IMPROVING GRADE 9 LESSON PLAN IN PROJECTILE MOTION THROUGH A LESSON STUDY CYCLE

Abatayo, Bonna Maris R.; Campos, Neilfe M.; Sabasales, Matthew T.

Completed 2022

Improving Grade 9 Lesson Plan in Projectile Motion through a Lesson Study Cycle

Abatayo. Bonna Maris R.[1]; Campos, Neilfe M.[2]; Sabasales, Matthew T.[3]
Teacher III[1]; Teacher III[2]; Master Teacher II[3]
Zamboanga del Sur National High School
Department of Education, Division of Pagadian City
email: bonna.abatayo001@deped.gov.ph[1]; nielfe.campos@deped.gov.ph[2]; matthew.sabasales@deped.gov.ph[3]
09091499073

Abstract

Improving student's participation in a science class is the major goal of every science teacher which is paramount to the maximum attainment of lesson objectives. However, student participation in the many activities and tasks assigned to them during each classroom teaching and learning session appears to be declining, according to the testimonials of several science professors. The lesson study cycle is a type of professional development activity that enables teachers to collaborate to plan, carry out, and reflect on lessons as well as to be able to enhance the flow of lessons across a number of cycles. This collaborative approach to instructional development and improvement gives the teachers a better means to study, think, and reflect on the way they teach a certain lesson as well as understand the way the students think and learn the lessons the teachers taught. Through a series of lesson study cycles, this investigation aims to enhance a projectile motion lesson for grade 9 students. Because the lesson was tested and used with actual students, this could improve the lesson's instructional flow. The result reveals a highly improved instructional flow of the lesson in Physics, specifically on projectile motion. Furthermore, the improved lesson plan becomes time-bounded, possesses a clear focus, is specific, achievable, and relevant to the learners.

Keywords: *Demonstration Teaching; Lesson Study Cycle; Projectile Motion*

Acknowledgement

The researchers want to express their appreciation, admiration, and respect for their colleagues and students in the Science Department who have given them valuable feedback and support throughout the conduct of this action research, which has played a crucial role in its completion. The researchers also extend their gratitude to the student participants of Grade 9-Eagle and Grade 9-Dove who offered their participation which led to the success of the conduct of the data gathering. Special thanks also to our Head Teacher IV in the science department Dr. Irish Hazel B. Jaim, and the subject teacher Luzbert Glee L. Bongga, who allowed the researchers to utilize these classes for demonstration teaching in the first and second cycle. The researchers consider this project to be a rewarding experience, and they attribute its success to the invitation of the Schools Division Research Committee (SDRC) led by Assistant Schools Division Superintendent Dr. Maria Colleen L. Emoricha, CESE, and Sir Joseph Fulloso, the SEPS for Planning, for their consideration. The researchers would also like to thank Schools Division Superintendent Dr. Maria Liza Tabilon for her call to advance evidence-based policy development and sound educational practices through the Basic Education Research Fund (BERF). Lastly, the researchers acknowledge and give praise to the Divine Providence, the Almighty God, Jesus Christ, for providing them with the grace, blessings, and strength to carry out this project.

Context and Rationale

Improving student's participation in a science class is the major goal of every science teacher which is paramount to the maximum attainment of lesson objectives (Sabasales 2018, 43). A better learning environment as well as a careful crafting of the lesson flow by the teachers would create an atmosphere that could carry out participation and engagement with the learners (Kiat et al. 2020, 3625). These major elements of an effective lesson flow are essential for maximum student participation and better achievement of the lesson context. However, testimonies from various science teachers reveal that students are less participative in the different activities and tasks given to them during every classroom teaching and learning session. This notion was supported by the study of Hadzigeorgiou (2005, 23-32) and that of Hadzigeorgiou and Stivaktakis, (2008, 138) confirming that students' interest is vital and pre-requisite to learning but students fail to gain such factor due to a non-engaging lesson flow designed by some science teachers.

One major cause of this phenomenon can be accounted for the failure of teachers to test their plans in an actual teaching and learning scenario (Oser and Baeriswyl 2001, 1031-1065). Teachers from an informal interview profess that sometimes the planned allotted time given to a certain activity within a certain lesson flow most of the time would not be enough in the actual teaching implementation, which would eventually lead the teachers to insist for the learners on doing the task quickly because they are running out of time. Incidents like this would also lead the learners to become discouraged from participating since they were not given enough time, and their outputs were done in a half-hazard manner.

The collection of instructions and procedures that are incorporated into some activities is another significant scenario that may be responsible for the learners' declining interest in the actual teaching and learning process. Most of the time, learners need help understanding the specified instruction in the various tasks and activities, which makes them confused about what to do about the task leading to decreased participation and engagement on their part. Unexpected scenarios like these during the actual lesson plan implementation are a major problem that needs to be given deep consideration by the side of the teachers and given appropriate action to produce a much better and improved lesson flow to address the problem.

Furthermore, the transition from one part of the lesson flow to another is also one of the most neglected phases of lesson planning. At times the transition becomes a distinguishing factor that could affect the flow of the lesson. Due to the unpredictable situation in the actual lesson implementation, students sometimes are affected by the inappropriate transition procedure implemented by the teacher. Studies on the adaptability of lesson plans suggest that even if thorough and careful the teachers are in planning the lesson, there will always be an unpredicted scenario that will arise in the implementation, which catches the teacher off guard, ruining the planned transition process (Haynes 2007, 1).

The least learned competency in Grade 9 science, as revealed in the previous school year's assessment, falls in the context of projectile motion in Physics. This issue on the content concept is also one of the challenges that need to be addressed by the teachers to increase participation and engagement. The lack of content knowledge about the subject matter would decrease student participation and engagement (Puad and Ashton 2021, 253). Because of this notion, it can be inferred that there should be careful and rigorous consideration needed on the side of the teacher to have an organized lesson flow, making every activity, task as well as transition designed properly for it to become favorable in driving the learners to maximum participation and engagement.

