessons in science are taught in a way that learners can build a correct conceptual understanding of the scientific ideas and find their application to real-world problems. According to Vosniadou (2019), students develop an understanding of science concepts based on three aspects of development: the creation of intuitive understandings, the process of science learning, and the presence of conceptual co-existence. To be effective in science education, it needs to make learners aware of their intuitive understandings, provide scientific information gradually and in agreement with students' learning progressions and develops their reasoning abilities and executive function skills. The stance stated above makes a construct that the more meaningful the learning experience by the learners, the greater the connections to students' understanding. Today, invaluable efforts are made by curriculum developers, administrators and teachers to uphold the Philippine standards of education, but still, the performance of the students in the country is low. Based on the 2018 Programme for International Student Assessment (PISA), Philippine students have low performance in science. This assessment tests critical thinking in math, science, and reading and do not measure memorization of facts, but rather demand that students draw on knowledge and real-world problem-solving skills. This result is also complemented by the low scores in the overall National 2 Achievement Test (NAT) (Albano Jr., 2020). These results show that Philippine Basic Education still has a gap in attaining the quality of basic education. Generally, with these results, we can say that student completers still lack in-depth nurturing of the essential skills. Thus, having a great impact on the lifelong learning of students to compete in the global world of work. This fact directly points out what students experience during their learning (in and out of the classroom) and the serious role of the educators in providing students genuine learning and eliminating the gap.

Many educators are implementing Project-Based Learning to address each learner's need. In many countries, it is currently considered to be an innovative approach to science and technology (S&T) teaching (Abdel et. al., 2016). PBL can reshape science education by engaging all learners in meaningful and robust knowledge-building experiences (Miller et. al., 2019). Learners are guided to construct educational experiences that prepare them to answer the challenges of real-world problems they will face after graduation (Taharu, et. al., 2019). In PBL courses, students complete various performance tasks that demonstrate that knowledge, understanding, and proficiency through tangible products or performances. Formative learning experiences, focused on the application of knowledge, occur throughout—problem-solving is the key to this type of knowledge acquisition. The format develops the students' ability to think critically, creatively, and productively about a problem, while also nurturing team skills. These meaningful experiences help students connect more deeply with the material while improving their enthusiasm and engagement with the work ("Project-Based Learning", n. d.). In the study of İlhan, 2014 entitled: "A study on the efficacy of project-based learning approach on Social Studies Education: Conceptual achievement and academic motivation", he found out PBL provides an effective way for teachers and students to develop creativity and supportive learning environment. This approach also has encouraged students' creative abilities (Isabekov and Sadyrova, 2018), learning motivations (Chiang and Lee, 2016) which are essential to extend their knowledge as they encounter unfamiliar 3 situations and to critically analyze scientific information to make informed decisions that affect their lives (Kim, 2005) (Rutledge, 2005). Many researchers have studied momentum through problem-based strategy (Sahin, 2010) and Activity-based (Ültay, E., & Alev, N., 2017) and none about learning Conservation of Momentum conducted in the Philippines in online and remote learning during a pandemic. This motivated the researcher to conduct this study to design a learning material that will provide students meaningful experience to think critically, creatively, and productively and to develop their learning. The researcher of this study developed a Learning material with activities that can be manipulated independently through online simulations which are advisable during pandemics to assist students' exploration and understanding of

science concepts. This study was therefore designed to make a PBL activity through an Inquiry-Based Approach to promote conceptual understanding of the conservation of momentum in Physics Grade 9. Moreover, this will be anchored on the constructivist theory where academic success will be based on the quality construction of the learner's conceptual understanding through the achievement scores and projects.

RESEARCH OBJECTIVES

The study aims to develop a Project-Based Learning activity in the conservation of momentum specifically to:

1. Develop the Project-Based Learning activity.
2. Determine the quality of the developed Project-Based Learning activity through:
   a. normalized gain between the pretest and posttest scores in the achievement test.
   b. quality of outputs from the Project-Based Learning Performance Task.
   c. perception of students on Project-Based Learning.
3. Investigate the gain scores in the achievement test.

METHODOLOGY

This study used pretest-posttest one group design online classroom-based study and quantitative with qualitative support research design. Qualitative findings could provide a mirror of the unseen characteristics of how a numerical value has arrived: underlying reasons, attitudes, and motivations behind various human behaviors. The quantitative data was based on the pretest and posttest achievement scores and quality of projects of respondents. Qualitative data is taken from the feedback of the evaluators and responses on the reflective journals of the respondents

Participants

The subjects of the study were 61 Grade 9 students officially enrolled in La Salle Academy during the school year 2020-2021. These students were enrolled on an online distance learning system. The Experts of the study were 14 experts in the field of Grade 9 and 10 Science, Science Coordinators and subject teachers rendering for 2 years and more in service who evaluated the Developed PBL and the achievement test.

Research Tools

The research instruments were used in the data collection of this study are as follows:

- K to 12 Basic Education Curriculum Guide

The Developed PBL Activities followed the Grade 9 MELCs of K to 12 Basic Education Curriculum Guide. The content, performance standards and competencies as the guide in the development of the learning materials.

- Developed Project-based Learning Activity

This material contained five (5) supplementary teaching materials on Conservation of Momentum developed based on learning competencies by the K to 12 Basic Education Curriculum Guide. These are: Activity 1- Defining Problem, Activity 2 - Define Momentum and Impulse, Activity 3 – Conservation of Momentum, Activity 4 – Problem Solving and Activity 5– Decision Day.

- Rubric for Evaluation of Supplementary Teaching Material

This rubric and scale were used by the evaluators to rate the content and appropriateness of the developed PBL Activity before the implementation. This is a Revised Version of the Rubric for Evaluating A Hands-on Activity from Hanifa M. Maurac.

- Perception Questionnaire

This questionnaire was adapted from Deci and Ryan (1994) cited by Variacion et. al (2021) in her thesis study entitled: Development of Differentiated Activities in Teaching Science: Its Effects on Students' Performance and was not modified by the researcher. This was used by the researcher to measure the perceptions of the respondents on the following areas: interest and enjoyment; application to real-life context; engagement, participation, self-regulation, value and relevance during the conduct of the PBL Activity. The items under interest and enjoyment determined respondents' interest, enjoyment and motivation as they meaningfully involved themselves in the activities. The items on value and relevance aligned with real-life contexts determined if respondents were able to connect and relate the learnings in real-life situations. In self-regulation items, respondents indicated whether they were engaging in their learning and was able to formulate and acquire knowledge and skills independently. This questionnaire summarized the effects of the developed PBL Activity in the respondents' learning process. This questionnaire had a Readability Index of 4.9 which means appropriate for Grades 8 to Grade 9 Students.

