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A LESSON STUDY ON TEACHING IMPULSE AND MOMENTUM IN THE NEW NORMAL

Aileen Mae G. Cañete[1*], Angel Rose J. Hitgano[1], Ella Marie G. Nuñez[1], Alisa Mae D. Talamo[1], Ricka Mae Marie L. Ymas[1], Joy A. Bellen[1]
[1]Visayas State University, Baybay City, Leyte, Philippines

[*]Email: *aileenmaecanete@gmail.com*

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ABSTRACT

Impulse and momentum are basic concepts of mechanics introduced in the K to 12 curricula. Despite its basic concepts, students still have difficulties understanding the topic, especially when they are out of school due to the pandemic. After reopening the gates for face–to–face classes in the Philippines, the researchers found a significant reason to conduct a lesson study to improve teaching strategies on the topic. Lesson study is a development process wherein teachers work collaboratively to improve teachers teaching capacity. This study was conducted at Plaridel National High School with 23 participants from Grade 9 Newton (Set A and B). The research was conducted in two cycles using a four – phase lesson study. The research lesson was implemented using a 4A Model lesson plan and the results were taken from the analysis of the lesson study observation sheets, along with the class proficiency level. The researchers used the following strategies to improve teaching, namely; (1) showing mastery of subject matter, (2) reviewing basic mathematical operations, (3) contextualizing the lesson, (4) allowing students to answer questions in mother tongue, (5) using collaborative activities, (6) giving rewards, and (7) applying proper time management. However, the findings still showed that both sets of students achieved beginning proficiency level. Despite the implementation of these strategies, the students still lack basic knowledge of the topic and mathematical operations, and they struggle to understand it. Thus, it is recommended to plan the lesson effectively, utilize other research instruments, and collect feedback from the students.

Keywords: lesson study, impulse, momentum, post covid, new normal

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INTRODUCTION

Science is beneficial because of its connections to industry and technology - two sectors with a high priority for development from a national standpoint. As it helps students develop their scientific inquiry abilities, values, and attitudes, science also provides means of systematic and logical understanding of the world. Each student can benefit from each of these for his or her own personal growth, future career, and overall quality of life. These abilities, principles, dispositions, and values are also beneficial to the community to which each student belongs as well as to the nation in which he or she resides. The goal of science education is to help students become more scientifically literate so that they can become informed, active citizens who can evaluate and make a decision using scientific knowledge in their daily lives (SEI-DOST & UP NISMED, 2011).

Among the different branches of science, physics is considered the most problematic area, and it traditionally attracts fewer pupils than in chemistry and biology (Guido, 2013). Physics topics such as mechanics is an area which students have various misunderstandings and difficulties (Rosa, Cari, Aminah, & Handhika, 2019). Yet, the concepts of impulse and momentum (IM), subtopics of mechanics, are vital in the study of Physics. Studies revealed that solving IM problems requires deep learning habit to learn advanced physics such as machine and structural design, advance dynamic, and structural mechanics (Fang, 2012; Xu, Liu, Koenig, Fritchman, Han, Pan, & Bao, 2020). The idea of IM is also relevant to students' daily lives and used in technical items like the design of helmets, airbags and the crack of a bat. These advantages allow impulse and momentum for technological applications.

However, although fundamental concepts in Physics, impulse and momentum are still accompanied with difficulties in understanding its concepts. These difficulties can be broadly classified into two broad areas, student-related and teacher-related aspects. The causes of students' difficulties in understanding the concept are divided into five aspects, — students' preconception, wrong intuition, wrong conception, misunderstanding in verbal representation, and factual misunderstanding (Rosa, et al., 2019). Historically, Physics was taught using conventional methods, i.e., the traditional stand-and-deliver lecture. Information is unilaterally transmitted from teacher to the student which makes them passive participants (Laad, 2013). This has left students the impression that Physics is a boring and a difficult subject which resulted to low performance and achievement in the subject.