A lesson study cycle is a type of professional development activity that enables educators to jointly prepare, carry out, and evaluate lessons with the goal of enhancing lesson flow over the course of several cycles (Yazlik and Cetin 2020, 1). This collaborative approach to instructional development and improvement gives the teachers a better means to study, think, and reflect on the way they teach a certain lesson as well as understand the way the students think and learn the lessons the teachers teach (Hassan and Ibourk 2021, 1-6). The most meaningful contribution a teacher can make is to engage in collaborative undertaking to advance the quality of lessons in the teaching and learning process. Lesson Study, in simple terms, is a means to better see the outcome of a lesson plan by subjecting it to a series of implementation and reflections that would lead to the improvement of the lesson flow because it was tested and revised according to the actual responses of the learners from the varied task and activities set in the plan. Eventually, this could presumably increase students' participation and engagement in the lesson content.

Various lesson study conducted on many concepts in physics shows a positive result in increasing students' participation and engagement in the teaching and learning process. Studies have established that students' interest in science increases as the teachers use a lesson flow that undergoes a lesson study cycle (Madjdi and Rokhayani 2021, 911). Profound learning transpires when students participate in the lesson study process. All these positive results in improving student participation through a lesson study cycle compel the researchers to subject a research lesson into a lesson study cycle to improve its efficiency in increasing student participation in various scientific contexts (Cagiltay et al. 2019, 189).

This study intends to improve students' participation by subjecting a lesson plan to a lesson study cycle. The specific competency in grade 9 science covered in this investigation is a lesson in projectile motion. This study further aims at improving the lesson plan by going through a series of lesson implementation and reflection so that actual testing of the lesson plan will be done to see the actual responses of the learners when they are subjected to the set task, activities as well as transitions from one part of the lesson to another. As an innovation and intervention strategy, this lesson study is presumed effective in enhancing students' interest and participation in the teaching and learning process, which would lead to a higher academic achievement of the learners in Physics.

Innovation, Intervention, and Strategy

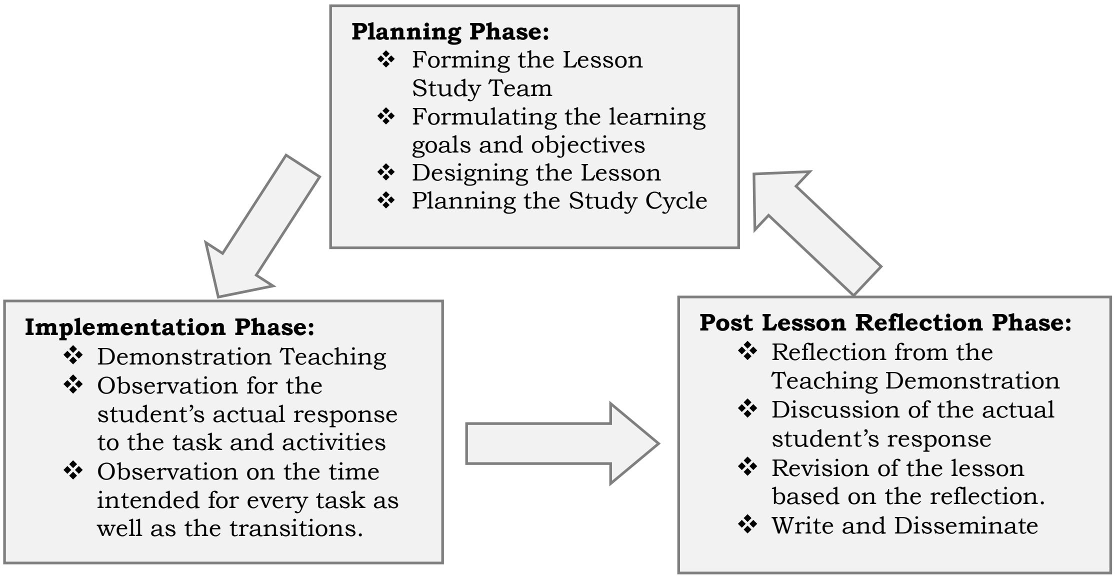
The lesson study cycle is a cutting-edge method for enhancing the effectiveness and quality of a lesson by putting it through a series of collaborative planning, teaching, and observation activities as well as reflections for the lesson's improvement (Bagherzadeh and Tajeddin 2021, 43-57; Hassan and Ibourk 2021, 1-6; Yazlik and Cetin 2020, 1). This intervention strategy involves a cyclical progression of the following steps: choosing a focus; planning the study lesson or the research lesson; public teaching of the planned lesson; focused observation of the lesson built on the set objectives; evidence-based debriefing; modification based on the groups' reflection; reteaching of the revised lesson; and evidence-based examination once more (Dudley 2012, 85-100). This intervention strategy's major goal is to maximize student involvement and participation in the teaching and learning activity, not to perfect the lesson plan or raise students' achievement in the subject matter (Cagiltay et al. 2019, 189-205).

The diagram shown in figure 1 reflects the conceptual flow of the innovative strategy employed in this investigation. This starts with the planning phase followed by the Implementation phase and lastly the Post Lesson Reflection Phase. The following is the detailed process implemented in the lesson study cycle.

Planning Phase. This stage includes the preliminary stage, which commences during the forming of the lesson study team. The lesson study team includes the primary key players in the conduct of the lesson study procedure. These identified key participants were specifically selected for their expertise in the subject matters as well as pedagogies applicable to specific content concepts. A qualifying criterion is formulated to identify the members of the lesson study team specifically. The planning phase also includes the planning of lesson study goals and objectives as well as designing the lesson.

Planning the whole flow of the lesson study cycle is the last stage but it is significantly the most essential part for this determines the success of the lesson study procedure.

Figure 1: Conceptual Framework of the Study



Implementation Phase. This stage is sometimes considered the heart of the whole lesson study cycle. In this part, a teacher member of the lesson study team will teach the lesson to a set of learners while other participants of the lesson study team will be observing the entire session. This demonstration process ensures maximum scrutiny of the parts of the lesson on the part of the lesson study team. Observation scope includes the responses of learners to the different tasks, activities, and transition strategies of the lesson from one part to another. The main aim of the observation is to see some flaws of the planned lesson, including the instructions specified in various activities, if it really is clear in the end of the students. The time allotted for each task is also observed to see if it is good enough for the learners to accomplish, as well as how the degree of difficulty of the specified task and activities were designed if it really suits the level of the learners.