- Science Journal

Adapted from Capangpangan (2013) and used by Variacion et al. (2021), this questionnaire was used by the researcher to allow students to describe their experience and gather qualitatively their feeling and reactions to the developed PBL.

- Achievement Test

To determine the effects of the Developed Project Based Learning Activity on the respondents' conceptual understanding, the achievement test was administered. This achievement test is a researcher-made test that was validated by the research adviser and panel of experts. The achievement test consisted of thirty (30) items that composes of Conceptual Multiple choices. The achievement test underwent a validity test through item analysis. To test the consistency of respondents' answers and performance, the sequence of questions was repeated in the Post-test. The researcher-made achievement test was face and content validated by evaluators. Evaluators' comments and suggestions were used to see the significant difference in the respondents' performance. Table 1 below summarize the evaluators, comments and suggestions in the researcher-made Achievement test.

Table 1 Summary of Evaluators' Comments and Suggestions in the Researcher-made Achievement Test

Criteria	**Comments /Suggestions**
Visuals/ Graphics	Members agreed that items should be added with pictures/ visual representation
Question	Members agreed that some questions are knowledge-based, which should be changed to conceptual questions. Specific examples such as a football player or an athlete's view should be changed to a general example which is commonly observed

- Online Resources Used in The Study

This section contains the online simulations, Phet Simulations and other online references used in the development of Project-Based Learning Activities.

1. Professor Dave Explains Impulse and Momentum with Url youtube.com/watch?v=E13h1E_Pc00. The Professor Dave Video is open-source which learners and teachers can use to aid learning, as mentioned in the about section of the author's channel. He has a video lesson describing the effect of force in changing the momentum of an object.
2. Phet Simulation Ramp: Forces and Motion with Url https://phet.colorado.edu/sims/cheerpj/motion-series/latest/motion-series.html?simulation=ramp-forces-and-motion.

Figure 1 Phet Simulation Ramp

Build November 6, 2012, a simulation showing the concept of forces and motion of different objects such as crates, cabinets, 27 refrigerators, cats, and textbooks with friction and frictionless surface and with bouncy or brick walls.

PhET simulations are open source and free to all students and teachers. Thus, with this, teachers and students have free access to the simulations to aid learning, as mentioned in the About Section of the webpage, see picture below.

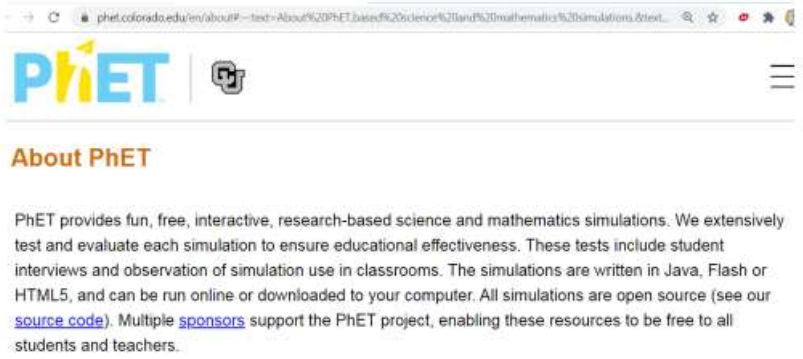

Figure 2 About Phet Webpage

3. Phet Simulation Collision Lab with URL https://phet.colorado.edu/sims/collision-lab/collision-lab_en.html

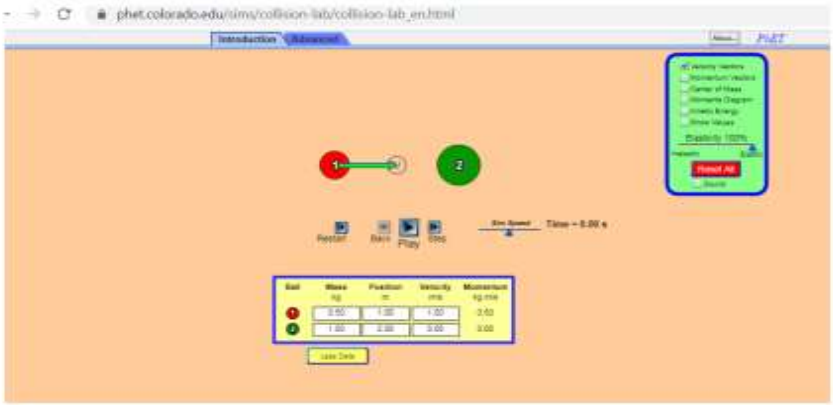

Figure 3 Phet Simulation Collision Lab

Build October 12, 2012, a simulation showing collisions in 1 and 2 dimensions of two objects with varying masses and elasticity. This is also showing the momenta and energy of the system during collisions.

4. Physics Classroom Egg Drop Simulation with URL https://www.physicsclassroom.com/Physics-Interactives/Momentum-and-Collisions/Egg-Drop/Egg-Drop-Interactive

The Egg Drop Interactive provides a virtual egg drop activity. Learners can vary the mass of the egg that is dropped, the height from which it is dropped, and the surface onto which it is dropped. The egg drop is simulated and the result is displayed in Figure 7. The impulsemomentum change theorem is used to show how the force is calculated from the egg drop parameters that are selected. The Interactive provides an eggcellent demonstration of how alterations in one variable affect another variable.