These difficulties occur when the material is only based on theory, without examples of applications in daily life. Ultay & Alev (2017) believed that students' interest and motivation will rise when they can make connections between various topics and recognize how beneficial their new knowledge is in real – world situations. Furthermore, Pahrudin, Misbah, Alisia, Saregar, Asyhari, Anugrah, & Endah (2021) emphasize that IM require deep understanding, and most students tend to be passive in learning this topic. The academic challenges worsened during the COVID-19 health crisis. Over 1.7 billion children's education was disrupted as a result of the crisis (Organization for Economic Cooperation and Development [OECD], 2020). The UNICEF (2020) issued a warning that when emergencies like illness outbreaks disrupt education, children are more likely to drop out entirely, which may have an impact on their general development. Studies show that distance education during the pandemic students portrayed poor comprehension and retention (Belgica, Calugan, Dumo, Simber, 2020), lack of interaction, lack of collaboration with other students, absence of feedback, and social support (Amadora, 2020).

In response to the crisis, educational leaders decided to adopt the new normal in education (Tria, 2020). The Department of Education (DepEd) created the Basic Education Learning Continuity Plan to guarantee the security of the faculty, staff, and pupils using blended and distance learning as the mode of instruction. Eventually, after two years of lockdown, DepEd implemented the limited face-to-face classes. The students were divided into two sets (set A and B) to observe COVID – 19 protocols. During the observation phase in Plaridel National High School (PNHS), pre-service science teachers observed that students were less participative. Literature points that teachers can design engaging classroom activities using lesson study (Wadji, 2017).

Lesson study (LS) allows teachers to collaborate on a curriculum topic or issue relevant to students' learning, analyze curriculum documents and teaching materials, and prepare and present a research lesson

that subsequently becomes an object of reflection (Ponte and Quaresma, 2020). These research lessons, also called "kenkyuu jugyou" in Japanese were used by Japanese teachers to teach science and mathematics in their classrooms where one teacher discusses a specific topic. The lesson study team observes the events and afterward analyzes students' learning, emerging difficulties, and possible alternatives to consider. Lesson study involves a combination of inquiry-based teaching and learning and a collaborative approach. Combining these two methods results in a more productive discussion and results in the lesson. In effect, lesson study will assist educators in developing as reflective professionals, i.e., use research-based lessons to develop and implement future classes collaboratively. This study aimed to improve classroom instruction in the new normal using a lesson study in the classroom of Grade 9 Newton students in Plaridel National High School (PNHS).

RESEARCH METHOD

Research Design

This study utilized the lesson study approach in teaching Impulse and Momentum to 23 Grade 9 junior high school students of Plaridel National High School (PNHS). The lesson study team was composed of five pre-service science teachers from Visayas State University taking up the course PrEd 200 Teaching Internship in the last semester of the Academic Year 2021-2022. This study followed a four-phased lesson study framework proposed by Catherine Lewis (2019), enumerating the following (in order): study phase, plan phase, teach phase, and reflect phase. This study utilized the qualitative descriptive research design.

In Cycle I, the team started with crafting goals and the research theme for the study. With the goal of creating a successful instruction in Impulse and Momentum, contextualization was decided to be applied to the lesson. Designations were assigned to the team members during this phase as well, which were (1) the model lecturer, and (2) the observers and facilitators of the research lesson. For Cycle II, the recommendations of the observers were taken into consideration, and minimal changes in the research lesson were applied by the model lecturer in her lecture once again (Study Phase). The LS team started with a meeting to plan the different procedures required for the next phase. It was agreed (1) focus on impulse and momentum based on the Most Essential Learning Competency (MELC) from the DepEd, and (2) follow a 4A Model Lesson Plan. An abridged version of the lesson plan is presented to show the design of the lesson (see Table 1).