Post Lesson Reflection Phase. This is the last and final phase of the study cycle, where the lesson study team will reflect upon the lesson demonstration and then brainstorm how they will improve the flow of the lesson. Each participant of the lesson study team will thoroughly give their observations and suggestions while others will be listening. A recorder will take note of the entire procedure so that whatever the result of the brainstorming will be incorporated into the lesson for improvement and better delivery of the learning context. A series of cycles will be conducted to ensure that every step, activity, instruction, task, as well as transition strategy, is improved and become a better lesson, increasing the participation and engagement of the learners.

Action Research Questions

This study intends to improve the participation of students in Grade 9 science lessons about projectile motion through a lesson study cycle. This was conducted among Grade 9 students of Zamboanga del Sur National High School for the School Year 2022-2023. This aims to improve the lesson plan in grade 9 science on projectile motion and specifically seeks to answer the following queries:

1. What are the remarks and observations noticed by the members of the lesson study team during the first cycle of lesson implementation using the 7E Model in terms of:
    1.1 the flow of the lesson and its transitions from one part to another;
    1.2 the students' response to every part of the lesson; and
    1.3 the time it takes for every task or activity included in the lesson flow?
2. What are the comments and suggestions derived by the lesson study team for the improvement of the lesson plan for the first and second cycles?
3. How can the lesson plan in grade 9 science on the projectile motion be improved and finalized?

Action Research Methods

Research Design

A lesson study cycle is an interactive professional development process that involves teachers collaboratively planning, monitoring, evaluating, and improving lessons together. The main goal of this process is to improve teaching practices through careful examination of a single lesson. The study employed exploratory case study design which relied on qualitative observational method. This research approach involves a systematic method of gathering particularly valuable insights to explore the complex behaviors of certain groups of individuals exposed to a particular situation. Specific social interactions among the participants can be clearly observed within their natural context.

Participants and/or other Sources of Data and Information

The study was conducted in Zamboanga del Sur National High School, Pagadian City, during the Third quarter of the School Year 2022-2023. Participants include the teachers who are members of the lesson study team and student participants, which includes those who participated in the lesson demonstration in the first and second cycle.

Research Instruments

Research instruments utilized in this investigation include the lessons study team comprising mainly the researchers of this study. As members of the lesson study team, their goal in conducting this investigation is to gather substantial information and ideas on how to enhance the lesson flow out from a series of responses of the learners with respect to the plan laid by the lesson. Observations during the implementation and demonstration of the lesson were utilized in the analysis to improve the flow and come up with a better and easier means for the learners to understand concepts and competencies taught in the lesson.

Furthermore, observation notes could be one of the most important instruments in the data gathering of this study. These observation notes were crafted by the lesson study team to be used as a basis for the reflection process. In addition, video documentation and recording are also other instruments that is substantial in gathering the essential information from the responses of the learners during the lesson demonstration. This video recording is transcribed and being used during the data analysis.

Data Gathering Procedure

This investigation primarily ensures the implementation of significant ethical measures before, during, and after the data-gathering process as well as during the analysis of results. An orientation was conducted by the researchers to identified participants of this study. They were informed on the purpose, risk & benefit as well as significance of the endeavor due to their involvement in the study. Moreover, confidentiality and privacy were the utmost consideration implemented in the conduct of the study.

The study uses descriptive qualitative research design which primarily obtains the data from observation and documentation. Furthermore, a detailed description of the participation and responses of the learners were carefully observed and documented to see the exact responses of the students as the teacher go through the designed flow of the teaching and learning process. Before, during, and after are also detailly observed and documented so that a more significant improvement will be contributed to the lesson afterward.

Two major cycles were conducted, the first cycle includes the implementation of the lesson plan through a class demonstration while the rest of the team was observing and documenting the class responses to every part of the lesson. This was then followed by a reflection and brainstorming of the actual effect of the lesson plan on the set of learners. Based on the observations and comments, the lesson study team then shared comments and suggestions for the improvement of the lesson plan.

The second cycle of the lesson study is followed by another implementation and classroom demonstration to another set of learners by another participant of the lesson study group. This was done further to test the improved lesson plan from the first cycle. Critical observation and documentation were done by the rest of the members of the lesson study team to see the effect of the updated lesson plan. The improved lesson plan was finalized and served as the final output of the lesson study process.

Data Analysis

This study employs an exploratory observational qualitative research design where observation and documentation are engaged in the data-gathering process. The qualitative data gathered from the observation of class demonstration as well as documentation of the responses of the learners in response to the planned lesson flow was subjected to analysis using the Miles and Huberman model. This method of data analysis includes a tabulation of the gathered observations, reduction of the data into meaningful codes as well as making the context in a matrix for easy qualitative analysis to come up with a conclusion necessary for the improvement of the lesson flow (Miles and Huberman 1994, 12).

Results and Discussions

The results of our lesson study cycles provide valuable insights into the efficiency of our teaching practices and the impact they have on student learning outcomes. In this section, we will present and analyze the data collected throughout the cycle, highlighting key findings and discussing their implications for our ongoing professional development and improvement of classroom instruction. Two cycles were initiated during the conduct of this investigation. The table below displays the different observations of the lesson study team during the first cycle. Since the Lesson plan employed in this investigation follows the constructivist approach, the researchers applied the 7E model. For a thorough analysis, components of the lesson flow were subdivided into segments to clearly examine the flow and be able to inspect if the parts included are okay or not.

Observations of the Lesson in the First Cycle Demonstration. The demonstration teaching was implemented by one member of the lesson study team to a set of grade 9 learners. Video recording as well as actual observation by the members of the lesson study team was conducted. Other members were using observation notes to really capture as much observation to the responses of the learners as well as the time of the demonstration, including the behavior of the learners being subjected to these different chunks of the instructional flow.

A few major observations can be enumerated during the demonstration teaching of the first cycle of the lesson study process. As shown in Table 1. The elicit part consumes much time compared to the allotted 5 minutes in the initial lesson plan. Time-bounded lesson flows can help teachers provide equal learning opportunities to all students. By dividing the lesson into smaller, structured segments, teachers can ensure that all students have the opportunity to participate and engage with the instructional flow, regardless of their learning style or ability (Ambrose et al. 2010). In the case of the initial elicit that this lesson employed it was clear that it failed to set things properly and that it consumed more than the 5 minutes intended for it in the presentation. Upon reflecting on what went wrong in the elicit part it was noticed that too many questions were raised and most of the questions are hard to process for the learners, making them spend much time framing appropriate answers.