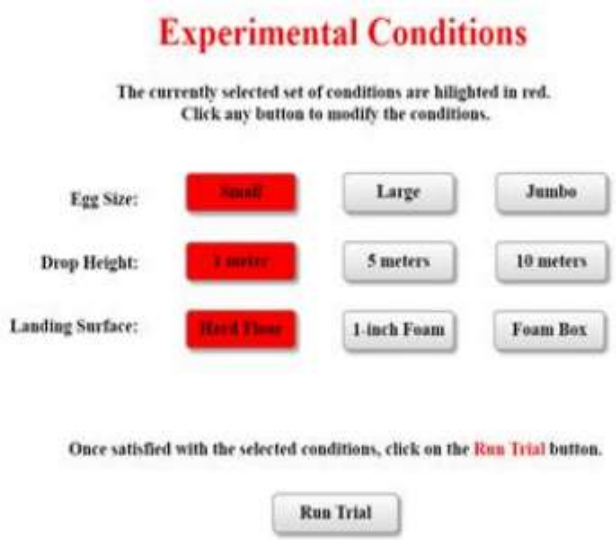

Figure 4 Physics Classroom Egg Drop Simulation

DATA COLLECTION

- Methods in the Development of the Developed Project-Based Learning Activities

First, the researcher determined the learning competencies of Conservation of Momentum in the DepEd K-12 Curriculum MELCs. Then the researcher developed activities based on the learning competencies. It was then validated by fourteen (14) Science in-service teachers who were teaching Science 9 and 10 for two years and more. The ratings, suggestions and comments of the evaluators were used in revising the supplementary teaching materials. After revision, the teaching materials were ready for try-out.

- Identifying Standards and Most Essential Learning Competencies

Developed Project Based Learning Activity was designed by the researcher based on the Most Essential Learning Competencies of the Department of Education K to 12 Curriculum Guide. In the development of the Developed PBL, the following steps were followed as seen in Figure 5.

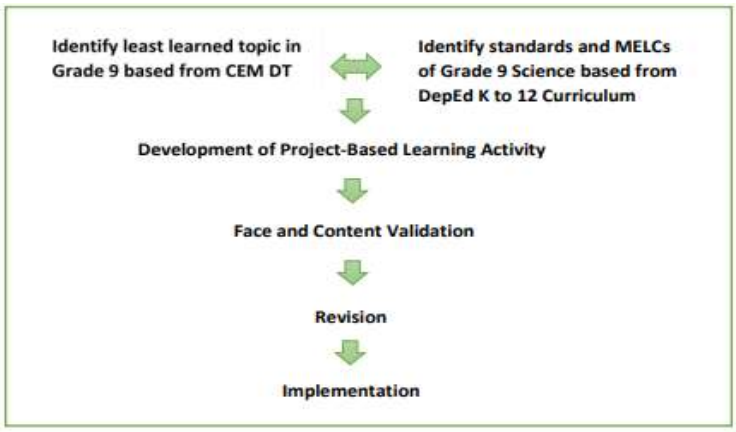

Figure 5 Development of the Developed PBL

DepEd K-12 Curriculum provided the list of standards and competencies for Grade 9 Science. Below is the identified standards and competencies for the fourth quarter.

Table 2 Standards and Competencies for Grade 9 Momentum

Quarter	**Content Standard** The learner demonstrates an understanding of…	**Performance Standard** The learner should be able to…	**Most Essential Learning Competencies**
4th	Projectile motion, impulse and momentum, and conservation of linea momentum	Propose ways to enhance sports relatec to projectile motion	Describe the horizontal and vertical motions of a projectile Investigate the relation-ship between the angle of release and the height and range of the projectile Relate impulse and momentum to the collision of objects (e.g vehicular collision) Infer that the total momentum before and after the collision is Equal

The researcher chose the topic MOMENTUM since this is one of the least learned topics of the grade level. The CEM DT Pre Test Result is shown below.

Table 3 CEM Pretest Diagnostic Test Result SY 2020-2021

Grade 9 Science Learning Competency	Proficiency Percentage	Proficiency Level
States conditions for a momentum change	46.8	Not Proficient

- Designing Developed Project-Based Learning Activity

The designing of the Project-Based Learning Activity is based on the Curriculum Guide of K to 12 Basic Education Curriculum Standards specifically Momentum. The five (5) activities included in the teaching material are researcher-revised and researcher-developed. The construction of pretest and posttest and other instruments used such as rubric for evaluator's validation and rubric for respondent's output and perception questionnaire as reflected in their science journals are also included in this step.

- Validation Process

A rating scale was used to validate the developed Project Based Learning Activity. Two elements were und in the validation process: Face Validation and Content Validation. The learning material contained five (5) supplementary teaching materials on Conservation of Momentum. These are: Activity 1- Defining Problem, Activity 2 - Define Momentum and Impulse, Activity 3 – Conservation of Momentum, Activity 4 – Problem Solving and Activity 5– Decision Day. The evaluators assessed the style and format for the face validity and the appropriateness for content validity. Each evaluator was given a letter (Appendix B) and a Rating Scale are used in the evaluation of the developed PBL. After which were collected back for interpretation. Their comments and suggestions were used for the revision.

- Revision of the Developed Project Based Learning Activity

The evaluator's suggestions and comments were significant in the revisions and modifications of the Developed Project Based Learning Activity before it was implemented. Specifically, the revisions focused on the areas of Curriculum Relevance, Presentation, Background/Information Objectives and Questions. All the evaluator's comments and suggestions were gathered. These criteria made the Developed Project Based Learning Activity valid, effective and ready for implementation.

- Try-Out

The try-out of the Achievement test and the Developed Project Based Learning Activity was administered to Grade 9 students who were officially enrolled or under the online distance learning system in La Salle Academy during the school year 2020-2021. A letter to the Principal was forwarded to seek approval of the pilot testing of the study. After the approval, the study was then pilot tested for 2 synchronous classes and 2 asynchronous classes with a 50-minutes duration per class. In the first synchronous class, a pretest assessment was given thru google form followed by a scenario/problem with the essential question and orientation for the developed PBL activity were given. In the next 2 synchronous classes, students completed the tasks and underwent the steps in PBL (Figure 2). The second synchronous was for feedback and critique to finalize their product/resolution to the essential question. Their final output was rated with the rubric (Appendix M). After the conduct of the posttest assessment, the respondents answered the Perception Questionnaire, Self-Reflection Questionnaire all in the google form. After the activity, students wrote their reflection (in google form) about their experience with the developed PBL. This activity has undergone approval from the Ethics Committee to ensure confidentiality of the identity and responses of the respondents who are below

eighteen years old. Figure 9 summarized the flow of the implementation of the developed PBL. Lastly, the scores and responses of the respondents were recorded and analyzed.