In Cycle II, a modified lesson plan was used considering the reflections and suggestions formulated after Cycle I. The highlights are team members (1) sit in front of the class for the whole lecture to make better observations of the learners' interactions and reactions, (2) make the sitting arrangement of the class heterogeneous wherein it was ensured that the students are well distributed based on their gender during the group activity, (3) interact more with the students by asking them questions and answering their queries in return throughout the activity, and (4) let students answer comfortably during recitations it was planned to let students answer in their mother tongue. (Plan Phase)

Table 1. Abridged 4As Lesson Plan for Science 9 (Cycle I and II)

I. OBJECTIVES	Relate impulse and momentum to collision of objects (e.g., vehicular collision) **(S9FEIVb-36)** 1.1 Identify the factors that affect the momentum of an object 1.2 Solve problems involving impulse and momentum
II. TOPIC	Impulse and Momentum

III. PROCEDURE ACTIVITY	The class will be divided into three groups and all of the members of the LS team will serve as the facilitators of each group. The varied activities of the group are as follows: **Group 1: Is Bigger Better?** The group will solve and compare the momentum of the cement mixer and mini dump truck given that they have different masses. They will identify which among the two has greater momentum and the factors affecting the momentum of each vehicle. **Group 2: Is Faster Better?** The group will solve and compare the momentum of two identical trimotors only that each vehicle has different velocities. They will identify which among the two has greater momentum and the factors affecting the momentum of each vehicle. **Group 3: Save the Egg!** The group will compare and solve for the impulse of two different eggs. The first one is dropped on the pillow while the other one is dropped directly on the floor.
ANALYSIS	The model teacher will discuss the concept and formulas of impulse and momentum. The students will be asked questions during the discussion and every student who will participate in the class will receive one star (equivalent to one point). This reward system will be called "Star of Mine".
ABSTRACTION	The students will once again have an activity where they have to compare which among the presented pair has greater momentum. Students that take part in the activity will receive rewards.
APPLICATION	In the same groupings, the students will then choose one representative to answer each item for another group activity. The representatives will answer the questions relating to impulse and momentum in daily life and explain their answers briefly.
IV. EVALUATION	The assessment will be divided into two parts: Part A requires students to complete the paragraph by adding the missing words, and Part B asks them to solve and supply the missing quantities on the blanks of the table.

Participants

The research lesson was taught to two groups (Set A and Set B) of Grade 9 section Newton junior high school students from PNHS. Cycle I was attended by 14 students from Set A while nine (9) Set B students attended for Cycle II. The attendance was determined by the number of in-person students on that particular day. The research lesson was delivered by one of the researchers assigned as the model lecturer. During the third phase, while the model lecturer delivered the research lesson to the students, the other team members were also observing and collecting data as agreed upon by the team. (**Teach Phase)**

Instruments

The research instrument utilized in this phase was an LS observation sheet (Dudley, 2014) which covered the following questions:

- Were the learning objectives presented well?
- Were the activities engaging for the students in the classroom?
- Were the students participative in the class discussion?
- Did the students communicate with each other in the class?
- Was the teacher/presenter able to present and discuss the ideas well?
- Was the conducted assessment effective enough to determine the students' progress?
- What difficulties (either technical or instructional) were faced during the lesson discussion?
- Which parts of the class instruction needs revision?

The same observation sheet was used for Cycle II of the Lesson Study.