Table 1: Summary of Observations During Cycle 1 (Elicit)

Parts of the Lesson Plan	Lesson Flow	Observations	Improved Lesson Plan
Elicit	▪ To elicit the students' prior knowledge about projectile motion, play a video showing the different games from Palarong Pambansa 2018, and after playing the video, ask the following questions to the students: ▪ **Guide Questions:** 1. In which of the games can you observe motion in two dimensions? 2. How will you describe the path traveled by the ball? 3. What makes the ball move in a curved path? 4. What do you call the curved path being traveled by the ball? In a free throw, what factors must be considered by a player when attempting to shoot the ball?	• *Lesson Flow* There are too many questions, learners tend to get confused when bombarded with a lot of questions. Questions must be specific and simplified so that the students can easily process them. • *Students' Response* For question 1, the students did not immediately understand what is meant by "motion in two dimensions". • *Time Allotment* This took up much time and exceeded the 5mins allotted time.	▪ To elicit the students' prior knowledge about projectile motion, play a video showing the different games from Palarong Pambansa 2018, and after playing the video, ask the following questions to the students: ▪ **Guide Questions:** 1. In which games can you observe motion in both horizontal and vertical dimensions? 2. How will you describe the path traveled by the ball? 3. In a free throw, what factors must be considered by a player when attempting to shoot the ball?

To address this issue, the lesson study team revised the elicit flow by reducing the number of questions. Some confusing questions were also simplified to reduce the time it takes for the learners to process the different questions. As shown in Table 1 questions were reduced from 5 to 3. Some questions were also paraphrased to simplify their form considering the level of comprehension the students could achieve. Simplifying questions for learners is essential in ensuring effective learning and comprehension. Complex questions can be overwhelming for learners, leading to confusion and a lack of understanding. Therefore, it is crucial to simplify questions and make them more accessible for learners to ensure they can fully engage with the material.

Research has shown that simplifying questions leads to increased comprehension and retention of the concept buildup. A study conducted by the University of Wisconsin-Madison found that simplifying questions improved students' understanding of the material and increased their test scores (Ambrose et al. 2010). Furthermore, simplifying questions can also promote critical thinking by encouraging learners to think deeply about the material. By breaking down complex questions into simpler ones, learners can focus on specific aspects of the material, allowing them to acquire a concentrated understanding of the topic (Barkley et al. 2014).

Another major observation that was clearly noted in the demonstration teaching is the difficulty of the learners to process the first guide question "In which of the games can you observe motion in two dimensions?". They find it hard to understand the term "motion in two dimensions". The lesson study team was able to notice this since much from the responses of the learners. One response that led the team to consider it difficult to understand is the answer of one student when he said:

"none sir… all games are still in the observable dimension" (SP12)

This answer of the students is a clear manifestation of misunderstanding of the context being described by the question. To address this issue, the lesson study team changed the question to "In which games you can observe motions in the horizontal and vertical dimensions?" This seems to be simpler and probably aligned with their field of comprehension. As educators, we must ensure that we are using language and questioning techniques that are accessible and appropriate for learners to encourage active engagement and learning (Ambrose et al. 2010).

The enumerated observation in the Engage part shown in Table 2 reflects a few major issues that need to be addressed. Same with the observation of the lesson study team in the elicit part, the teacher exceeded the 10-minute allotment in the Engage part. Assumptions like dragging moments due to the slow movement of the learners could be one reason that can be attributed to the delay in the accomplishment of the task given to the students. Take for example the giving of instructions as to what to do regarding the passing of a Ping-Pong ball. It consumes much of the time and the learners are very slow in their phase performing the task. To address this issue the teacher should give clear instructions on what to do and encourage them to really do the task as quickly as possible.

Another major observation by the members of the lesson study team is the reading of the objective at the beginning of the Engage part. It was found that this could compromise the inquiry approach employed in the instructional flow. One potential rationale for delaying the reading of lesson objectives is to promote learners' intrinsic motivation and curiosity. When learners are given more autonomy to explore and discover on their own, they may feel a greater sense of ownership and engagement with the learning process. To allow the learners to really be able to attain maximum curiosity in the lesson the lesson study team moved the reading of the lesson objective at the end of the engage part.

Table 2: Summary of Observations During Cycle 1 (Engage)

Parts of the Lesson Plan	Lesson Flow	Observations	Improved Lesson Plan
Engage	➢ Introduce the subject matter – Projectile Launched at an Angle ➢ Allow the students to read the lesson objectives. ➢ Call two students and let them stand in the opposite part of the room. Let one student throw a Ping-Pong ball at the other student on the other side. Let one student observing from the class draw the path of the Ping-Pong ball on the board. ➢ Ask the following questions to the students: 1. *What do you think is the term that we use to describe this path?* 2. *Which do you think is the highest point the object reached following this kind of path?* 3. *What do you think is the maximum distance the object has reached horizontally?* 4. *Considering the angle, what angle do you think the object obtained the highest height vertically?* *What have you observed with the time it takes for the object to move upward and as it moves downward?*	• *Lesson Flow* The students already had a clue about the activity since the topic and objectives were introduced first. Allow the students to perform the activity before introducing the topic/lesson. It is better to discuss the Pythagorean theorem in the elaborate part. • Students' Response Need to modify the questions because the students were not able to answer them right away. • *Time Allotment* This part exceeded the time allotment. The discussion on angles and the Pythagorean theorem to further the ideas of the learners about the horizontal and vertical dimensions of the moving object in the horizontal with an arbitrary angle took up much time.	➢ Call two students and let them stand on opposite sides of the room. Let one student throw a Ping-Pong ball at the other student on the other side. Let one student observing from the class draw the path of the Pong-Pong ball on the board. ➢ Ask the following questions to the students: 1. *What do you think is the term that we use to describe this path?* 2. *Can you point the maximum height that the ball reached in the drawing?* 3. *Can you point out the distance traveled by the ball in the horizontal dimension?* 4. *How will you adjust the angle to obtain maximum height? Maximum horizontal distance?* 5. *What have you observed with the time it takes for the object to move upward and as it moves downward?* ➢ Introduce the subject matter – Projectile Launched at an Angle. Allow the students to read the lesson objectives.