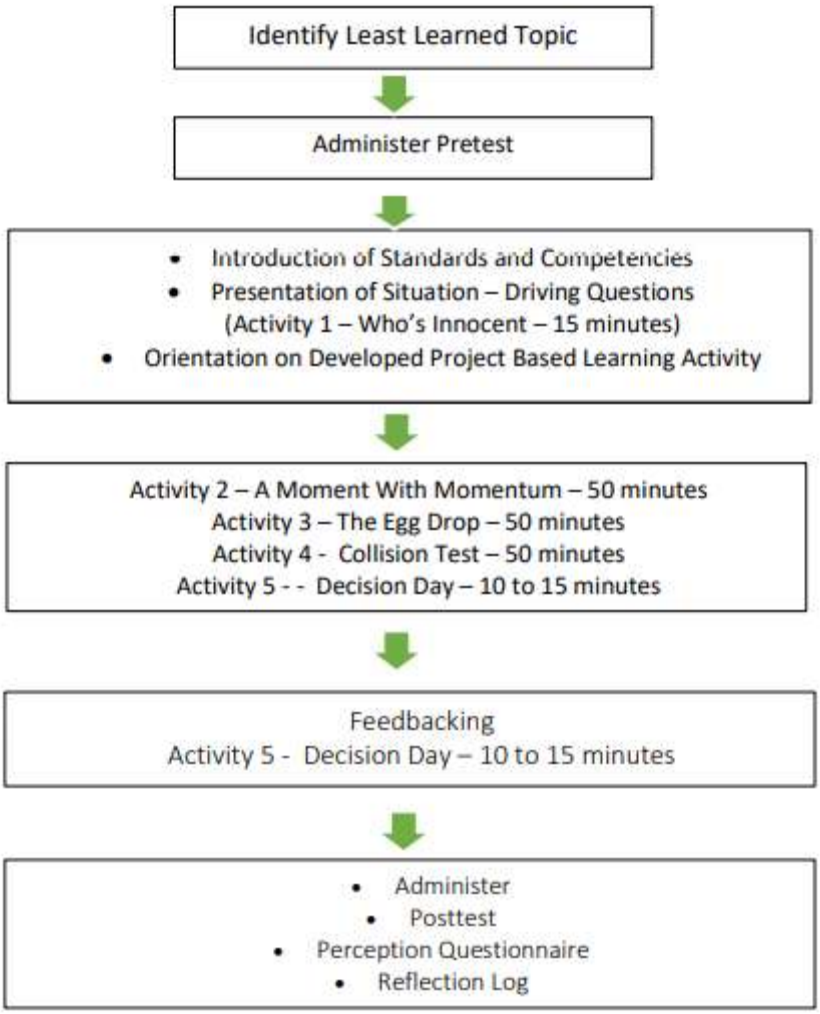

Figure 6 Flow of the Implementation of the Developed PBL

DATA ANALYSIS

Both quantitative and qualitative data were gathered to achieve the objectives of the study.

Rating Scale

A rubric with a rating scale was used by the experts to evaluate the developed PBL. The mean rating was used to analyze and interpret the quantitative data. To interpret the mean rating, the following intervals and descriptions were used (Adapted from Maurac, 2016) used by Variacion et. al (2021).

Table 4 Rating Scale

Rating	Equivalent:
4.20 – 5.00	Excellent
3.40 – 4.19	Very Good
2.60 - 3.39	Good
1.80 - 2.59	Fair
1.00 – 1.79	**Poor**

Statistical Treatment

The following treatments of data were used in the presentation of the results in this research study.

Dependent/Paired Sample T-test. This is a statistical procedure used to determine whether the mean difference between two sets of observations is zero. This was used to compare the gain of the students in the pre-test and post test score.

Normalized Gain. It is a statistical procedure used to determine whether the mean difference between two sets of observations is zero. This was used to compare the pretest and posttest scores.

Weighted Mean. The weighted mean is a type of mean that is calculated by multiplying the weight (or probability) associated with a particular event or outcome with its associated quantitative outcome and then summing all the products together. This was used to interpret the perception level of the students and the characteristics of the Developed PBL as rated by the experts.

Interpretation of the Respondents' Perception Questionnaire

To interpret the Respondents' Perception Questionnaire, the following ranges and scores and analyses were used (adapted from Deci and Ryan (2014) used by Variacion et. al (2021).

Table 5 Rating Scale for Perception Questionnaire

Scale	Range	Description	Analysis
1	1.00 – 1.84	Not at all true	Never true
2	1.85 – 2.70	Rarely true	Rarely true in less that 10% of the time
3	2.17 – 3.56	Occasionally true	Occasionally true, only 30% of the time
4	3.57 – 4.42	Somewhat true	Somewhat true, only 50% of the time
5	4.43 – 5.28	Frequently true	Frequently true, only 70% of the time
6	5.29 – 6.14	Usually true	Usually true, in about 90% of the time
7	6.15 – 7.00	Very true	All the time true

Level of Proficiency Adapted from Dep Ed (Llego, 2012)

To interpret the level of proficiency of the respondents in their pretest and post test results.

Table 6 Level of Proficiency

Level of Proficiency	Equivalent Numerical Value
Beginning	74% and below
Developing	75-79%
Approaching Proficiency	80-84%
Proficient	85-89%

Normalized Gain Interpretation

Adapted from Hake, 1999 and used Rani, Wiyatmo, & Kustanto, 2017 in his thesis entitled "Concept Attainment Worksheet to Enhance Concept Knowledge and Science Process Skills in Physics Instruction".

Table 7 Normalized Gain Interpretation

Standard Gain Score (g)	Criteria
$0.70 < (g)$	High
$0.30 \leq (g) \leq 0.70$	Medium
$(g) < 0.30$	Low

(Hake, 1999)

Coding of Data

The respondents and the experts were represented by codes:

A1 to A61: represent the Grade 9 students

E1 to E14: represent the In-Service Secondary Science Teachers teaching for two (2) years or more.

RESULTS AND DISCUSSION

This chapter presents the analyses and interpretation of the data gathered both quantitatively and qualitatively.