Data Analysis

In the reflection phase, additional meetings were conducted to reflect on the entire lesson study cycle. A post-lesson discussion immediately followed the model lecturer's research lesson so that the

observers could analyze the data and determine what to share. During Cycle I the reflection phase was attended by the whole LS team, including the researchers' college supervisor who served as the More Knowledgeable Other (MKO) in the observation. Comments and suggestions from all the observers were given to the model lecturer which were used to modify the TLP for the next cycle. In Cycle II, another post-lesson discussion was conducted. All the LS team members were present, but this time the adviser of Grade 9 Newton was present to serve as the MKO of the cycle. They again shared main points in their observations along with constructive criticisms on how to improve the lesson even further. The Class Proficiency Level (CPL) for every cycle was also computed in this phase. Measuring the student's performance in a particular lesson at the end of every quarter is one of the teacher's require to measure the student's proficiency in a particular lesson. This study used CPL to compute the percent value for the number of students who mastered the topic impulse and momentum. In computing the value for CPL the LS team used the formula:

$$CPL = \frac{No.\ of\ students\ within\ mastery\ level}{Total\ number\ of\ students}\ x\ 100$$

Where, the number of students who masters the topic is divided by the total number of students and multiplied by 100 to get the percentage. The proficiency level of the class will follow the five (5) levels of the proficiency scale from DepEd Order no. 31 (2012). To quote:

> *In the advanced level of proficiency, the students exceed the core requirements in terms of knowledge, skills, and understanding. Students at the proficient level have developed fundamental knowledge, skills, and core understandings and can transfer them independently through authentic performance tasks. The students have developed fundamental knowledge and skills and core understandings in the approaching proficiency level. With little guidance from the teacher and with some assistance from peers, can transfer these understandings through authentic performance tasks. For the developing level of a student's level of proficiency, the minimum knowledge and skills and core understanding is possessed but needs help throughout the performance of authentic tasks. Lastly, students struggle with understanding at the beginning proficiency level, and the fundamental knowledge is not acquired. (**Reflection Phase)***

RESEARCH FINDINGS AND DISCUSSION

Research Findings

The implementation of the LS was conducted in two cycles. These steps were important in determining teaching strategies to improve instruction in impulse and momentum. In this study, the LS team observed the following (1) research lesson implementation, and (2) results of the assessment conducted. Moreover, strategies on how to improve the instruction were developed. This section shows the computed CPL of the students and the consolidated observations and reflections during Cycles I and II.

Table 2. Computed CPL of Set A and B

	Set A	**Set B**
Number of students within mastery level	8	4
No. of learners needing remediation	6	5
Total number of students	14	9
Class Performance Level (CPL)	**57.14%**	**44.44%**

During Cycle I, the lesson was led by the designated model lecturer, while the other members of the LS team observed. Subsequently, the researchers reflected and computed the CPL of the students where Set A obtained 57.14%, classified under the beginning level of proficiency. The researchers then discussed the observations and the modifications for the next cycle (see Table 3).

Table 3. Observation Findings, Analysis and Alternatives of Solution (Cycle II)

No	Observation Findings	Analysis	Alternatives or Solutions
1	The model lecturer presented the objectives well. She prepared a good activity for the motivation. Also, the students were able to ponder on the problems. However, the learners were a little confused on what to expect from them at the end of the lesson.	Students were able to grasp the topic even at the start of the discussion. They also learned a few concepts out of the motivational activity.	The objectives should still be posted even after presenting it, so that students will still know what are expected from them. In addition, the given of the word problems should still be shown for the students to easily answer the questions.
2	The instructional materials presented were well – organized and the delivery of the lesson was well– prepared. The initial plan of the lesson study team to apply contextualized teaching and learning strategy was applied in the lecture.	The real-life examples were relatable to the students. However, they were unable to manipulate formulas and substitute the given and get the unknown of the problem.	Contextualization should be continued for the next cycle. The manipulation and use of formulas must also be explained thoroughly so that students can answer the activities faster.
3	Due to the safety protocol set by the DepEd in conducting limited face–to–face classes, the LS team decided that the students for Cycle I and II are from different groups. During the activity, they were divided into three groups, which are completely boys or girls. In this arrangement, it was observed that there was less interaction among them.	The health protocols on the limited face – to – face classes created less interaction between each member of the group. As groups were set according to their seating arrangement which separated the boys and girls, the students were not able to collaborate well in answering the activity.	Groups should be heterogeneous to increase interaction between students. It was observed that girls were more participative compared to boys. So, if each group will consist of girls, there will probably be more interaction and quicker responses.
4	The activities were engaging because students can relate to the scenarios presented. However, as the time was limited to an hour only, the discussion hastened.	Although there was student-to-student interaction, as well as teacher-to-student interaction, the time was not enough for them to learn effectively.	The activities should be given more focus instead of the review time to establish effective learning.
5	The research lesson's assessment was able to determine whether the students have learned from the discussion or otherwise.	Although some of the students received low marks, the assessment covered all aspects of the discussion, including terminology and problem-solving.	Give emphasis on discussing the terminologies and formulas used in the assessment.