Furthermore, it was also noted that giving additional information to enhance their responses to the guide question during the Engage part could also consume much time and compromise the intended time for other parts of the instructional flow. This issue was addressed by not introducing or reviewing concepts about the Pythagorean theorem in this part of the instructional flow but moving it to the elaborate part instead. Lastly, there is also a need for the lesson study team to modify some questions to make it easier for the learners to grasp its meaning and they can process these questions easily without delay reducing the wasted time accomplishing this part of the lesson.

Table 3: Summary of Observations During Cycle 1 (Explore)

Parts of the Lesson Plan	Lesson Flow	Observations	Improved Lesson Plan
Explore	➢ Give a short introduction about the motion of objects launched at an angle. ➢ Point out that the horizontal and vertical axes are the two coordinates that are typically employed to describe projectile motion. The range refers to the projectile's horizontal distance traveled. While the height refers to the vertical distance, or the distance from the point of launch to the highest point along its course. ➢ Divide the class into 5 groups. ➢ Give the necessary data and instructions, then allow the students to manipulate the PhET interactive simulation about projectiles. In this activity, the students will learn how vertical motion differs from horizontal motion. They will also learn that the launching position affects the trajectory (time of flight, height, and range) of a projectile given that the mass, initial velocity, air resistance, and acceleration due to gravity are constant. https://phet.colorado.edu/sims/html/projectilemotion/latest/projectile-motion_en.html ▪ **Guide Questions:** 1. How do you compare the difference in the	• *Lesson Flow* The use of PHET Simulation to understand the behavior of objects in projectile motion is very ideal. • *Students' Response* Learners were able to understand the mechanism and principle of projectile motion as they manipulate the computer-based learning simulation. • *Time Allotment* The students were not able to finish answering the activity within the allotted time because of too many guide questions. The guide questions must better be differentiated so that each group can finish on time.	➢ Give a short introduction about the motion of objects launched at an angle. ➢ Emphasizes that when discussing projectile motion, two coordinates are commonly employed: the horizontal and vertical axes. The projectile's travel across the horizontal axis is denoted as its "range," while the vertical displacement, which indicates the distance from its launch point to the highest point on its trajectory, is identified as its "height." ➢ Divide the class into 5 groups. ➢ Give the necessary data and instructions, then allow the students to manipulate the PhET interactive simulation about projectiles. In this activity, the students will learn how vertical motion differs from horizontal motion. They will also learn that the launching position affects the trajectory (time of flight, height, and range) of a projectile given that the mass, initial velocity, air resistance, and acceleration due to gravity are constant. https://phet.colorado.edu/sims/html/projectilemotion/latest/projectile-motion_en.html ▪ **Guide Questions:**

	motion of the object in a projectile in terms of the total time it takes for the object to reach the maximum range and height provided by the given angular variation? 2. Which angle obtained the highest height? Explain why. 3. Which angle obtained the maximum range? Why? 4. What do you think will happen if the initial velocity is increased? What happens to the range and total time of flight? 5. What are some real-life situations that need our knowledge of projectile motion? Support your answer.		Question 1: Group 1 ▪ How do you compare the difference of the motion of the object in a projectile in terms of the total time it takes for the object to reach the maximum range and height provided the given angular variation? Group 2 ▪ Which angle obtained the highest height? Explain why. Group 3 ▪ Which angle obtained the maximum range? Why? Group 4 ▪ What do you think will happen if the initial velocity increases? What happens to the range, height, and total time of flight? Group 5 ▪ What can you say about the velocity as the object move upward and as the object moves downward? Question 2 (Same for all groups) What are some real-life situations that need our knowledge on projectile motion? Support your answer.

A major observation noticed by the lesson study team in the Explore part is the delayed accomplishment of the learners in doing the activity. Originally, each group in the explore part is supposed to answer all these intended guide questions. However, when the demonstration took place in the first cycle the team found out that there is a need for us to revise these steps. Time is really very important in teaching. So, to reduce the time it takes for the learners to accomplish the task in the explore part, we need to decrease the number of questions that they need to answer. However, the different questions are highly vital for the learners to grasp the concept. The lesson study team was able to finalize its revision by distributing differentiated questions to the 5 groups and 1 common question for all the groupings. This update to the giving of guide questions maximizes the chance for all students to be able to hear those varied questions since after the Explore part is the presentation of their output and all of them hear the presentation of answers of the different groups of the different essential questions in the exploration part.

Table 4: Summary of Observations During Cycle 1 (Explain)

Parts of the Lesson Plan	Lesson Flow	Observations	Improved Lesson Plan
Explain	➢ Each group will be given time to present their output in front of the class. ➢ The teacher will take note of the presented misconceptions of the students during their output presentation to be addressed later during the elaborate part.	• *Lesson Flow* The guide questions might be differentiated and reduced for them to focus on one factor that affects the trajectory of a projectile. • *Students' Response* Each group must be given a manila paper where they can write their answers so that the audience can clearly understand their presentation. • *Time Allotment* The allotted time for the presentation of outputs is not enough.	➢ Each group will be given a maximum of two minutes to present their output in front of the class. The teacher will take note of the presented misconceptions of the students during their output presentation to be addressed later during the elaborate part.

No major changes took place in the Explain part since this only let the learners present their output from Explore. However, the minor issue here could greatly affect the overall instructional flow. The major flaw noticed by the lesson study team in this part is the huge consumption of time as the learners progress in presenting their output. Learners are encouraged to compress their presentation in a summarized manner to save time. The guide questions utilized in this part are already good enough to draw their gained knowledge after the exploration part. It is also good to have a timer so that the presenter in the Explain part will really be trying their best to contain the presentation within the specified time. Furthermore, Providing the groups with manila paper makes it easier for them in the presentation. Moreover, with the manila paper learners will lessen the time it takes for them to finish the task.