Development of the Project Based Learning Activity

The developed PBL was designed by the researcher with the assistance of the Thesis Adviser and 14 experts in the field of Grade 9 and 10 Science. It is all about Momentum (impulse and momentum and conservation of momentum). Prior to the development of the learning material, the researcher insured its alignment to the DepEd K-12 MELCs Identified Standards and Competencies which are targeting the power competencies essential for learners to learn in Grade 9 Science. Even during pandemic, under "Sulong EduKalidad," DepEd's battle cry moving forward, education must continue. From S. (2020), Salustiano Jimenez, DepEd 7 Director, stated:

... . 'That's what we're prioritizing now amid this crisis. We tried to find a solution that's suitable for these challenging times. It would be difficult for us to go all the way since we'll be using different modalities in the delivery of instructions and lessons."

Table 8 Alignment of Daily Learning Targets to DepEd K-12 MELCs Identified Standards and Competencies

Content Standard *The learners demonstrate understanding of...*	**Performance Standard** *The learners should be able to...*	**Most Essential Learning Competencies**	**Project Based Outcomes**
impulse and momentum, and conservation of linear momentum	propose ways to enhance sports related to projectile motion	Relate impulse and momentum to collision of objects (e.g., vehicular collision) Infer that the total momentum before and after collision is equal	Students were able to relate impulse and momentum in analyzing vehicular collision. Students were able to give a correct and detailed observation of the collision.

Designing Project Based Learning Activities

The learning material was designed in the alignment to K-12 Deped MELCs. This material contained five (5) supplementary teaching materials on Conservation of Momentum. These are: Activity 1- Defining Problem, Activity 2 - Define Momentum and Impulse, Activity 3 – Conservation of Momentum, Activity 4 – Problem Solving and Activity 5– Decision Day.

Based from the comments and suggestions of the evaluators, the PBL were revised before its pilot testing. Towards the last synchronous and asynchronous making of their performance task, validated questionnaire was administered to determine the normalized gain and students' perception to the learning material. The results from the data gathered were analyzed and treated with utmost confidentiality.

Evaluation of the Developed Project Based Learning Activities

The Developed Project Based Learning Activities were evaluated in two aspects; face and content validations which were done by the adviser of the researcher, administrators and in-service science teachers.

Table 9 Evaluators' Comments, Suggestions and Perception on the Developed Project Based Learning Activities

Area	**Summary of Comments and Suggestions**
Content	Members agreed that this is a good supplemental material to the distance and homebased learning, cater the different learning styles of the students and very useful in developing problem solving skills and logical reasoning.
Assessment	Include a rubric on how students will be assessed on this project
Activities	The members suggest to employ a personalized situation, application to the society or local community
Problem Solving	Problem Solving is difficult especially to slow learners since examples given need thorough analytical understanding for students to be able to come up with the correct answers.
Time Allotment	The members suggested to place a time allotment in each activity to give learners direction on when it should be accomplished.

Summarized in Table 9 are the comments and suggestions of the experts on the areas of Curriculum Relevance, Presentation, Background Information and Questions. Prior to the try out on Grade 9, other revisions were done based on the experts' suggestions.

Revisions of the Developed PBL Learning Activity were based from the comments and suggestions of the evaluators. Based from the accumulated comments and suggestions, instructional material is a good supplemental material to the distance and homebased learning, cater the different learning styles of the students and very useful in developing problem solving skills and logical reasoning. The experts have advised to revise the problem solving to contextualized questions for students to easily comprehend. Furthermore, the experts suggested to include rubric and time allotment to guide students on what to achieve for a specific period of time. With this suggestion and rating, it implies that the Developed PBL is a good material to guide students in their learning experience targeting the development of the 21st century skills even in online learning modality.

These comments and suggestions affirm to the idea of Levy (2008) cited by Willey (2016) that flexibility in content, process and assessment based on the students' strengths, needs and learning styles is the way for students to succeed. Learning experience should enhance life skills and increase students' motivations and engagement more in an online learning set-up.

Table 10 Mean Rating of the Developed PBL Learning Activity

Criteria	Rating	Description
CURRICULUM RELEVANCE	**4.23**	Very Good
PRESENTATION	**4**	Very Good
BACKGROUND/ INFORMATION	**3.6**	Very Good
OBJECTIVES		
QUESTIONS	**3.8**	Very Good
Overall Rating	**3.91**	**Very Good**

The table above presents the ratings given by the expert evaluators on the developed PBL learning activity based on the identified criteria. Based from the overall rating of 3.91 which is Very Good, it can be said that the experts agreed that the developed PBL learning was well crafted. The result of the rating connects to the Khaliq et. al (2015) that the interest and motivation of students depends on information and communication technology, specially the challenges and chances it provided in form of internet and other multimedia tools to beautify and the results of the projects their assembling and presentation. These factors were found in the activities.

Evaluators' Evaluation, Comments and Suggestions on the Researcher-made Achievement Test

Table 11 shows the evaluations, comments, and suggestions of evaluators in the achievement test. These comments are considered in the revisions of the researcher-made achievement test prior to pretest.

Table 11 Summary of Evaluators' Evaluation, Comments and Suggestions on the Researcher-made Achievement Test

Area	Comments /Suggestions
Visuals/ Graphics	Members agreed that items should be added with picture/ visual representation
Question	Members agreed that some questions are knowledge- based, which should be changed to conceptual question.
Instruction	Specific example such as a football player or an athlete's view should be change to a general example which is commonly observed even by nonathlete

Prior to test administration, three revisions were done based from the comments as some questions are ambiguous and knowledge-based. Thus, the achievement test was revised before the implementation.

Performance of Respondents in Pretest and Posttest

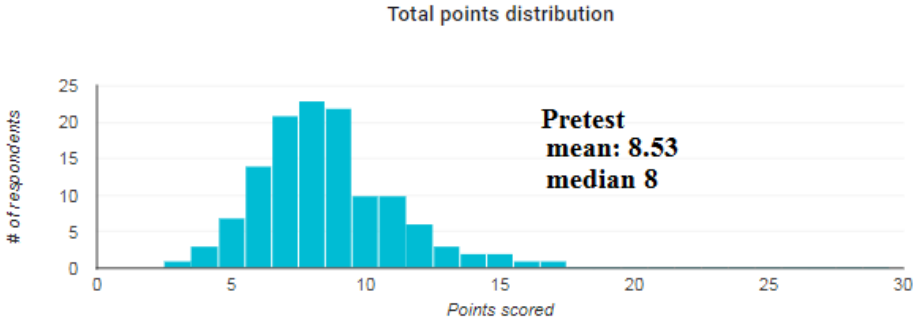

Figure 7 Performance of Respondents in Pretest

Figure 7 shows the point distribution of pretest scores of respondents. Its mean is 8.53 with a median score of 8. The respondents have the lowest score of 3 and the highest score of 17. Based on table 18, the class has a beginning proficiency level. This shows that majority of the respondents have a low average score which implies having limited idea about conservation of momentum.