Cycle II was immediately implemented after Cycle I. Several challenges observed in the previous cycle have been complied with and improved by the team. However, as Cycle II was attended by Set B, it was observed that their rate of response was slower compared to Set A which made the lecture more time-consuming. This prompted the model lecturer to skip the generalization and advanced to the assessment part immediately. Note that the class was only given an hour to finish the discussion. Then, the LS team discussed their observations and computed the CPL of Set B. This time, the students' assessment was lower with only 44.44%, still classified under the beginning level of proficiency. This means that there is a decrease in student participation in Cycle II and that several strategies must be improved to ensure better results (see Table 4).

Table 4. Observation Findings, Analysis and Alternatives of Solution (Cycle II)

No	Observation Findings	Analysis	Alternatives or Solutions
1	The objectives were clearly presented on the board.	When the objectives were placed on the board during the discussion, students were guided as to what was expected of them at the end of the lesson.	Teachers may continue to present the objectives in separate material so that they are seen all throughout the discussion.
2	The teacher was organized in delivering and organizing the learning	The context was given enough emphasis during the discussion.	Continue the use of contextualized learning materials and basic

	materials. The concepts and activities were applied to real-life situations as well. Yet, they lack basic mathematical skills in solving the problem.	However, they have difficulties in analyzing the formulas and solving the given problems.	mathematical operations must be reviewed as well.
3i	Set B was less participative due to the small class size of nine students and there has been no discernible progress.	Since the number of students in the class was relatively small, the students were less active compared to those in a bigger class (Set A). One reason is that students were anxious. Additionally, the observers' presence were unfamiliar to them, so students were more afraid to be corrected in the class.	The teacher can provide alternative activities in the instruction that considers all the learning styles. Activities that encourage student interaction are important as well. This is to build students' confidence in giving their answers in class.
4	Since the activities were varied for each group, the students showed interest and asked questions to the LS team for guidance on how to solve the problems.	The teacher-student and student-student interaction were present and the varied activities captured students' attention and willingness to learn. However, activities such as these if not properly timed will become time-consuming for the class.	Maintain varied activities for students to become more interested to participate in class. However, activities must be timed-bounded to not consume the allocated time for the other parts of the lecture.
5	Some students were slow in responding, and parts of the lesson were missed in favor of the assessment. The time was not enough for the lesson despite the changes applied.	Questioning the students could take a lot of time if the students were slow at responding. As the teacher must wait for the students, the slow rate of response could be time-consuming.	Apply strategies like "call a friend" so that students can ask help from their classmates when they cannot answer the questions.