Table 5: Summary of Observations During Cycle 1 (Elaborate)

Parts of the Lesson Plan	Lesson Flow	Observations	Improved Lesson Plan
Elaborate	➢ Introduce the equations used in describing the motion of objects moving in full projectile motion: time of flight, maximum height reached, and horizontal range. ➢ Show an example of solving a word problem about projectiles. ➢ Address the misconceptions during the presentation of answers. ➢ Let the students solve a word problem to prove their answers during the group activity.	• *Lesson Flow* There is no need to review the derivation of formulas for horizontal and vertical dimensions. The discussion must start with the derivation of formulas for full projectile motion and relate it to the Pythagorean theorem in Mathematics. • *Students' Response* It was noted that the learners become less interested when the derivation of formula was introduced. • *Time Allotment* This part is too long and goes beyond the allotted time.	➢ Introduce the equations used in describing the motion of objects moving in full projectile motion: time of flight, maximum height reached, and horizontal range. ➢ Show an example of solving a word problem about projectiles. ➢ Address the misconceptions during the presentation of answers. ➢ Let the students solve a word problem to prove their answers during the group activity.

The elaborate part is the part where the teacher gives his input to the learners on the concept. During the concept build-up, it was noticed that as the teacher shares the concept of projectile motion in physics, the learners are less interested especially there is the presentation of mathematical principles on equality. Derivation of formula or formula transformation is essential in this concept because the learners will be using various equations to solve hypothetical problems in projectile motion. The derivation is vital in the solving process for them to understand where these equations were taken from. However, it was clearly noticed that the learners find it hard to catch up with the computational process as well as the involvement of mathematical equation derivation.

Table 6: Summary of Observations During Cycle 1 (Extend)

Parts of the Lesson Plan	Lesson Flow	Observations	Improved Lesson Plan
Extend	Allow the students to share their ideas on the uses and importance of projectile motion in real life. Give more	• *Students' Response* The students were able to express their thoughts well. • *Time Allotment*	Allow the students to share their ideas on the uses and importance of projectile motion in real life. Give more

	examples of the uses of projectiles.	The time allotment is enough.	examples of the uses of projectiles.

The Extend part is a life application portion where the teacher will bring the lesson learned by the learners into the real world. In the case of this lesson on projectile motion, the teacher would ask the students about how they might use their knowledge of projectiles in the real world. The responses of the learners show that they truly were able to grasp the concept and become more aware of the significance of projectile motion in real-life contexts. No changes were done in this part since the allotted time fits already to what really took place during the actual demonstration teaching in the first cycle.

Table 7: Summary of Observations During Cycle 1 (Evaluate)

Parts of the Lesson Plan	Lesson Flow	Observations	Improved Lesson Plan
Evaluate	Test A. (TRUE or FALSE) 1. The trajectory is the total horizontal distance acquired by an object as it propels into a projectile path. 2. The trajectory refers to the path of an object projected in space with an initial velocity at a given angle in the horizontal. 3. The angle that could allow an object to attain maximum range in a trajectory path is 45^{o}. 4. In a projectile motion, the time it takes for an object to move upward is not equal to the time of an object to reach downward. 5. In playing basketball the concept of a projectile is NOT vital in shooting the ball to the ring. Test B (Problem-Solving) A cannonball was fired at an angle of 60^{o} with an initial velocity of 25 m/s. Calculate the total time of flight of the cannonball as it is projected in the air, the maximum height the cannonball can reach, and the range the cannonball reached in the horizontal distance.	• *Lesson Flow* Test A and B must be posted separately so that the students who finished answering Test A can proceed immediately to the next part without waiting for the rest of the class to finish. • *Students Response* The students were able to understand and answer Test A. • *Time Allotment* The students were not able to finish answering the quiz on time.	Test A. (TRUE or FALSE) 1. The trajectory is the total horizontal distance acquired by an object as it propels into a projectile path. 2. The trajectory refers to the path of an object projected in space with an initial velocity at a given angle in the horizontal. 3. The angle that could allow an object to attain maximum range in a trajectory path is 45^{o}. 4. In a projectile motion, the time it takes for an object to move upward is not equal to the time of an object to reach downward. 5. In playing basketball the concept of a projectile is NOT vital in shooting the ball to the ring. Test B (Problem-Solving) A cannonball was fired at an angle of 60^{o} at the horizontal with an initial velocity of 25 m/s. Calculate the total time of flight of the cannonball as it is projected in the air, the maximum height the cannonball can reach, and the range the cannonball reached in the horizontal distance.

During the Evaluation in the first demonstration in the first cycle, students failed to finish the test on time. It was revealed from the complaints of some of the learners that due to the very slow phase of Test A where the questions were revealed to them one by one. Some were able to spend much of the time taking test A, and their time to be spent answering test B, which is a problem-solving type, was used up, and they ended up losing much of the time on the quiz. The lesson study team revised this setup in the second cycle and revealed directly all the answers at the same time so that the learners would be able to manage their time properly because they had seen already the whole test. It was found out in the second cycle that this scheme was more effective, and the learners were able to maximize their time and finish the test within the given time frame.

Observations of the Lesson in the Second Cycle Demonstration. When the lesson study team conducted the second demonstration teaching to another set of learners using the revised instructional flow of the same lesson on projectile motion, it was noticed that everything runs smoothly. The lesson becomes clearer to the learners. The updated instruction has lessened the time for the learners to follow since they understand it directly. The lesson plan becomes more achievable and relevant to the minds and learning scope of the students. It becomes time-bounded that it truly utilizes the allotted time without the learners spending much effort to accomplish the given task. This becomes ideal and better compared to the first demonstration in the first cycle. Here are some of the few observations and comments of the lesson study team during the second demonstration under cycle 2.

Table 8: Summary of Observations During Cycle 2

Parts of the Lesson Plan	Observation
Elicit	• The students were able to easily understand the guide questions and shared their ideas clearly. The elicit part did not exceed the allotted 5 minutes.
Engage	• Since the subject matter and objectives were not yet introduced, the students were more engaged and excited about what the next activity would be. Some students did not clearly understand questions 3 and 4.
Explore	• The students were able to finish answering the activity within the allotted time. There were only a few questions/clarifications asked about the simulation activity.
Explain	• Students were able to answer the differentiated guide questions. • The audience was able to relate to the presentation of outputs since there were visuals presented. The presentation of outputs was done within the allotted time
Elaborate	• This part was finished within the allotted time. The students were able to derive the formulas for projectile motion and solved a sample problem in their notebooks.
Extend	The students were able to express their thoughts within the allotted time.
Evaluate	The students were able to finish answering the quiz on time and most of them got high scores on the test.