Table 12 Level of Proficiency of Respondents' Pretest Performance

Average	Frequency	Percentage	Descriptor
75 – 79	1	1.64	Developing
74 and below	60	98.36	Beginning
Total	61	100	
Mean	8.53		Beginning

The result of the pretest imply that students have few knowledge or misconceptions about the topic which according to Efstratia (2014) needed to be enhanced through activities that connects problems with the real world. This gives the students an opportunity to develop additional skills, apart from cognitive skills, which are significant

abilities that could change our world to a better one, while they enhance their learning outcomes.

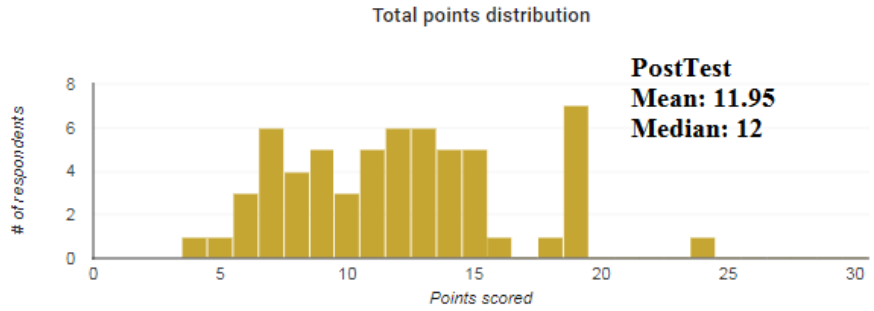

Figure 8 Performance of Respondents in Posttest

Figure 8 shows the point distribution of posttest scores of respondents. Its mean is 11.95 with a median score of 12. The respondents have the lowest score of 5 and the highest score of 24. Based on table 19, the class has an average beginning proficiency level. This means that there is a difference of the scores from pretest to posttest but remaining to the same proficiency level. This implication is probably an effect of the responses of the students in their reflection of having problems about cooperation among members of the group in performing the activities and also not getting used to online self-directed instructions shifted from a face-to-face classroom instruction.

Table 13 Level of Proficiency of Respondents' Posttest Performance

Average	Frequency	Percentage	Descriptor
85 – 89	1	1.64	Proficient
80 – 84	5	8.20	Approaching Proficiency
75 – 79	6	9.84	Developing
74 and below	49	80.33	Beginning
Total	61	100	
Mean	11.95		Beginning

Results shown in Table 12 and 13 mean the difference of scores of respondents from their pretest to posttest still remains to be in the same level of proficiency which is rated Beginning. This result, though found to be significant based from table 18, shows an evidence of the effect to the respondents during the transition stage from offline face to face to online distance learning. Based from the response to their Reflective Journal, a student said "*That some of the activity was hard and also I did not know what to do first and it's really hard to do the activity with my group mates since we cannot meet in real life."* This thought could have affected their learning since they were used to performing learning in a physical face to face set up and this shift caused academic stress to learners.

According to Mahapatra and Sharma (2020), academic-related stress (unable to avail online classes or submit their assignments, thus falling behind their peers in their

curriculum, problematic use of technology, increased gaming, spending more time on social media) has an adverse effect on academic performance, mental health and well-being of children and adolescents. Academic-related stress is significantly associated with reduced student academic motivation (Liu, 2015) and academic disengagement (Liu & Lu, 2011). This is also identified in the response of the student in their least like of the PBL saying *"Internet problems which is common for all of us since we use internet to access files, communicate with the group members".*

On the other hand, this learning opportunity also found light to developing independent learning as given by a student saying *"The time where I realized that even if we don't see each other, we make (things) learning happen no matter what".* This will allow the learners to appreciate learning independently and in an online modality which is needed to not hamper their intellectual growth even during pandemic.

Table 14 Comparison of the Pretest and Posttest Scores of Respondents

Achievement Test	Mean	Mean Difference	T-test	P-Value
Pre test	8.53	3.42	5.74434	**0.0000327**
Post Test	11.95			

*(α =0.05)

Table 14 shows the comparison between the Pretest and Posttest scores of the respondents. The mean score before the use of the developed PBL is 8.53 while after is 11.95. Comparing the mean scores before and after the administration of developed PBL shows that there is a mean difference of 3.42. A dependent/paired t-test observation was done to find out whether the mean difference is significant at α =0.05. It is indicated in Table 8 that the p-value is 0.0000327, which shows p-value < α.

Therefore, it shows that there was a significant increase in the conceptual understanding between scores of the respondents before and after the use of the developed PBL activity. The result supports the studies of Chiang and Lee (2016) and Ergül and Kargın (2014) which address on students engaging in their learning through PBL made better progress in motivation, problem solving, and on students' success. With this finding, it can be implied that teachers' instruction and activities effect students' learning if they are aware of their learning and learning at their own pace with or/and without a team.

Conceptual Understanding of the Respondents

Table 15 Average Normalized Gain of the Class

Achievement Test	Mean Average	Average Class Gain
Pre test	8.52	**0.241683**
Post Test	11.73	

Table 15 shows the 24% gain of the entire class on average. The gain starting at the pretest mean score of 8.52 and gaining to 11.73 in the posttest with a low rating (based from Normalized Gain Interpretation (Table 13)) but is still significant in the individual

gain of each respondents. This can be a good reference to determine the individual gain of each respondents.