Discussion

With the low CPL on impulse and momentum, the LS team reflected on the observations (see Table 4 & 5) and developed strategies that can improve the instruction on the topic: showing mastery of the content, reviewing basic mathematical operations, contextualizing the lesson, using a familiar language in responding, making activities collaborative, giving rewards, and organizing the time for learning activities. First, showing content mastery of the subject is vital in delivering the topic. Based on the TPACK framework specifically on content knowledge, the teacher must be knowledgeable of the subject matter to teach effectively and confidently (Koehler, Mishra, Kereluik, Shin, & Graham 2013). A teacher who masters the lesson influences the learner's understanding, performance, and attaining goals. Teachers must improve their topic knowledge to have a complete understanding of the curriculum and deliver successful education in the classroom (DepEd & World Bank, 2016). Second, reviewing basic mathematical operations can help students to analyze and answer the given problems easier and faster. Wriston (2015), believed that if the basics of mathematics is not learned, students will struggle to draw crucial connections within the content material or completely comprehend higher-level mathematical ideas. Third, contextualizing the lesson helps the practitioners to connect between learning materials and the real-world situation of the students. Contextualization can aid students to learn and perform better (Picardal & Sanchez, 2022). Fourth, allowing students to respond using their mother tongue increases their understanding of the lesson, and gives them confidence in reciting during class discussion. Yadav (2014) claimed that most students prefer reciting in their mother tongue which has positive effects on their learning. Fifth, developing collaborative activities for students can improve the rate of student performance as they can help each other in completing their tasks. Osterholt and Barrat (2012) demonstrated the advantages of using collaborative activities in the classroom, including students having a give-and-take experience as listeners, speakers, and evaluators, as well as the opportunity to model outstanding thinking. Sixth, giving rewards help students increase their participation because they look forward to the rewards they receive as they participate. Furthermore, Ilegbusi (2013) suggested students must be closely observed for indications of what motivates

them to learn aside from using rewards. Seventh, organizing the time for learning activities through wise planning, careful designing, and proper implementation can achieve desired results through various activities (Zafarullah et al., 2016), and is associated with greater academic achievement (MacCann, Fogarty, & Roberts, 2012).

Despite the strategies formulated by the LS team after the reflection phase of each cycle, students still obtained low CPL in both Cycles I and II, wherein both results fall under the beginning level of proficiency. This means that students have a limited understanding of the topic, an indication of learning loss caused by the COVID-19 pandemic (United Nations, 2020). Even with improved instruction on Cycle II, their lower CPL showed that most of the students still had difficulty understanding the complexity of the lesson. The team reflected the plausible reasons behind the results (see table 5). The major reasons i.e., students' slow response and lack of basic knowledge of the mathematical operations which caused time-consuming activities, and abrupt skipping of some parts of the discussion.

CONCLUSION

This lesson study provided opportunities for teachers to carefully plan and implement strategies to improve instruction in the new normal. However, despite the two cycles, the results attained were low. Considering their rate of responses during the discussion, the team observed that the students despite being engaged in the class lacks basic knowledge about the topic. Nonetheless, the lesson study helped the researchers to collaborate with each other through sharing of ideas and insights that would best fit the students' needs in the new normal. Through thorough reflections and meetings, they consolidated their observations and made revisions to the research lesson. Strategies such as showing mastery of subject matter, reviewing of basic mathematical operations, contextualizing the lesson, allowing students to respond in a language they are familiar with, using collaborative activities, rewarding student participation, and applying proper time management were developed to improve instruction. Teachers can apply the strategies mentioned to other topics in Physics and in more lesson, study cycles for more observations and modifications. Other strategies to gain students' attention such as the art of questioning can also be used since being away from school has lessened their attention span in class. The school can integrate the lesson study approach in SLAC (School Learning Action Cell) sessions, meetings, and trainings, as well. With the results, this study hopes to provide information on how teachers can improve instruction in teaching impulse and momentum through lesson study.

The LS team realized the following during the conduct of lesson study: (1) plan the lesson effectively. The research lesson must consider the prior knowledge of the students, implement activities that are not time-consuming, and anticipate problems that may occur during the discussion, (2) utilize other research instruments such as rating scale, interviews, motivation test, pre-test, post-test, and others in acquiring research data. These tests are beneficial in identifying learners' prior knowledge and perception of the topic, and obtaining more accurate results, (3) receive feedback from the students. It is essential for teachers to collect feedback from students to bridge the gap between the needs of the learners and what teachers can offer.

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