As shown in Table 8, it clearly manifests the significance of revising the lesson plan constructed on the actual observations noticed during the actual implementation of the lesson. The lesson study did a good job of transforming the lesson to have a better instructional flow. Very minor problems were noticed but everything is manageable and within the bounds of the teacher's management of the teaching and learning process. The lesson study team then agreed to follow this revised and finalized it in this form. Two major cycles were applied by the team after they were able to come up with a better lesson flow in projectile motion.

Conclusion and Recommendations

Based on the result of the investigation, the lesson study cycle has been shown to be an effective method for improving instructional flow in various subject areas, including physics education. By using this cycle, teachers can collaborate and revise their lesson plans based on data gathered from observing students' responses and engagement during the first and second cycle teaching demonstration process. It was concluded that the developed lesson plan about projectile motion has become more able to guide the teacher user in facilitating different sets of grade 9 learners, indeed the lesson study cycle can help teachers identify areas where students may struggle and adjust the lesson plan accordingly to improve student understanding and engagement. As the lesson plan undergoes the first and second cycles, it becomes more specific, time-bounded, measurable, attainable, and relevant to the learners. Meaning, the lesson study team was able to refine and improve the lesson on projectile motion through their collaborative efforts. Overall, the lesson study cycle is a useful tool for teachers to improve the quality of their instruction and help students better understand complex concepts like projectile motion. By continually revising and refining lesson plans through the collaborative efforts of a group of educators, the lesson plan can become smarter and more effective at helping students achieve their learning goals.

The following includes the recommendations derived from the outcome of the investigations. (1) Utilization of the lesson plan in projectile motion in the different sections of grade 9 to achieve maximum engagement and interest in the learners. (2) Train teachers on how to conduct a lesson study cycle. (3) Other subject areas are recommended to also use lesson study for instructional purposes relevant to the needs of the learners. (4) Further lesson study will be conducted in lessons on the projectile motion to increase our knowledge in this field of the educative process. (5) Test the effectiveness of this lesson study output on the academic achievement of students in Grade 9.

Republic of the Philippines
Department of Education
Region IX, Zamboanga Peninsula
Division of Pagadian City
ZAMBOANGA DEL SUR NATIONAL HIGH SCHOOL
Pagadian City

Action Plan for the Conduct of Seminar Workshop on Lesson Study Cycle

Subject Focus	Program Description	Objectives	Strategies/ Activities	Time Frame	Persons Involved	Sources of Fund	Expected Outcome
Grade 9 Science	Utilization of the improved lesson plan in teaching projectile motion	• Improve achievement and performance of both the teacher and students	• Utilization of the improved lesson plan in projectile motion in classroom observation and in daily classes	First and Second semester	Science Teachers and Students	School MOOE	80% Increase in MPS on concepts on projectile motion among grade 9 learners.
	Seminar – Workshop on the making lesson study cycle	Improve teacher's knowledge and skills in the lesson study cycle.	Intensive In-service Training for Science Teachers on the concept of lesson study cycle.	First and Second Semester	Science Teachers and Teacher Trainers Head teacher in science	School MOOE	98% of the teachers were trained in the implementation and organization of lesson study teams and lesson study cycles.

References

Ambrose, Susan A., Michael W. Bridges, Michele DiPietro, Marsha C. Lovett, and Marie K. Norman. 2010. *How learning works: Seven research-based principles for smart teaching*. John Wiley & Sons.

Bagherzadeh, R., & Tajeddin, Z. 2021. "Teachers' Curricular Knowledge in Teacher Education Programs: A Case of Iran's Sociocultural Context." *International Journal of Society, Culture & Language*, 9(1), 43-57.

Barkley, Elizabeth F., K. Patricia Cross, and Claire H. Major. 2014. *Collaborative learning techniques: A handbook for college faculty*. John Wiley & Sons.

Cagiltay, Kursat, Hasan Cakir, Necdet Karasu, Omer Faruk Islim, and Filiz Cicek. 2019. "Use of educational technology in special education: Perceptions of teachers." *Participatory Educational Research* 6, no. 2: 189-205.

Dudley, P. 2012. Lesson Study in England: from school networks to national policy. *International Journal of Lesson and Learning Studies*, 1.1 pp 85-100.

Hadzigeorgiou*, Yannis. 2005. "Romantic understanding and science education." *Teaching Education* 16, no. 1: 23-32.

Hadzigeorgiou, Yannis, and Stathis Stivaktakis. 2008. "Encouraging involvement with school science." *Journal of Curriculum and Pedagogy* 5, no. 1: 138-162.

Hassan, Oulhou, and Aomar Ibourk. 2021. "Burnout, self-efficacy and job satisfaction among primary school teachers in Morocco." *Social Sciences & Humanities Open* 4, no. 1: 1-6.

Haynes, Anthony. 2007. *100 ideas for lesson planning*. A&C Black.

Kiat, Teo Yang, Kriswanto Jumintono, Sugiri ES, E. Handayani, Y. Anggarini, and M. Rofik. 2020. "The effectiveness of multimedia learning on academic achievement in reproduction topic science subject." *Universal Journal of Educational Research* 8, no. 8: 3625-3629.

Madjdi, Achmad Hilal, and Atik Rokhayani. 2021. "Lesson study in increasing student learning participation in class." *Linguistics and Culture Review* 5, no. S3: 911-917.

Miles, Matthew B., and A. Michael Huberman. 1994. *Qualitative data analysis: An expanded sourcebook*: 12.

Oser, Fritz K., and Franz J. Baeriswyl. 2001. "Choreographies of teaching: Bridging instruction to learning." *Handbook of research on teaching* 4: 1031-1065.

Puad, Lalu Mohammad Abid Zainul, and Karen Ashton. 2021. "Teachers' views on classroom-based assessment: an exploratory study at an Islamic boarding school in Indonesia." *Asia Pacific Journal of Education* 41, no. 2: 253-265.

Sabasales, Matthew T. 2018. "The Effects of Using Virtual Laboratory Materials on Students' Academic Performance in Physics." *International Journal of Science and Engineering Investigations*, (83) 7: 43.