Table 16 Average Learning Gain of the Class

Gain	Student Code	Number of Students	%
Positive	A3, A4, A5, A6, A8, A9, A12, A13, A14, A17, A20, A22,A26, A31,A32,A33,A35,A36,A37,A38, A39, A44, A46, A48, A49, A50, A51, A52, A58	45	**74%**
positive, below the class gain	A1, A27, A29, A30, A34, A47, A55, A54, A59	10	**16%**
Negative	A2, A7, A15, A16, A19, A21, A40, A43, A45	9	**15%**
zero	A7, A10, A18, A24, A28, A41,A53,A61	7	**11%**

Table 16 shows 74% of the class had a positive gain, from this population, 16% had a gain lower than the class gain which means these students had higher posttest scores from their pretest but the score is less than the average class gain. 15% had negative gains which means higher pretest than their posttest. These students probably had more misconception and confusion with the items. 11% had no gain from their pretest to posttest. These students had the same pretest scores and posttest scores. The students who had a negative and no gain probably did not cooperate in the conduct of the activities as this is one of the identified least like part of conduct of the activity as mentioned in the reflection journal of the respondents.

Table 17 Learning Gain of Respondents with Pretest Score Below Average Mean

Student Code	Pre	Post	Gain	Rating	Student Code	Pre	Post	Gain	Rating
A3	9	18	42.9	Medium	A33	5	12	28	Low
A4	9	14	23.8	Low	A35	7	13	26.09	Low
A5	5	14	36	Medium	A36	8	12	18.18	Low
A6	9	12	14.3	Low	A38	11	19	42.11	Medium
A8	11	24	68.4	Medium	A39	7	14	30.43	Medium
A9	9	19	47.6	Medium	A44	6	12	25	Low
A11	11	12	5.26	Low	A46	8	13	22.73	Low
A12	8	16	36.4	Medium	A48	3	15	44.44	Medium
A13	11	19	42.1	Medium	A49	7	13	26.09	Low
A14	7	13	26.1	Low	A50	6	19	54.17	Medium
A20	7	13	26.1	Low	A51	11	15	21.05	Low
A22	9	14	23.8	Low	A52	5	12	28	Low
A32	7	13	26.09	Low	A58	8	15	31.82	Low

Table 17 shows the individual gain of the respondents with pretest score below average mean. The highest individual gain starting at the pretest mean score of 11 and

gaining to 24 in the posttest with a medium gain rating. The lowest individual gain starting at the pretest mean of 11 and gaining to 12 in the posttest with a low gain rating. Based in the table, majority of the group have higher individualized learning gain of 63.14.

The results above support Bao (2006) stating that if individual gain is greater than class average gain, we can infer that students with low pre-test scores tend to have either smaller or similar score improvement than students with high pre-test scores. In this case, based from the respondents scores, students with low pretest scores have similar score improvement that the students with high pre-test scores. This implies that students with low pretest scores have gained more interest than those students with high pretest scores.

This result also is complementary to the result of the study of Han et. al. (2015) with the title "How Science, Technology, Engineering, and Mathematics (STEM) Project-Based Learning (PBL) Affects High, Middle, and Low Achievers Differently: The Impact of Student Factors on Achievement" which showed low performing students had a statistically significantly higher growth rates on mathematics scores than high and middle performing students over the 3 years.

Table 18 Learning Gain of Respondents with Pretest Score Above Average Mean

Student Code	Pre	Post	Gain	Rating
A29	13	15	11.8	**Low**
A31	17	19	15.4	**Low**
A37	12	18	33.33	**Medium**

Table 18 shows the individual gain of the respondents with pretest score above average mean. The highest individual gain is 33.33, with a rating of medium gain, which is higher than the class average gain. The lowest individual gain is 11.8, which is rated as low gain.

Based in table 18, the range of individual gain of 21.53 which is lower than the average class gain. This idea is an example of an Idealized situation called Contraction Case of Bao (2006) on his study entitled 'Theoretical comparisons of average normalized gain calculations'. This case assumes that the students with above average pre-test scores have smaller score changes than the students with below average pre-test scores, but all students still remain on the same side of the distribution curves of the pre- and post- tests.

Using the normalized gain interpretation shown in table 13 of Chapter 3, it reveals that the performance of Grade 9 students on the conceptual achievement test in Conservation of Momentum under the online distance learning modality with the developed PBL used as learning material is low .

Moreover, the concept of an average normalized gain is a reasonable way to describe the learning of individuals with pretest scores below the average mean but a poor way to characterize the learning of individuals with a very low pretest score. One possible explanation for this split that bears investigating is whether there are certain key misconceptions that are not well addressed in the course. The presence of key misconceptions could result in the split observed if students who come in without these misconceptions are able to learn the remaining concepts at a standard rate dictated by the structure of the course (and thus achieve consistent gains), but students holding one or more key misconceptions are prevented from learning on a significant group of questions at the same rate as those who do not hold the misconception (and thus achieve reduced gains). Students achieving high pretest scores would be unlikely to harbor the key

misconceptions, while students achieving low pretest scores would likely hold one or more key misconceptions and therefore show varying levels of learning (depending on exactly how many were held or the impact of those that are held) (Pawl, 2015).

Perception of the Respondents

Table 19 shows a summary of the response to the Perception Survey of the Developed PBL Activity. Most respondents have agreed that the statements are Frequently True. With a Cronbach's α of 0.95 which rated the perception questionnaire to have an excellent consistency, this suggests that most of respondents perceive the activity favorably.

Table 19 Perception of the Respondents

Statement	Mean	Interpretation
I believe that doing the activities made me have more interest with the lesson.	5.09	Frequently true, only 70% of the time
I believe the activities are enabling us to relate to what is really true in real life situations.	5.83	Usually true, in about 90% of the time
I felt like the activities I did are helping me develop teamwork, communication and collaboration.	5.01	Frequently true, only 70% of the time
I enjoy doing the activity very much.	4.65	Frequently true, only 70% of the time
For me, the activities are important for my improvement because it encourages me to find more information and ask questions.	5.59	Usually true, in about 90% of the time
The activities are allowing us to develop and acquire good values and character.	5.46	Usually true, in about 90% of the time
I believe that the activities I did challenges me to succeed and do my very best.	5.65	Usually true, in about 90% of the time
I gained new self-regulated learning strategies and techniques through the activities I did such as taking down notes, sharing ideas with others and having further research.	5.21	Frequently true, only 70% of the time
I did the activities because I wanted and liked it much.	4.76	Usually true, in about 90% of the time
I think those activities motivate me to perform better because I believe it is not anymore about having good grades but experiencing lessons I could use in the future.	5.41	Usually true, in about 90% of the time
I believe the activities helped me learn the purpose of being careful and cautious about road and sports safety which me and my family are exposed to everyday.	5.89	Usually true, in about 90% of the time

Statement	Mean	Interpretation
I am willing to do the small and big group activities because it encourages me to be open-minded	4.97	Frequently true, only 70% of the time
I am very much interested in the activities because I got to learn ideas and concepts not only from my teacher but also from other sources like my classmates, from reading books and through browsing the internet.	5.23	Frequently true, only 70% of the time
While doing the activities, I felt like I developed the value of being mindful and careful of actions and decisions I make.	5.59	Usually true, in about 90% of the time
The online simulations, science terms and words were easy to understand since I have known them in real life.	5.03	Frequently true, only 70% of the time
I would describe the activity as very enjoyable because I can relate to the experiences shared by my classmates.	4.68	Usually true, in about 90% of the time
I would be willing to do the activity again because it has value for me.	4.67	Frequently true, only 70% of the time
18. Through big group activities, I realized that even if we have different ideas we can be successful if we try to develop teamwork	5.73	Usually true, in about 90% of the time
19. I would describe the activities as hard and difficult to do.	4.82	Frequently true, only 70% of the time
20. The activities are somehow easy because the examples used are common occurrences in road and sports events.	4.83	Usually true, in about 90% of the time

This data revealed that the students exposed to developed PBL has higher interest, motivation level and positive attitude towards momentum. This result affirmed the study of Bhagi (2017). According to Bhagi, a benefit of PBL is enabling student to face real world situations simulated in the form of projects which later may become their new hobbies, passions and careers which is relevant to the perception of the respondents. This simulation also improves student's level of creativity in applying new knowledge to respond to other situations. Furthermore, Guskey (2003), cited by Variacion et. al (2021) also states that teachers who develop useful activities, assessments, provide corrective instructions and give students chances to demonstrate success can improve their instruction and help students learn better. Therefore, the result shown above is another finding that strongly supports Project-Based Learning as an effective approach to make learners more interested, motivated, engaged in their learning.

Sample Best Product of Respondents

Shown in Figure 9 is a sample best product, a video presentation and the problem analysis and problem-solving strategy. The output was rated excellent based from the criteria: Understands the problem, Identifies Necessary Tools/ Formula, Develops a Problem-Solving Strategy and Implements a Strategy to Reach a Solution. The output indicates thorough understanding of the problem, correct identification of additional

information and tools needed to solve the problem, select and implement the problem-solving strategy to reach a valid solution.

The said product was done during their Asynchronous Science Class schedule. They were given freedom to choose their group members, by pair, triad or by four members. They had autonomy to solve the problem. The respondents were given the rubric upon the start of the task to assess their performance.

Figure 9 Product of Respondents

The said activity helped the respondents to apply their understanding and at the same time are reflective in making decisions while performing the tasks. This approach supports the idea of Khaliq et. al (2015) on students at the center of their learning process where they engage in long-term studies of the topics, connect their learning to the real world and collaborate with each other- by letting them solve a real-world challenge with their experience of the topic and have reflection.

Summary of the Reflection of the Respondents on the Use of Developed PBL Activities

As seen in table 20, the top three most learned lessons are Conservation of Momentum, Speed and Time and Road Safety. Respondents also enjoyed the PBL activity, Group Discussion and Online Simulations but least enjoyed the member's cooperation and the nature of independent learning since they were not used to the strategy. Moreover, respondents claimed that they were able to develop the values of Teamwork**,** Communication and Critical-Thinking. Lastly, respondents suggested that they want to experience more flexible grouping, easier task, longer time for the tasks and more interactive online simulation activities.

Table 20 Summary of Perception of Respondents' Responses of Developed PBL

Responses	F	%	Rank
Most Important Things Learned			
1. Conservation of Momentum	14	23	**2**
2. Speed and time	3	5	**3**
3. Road Safety	38	62	**1**
Values and Skills Developed			
1. Teamwork	25	41	**1**
2. Communication	13	21	**2**
3. Critical-Thinking	5	8	**3**
Most Enjoyable and Meaningful Experience			
1. Group Discussion	17	28	**1**
2. Online Simulation Activities	9	14	**3**
3. PBL	10	16	**2**
Least Enjoyable and Meaningful Experience			
1. Member's Cooperation	23	38	**1**
2. Nature of experiential, independent learning	27	44	**2**
Suggestions for the Improvement of the Activity			
1. Flexible Grouping	14	23	**1**
2. Easier task	12	20	**2**
3. Longer time for the tasks	9	15	**3**
4. More interactive online simulation activities	4	7	**4**

With these results, it supports the idea of Chen (2019) cited by Gerhátová (2020) that the idea of teaching Physics is not to pass on a certain amount of knowledge to students but to prepare them for planned work, independent knowledge acquisition and problem solving. It has been evident that students were able to have undergone a self-regulated learning process, having autonomy with the design, and coming up with a solution and a reflective learning in developing the conceptual understanding. Though some of the students had expressed experiencing behavior such as less cooperation and less participation, majority had also developed the skill and attitude to manage such problem which we have seen occurring mostly in the real world. Therefore, based from the result above, the developed PBL is found to be a good way for respondents to develop life skills in preparation for bigger tasks and problems in the real world.

CONCLUSION AND IMPLICATIONS

Based on the findings and analyses, the researcher concluded that the Developed Project-Based Learning Activity significantly brings positive effects to students' conceptual understanding. This is supported by the pieces of evidence drawn from the findings, namely:

1. The developed PBL Activity were aligned to the K to 12 Basic Education Standards and Most Essential Learning Competencies.
2. Based on the result of the evaluation of the developed PBL, the activities were rated based on the different criteria as Very Good and were ready to be implemented.
3. After the pilot testing of the developed PBL, results showed a significant difference between the Pretest and Posttest results of the students. Thus, the use of the

Developed Project-Based Learning Activity in online instruction improved the students' conceptual understanding of Conservation of Momentum.

4. It can also be seen that students who experienced PBL activity have a higher interest, motivation level and positive attitude towards momentum based on the checklist and a descriptive agreement that the activities helped them learn the purpose of being careful about road and sports safety.

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