Yazlik, Derya Özlem, and İbrahim Cetin. 2020. "Examining the relationship between mathematics anxiety and mathematics teaching anxiety of prospective mathematics teachers." *Türk Bilgisayar ve Matematik Eğitimi Dergisi*: 1-1.

Financial Report

The table below shows the total cost spent before, during, and after the conduct of this action research.

General Descriptions	Quantity	Unit	Unit Price	Total Estimated Costs
Short Bond paper sub-20	1	ream	274.00	274.00
Ink for printer	4	bottles	269.00	1,076.00
Printing and Binding	6	copies	60.00	360.00
Ballpen	2	pcs	10.00	20.00
White Board Markers	2	pcs	60.00	120.00
Snacks (90 Students) during the data gathering	100	Students	32.70	3,270.00
Total				5,120.00

Appendices

The lesson plan before the lesson study cycles

Republic of the Philippines
Department of Education
Region IX, Zamboanga Peninsula
Division of Pagadian
Pagadian City

CURRICULUM and INSTRUCTION DIVISION

LESSON PLAN ON PROJECTILE MOTION
Grade IX - Science

Content Standard	**Performance Standard**
The learners demonstrate an understanding of projectile motion, impulse and momentum, and conservation of linear momentum.	*The learners shall be able to propose ways to enhance sports related to projectile motion.*

I – LEARNING COMPETENCY:

Describe the horizontal and vertical motions of a projectile.

- **Code: S9FE-IVa-34**

Objectives:

a. Describe the path of an object in projectile motion.
b. Differentiate the horizontal and vertical motions of a projectile.
c. Solve problems about projectile motion.
d. Appreciate the use of projectile motion in real life.

II – LEARNING CONTENT:

- **Subject Matter – PROJECTILE MOTION**
- **Quarter and Week: Quarter 4, Week 1**
- **Materials:**
    - Smart TV
    - Laptop
    - Activity Sheets
    - Manila Paper

- **Sources:**
  Offline:
  Learning Materials in Grade IX Science Quarter 4 Module 1
  Online:
  - https://www.youtube.com/watch?v=V6l58mLIg50
  - https://phet.colorado.edu/sims/html/projectile-motion/latest/projectile-motion_en.html

III – LEARNING PROCEDURE:

PRELIMINARIES/ELICIT (5 Minutes)

- **PRELIMINARIES**:
  - Prayer
  - Checking of arrangement of learners to address students with special needs like those who have problems in hearing and seeing to be transferred in front.
  - Short clean-up

- **ELICIT:**
  - To elicit the students' prior knowledge about projectile motion, play a video showing the different games from Palarong Pambansa 2018, and after playing the video, ask the following questions to the students:

  - **Guide Questions:**
    1. In which of the games can you observe motion in two dimensions?
    2. How will you describe the path traveled by the ball?
    3. What makes a move in a curved path?
    4. What do you call the curved path being traveled by the ball?
    5. In a free throw, what factors must be considered by a player when attempting to shoot the ball?

ENGAGE (10 Minutes)

- Introduce the subject matter – Projectile Launched at an Angle
- Allow the students to read the lesson objectives.
- Call two students and let them stand in the opposite part of the room. Let one student throw a crumpled paper at the other student on the other side. Let the student draw the path of the crumpled paper on the board.
- Ask the following questions to the students:
  1. *What do you think is the term that we use to describe this path?*
  2. *Which do you think is the highest point the object reached following this kind of path?*
  3. *What do you think is the maximum distance the object has reached horizontally?*
  4. *Considering the angle, what angle do you think the object obtained the highest height vertically?*
  5. *What have you observed with the time it takes for the object to move upward and as it moves downward?*

EXPLORE (10 Minutes)

- Give a short introduction about the motion of objects launched at an angle.
- Emphasize that there are two coordinates usually used to describe projectile motion: horizontal and vertical axes. The horizontal distance traveled by the

projectile is called the *range*. While the vertical distance, that is, the distance from where it was launched to the topmost point of its path, is called its *height*.

- Divide the class into 5 groups.
- Give the necessary data and instructions, then allow the students to manipulate the PhET interactive simulation about projectiles. In this activity, the students will learn how vertical motion differs from horizontal motion. They will also learn that the launching position affects the trajectory (time of flight, height, and range) of a projectile given that the mass, initial velocity, air resistance, and acceleration due to gravity are constant.
- https://phet.colorado.edu/sims/html/projectile-motion/latest/projectile-motion_en.html

EXPLAIN (10 Minutes)

- Each group will be given time to present their output in front of the class.
- The teacher will take note of the presented misconceptions of the students during their output presentation to be addressed later during the elaborate part.

ELABORATE (15 Minutes)

- Introduce the equations used in describing the motion of objects moving in full projectile motion: time of flight, maximum height reached, and horizontal range.
- Show an example of solving a word problem about projectiles.
- Address the misconceptions during the presentation of answers.
- Let the students solve a word problem to prove their answers during the group activity.

EXTEND (5 Minutes)

- Allow the students to share their ideas on the uses and importance of projectile motion in real life.
- Give more examples of the uses of projectiles.

IV – ASSESSMENT:

EVALUATE (10 Minutes)

Test A. (TRUE or FALSE)

6. The trajectory is the total horizontal distance acquired by an object as it propels into a projectile path.
7. The trajectory refers to the path of an object projected in space with an initial velocity at a given angle in the horizontal.
8. The angle that could allow an object to attain maximum range in a trajectory path is 45^o.
9. In a projectile motion, the time it takes for an object upward is not equal to the time for an object to reach downward.
10. In playing basketball the concept of a projectile is NOT vital in shooting the ball to the ring.

Test B (Problem-Solving)

11. A cannonball was fired at an angle of 60^o at the horizontal with an initial velocity of 25 m/s. Calculate the total time of flight of the cannonball as it is projected in the air, the maximum height the cannonball can reach, and the range the cannonball reached in the horizontal distance.

V – ASSIGNMENT:

Homework (short bond paper)

Solve the given problem:
A soccer ball was kicked by a boy at an angle of 40^{o} at the horizontal with an initial velocity of 30 m/s. Calculate the total time of flight of the ball as it is projected in the air, the maximum height the ball can reach, and the range the ball reached in the horizontal distance.

Group Number: __________Grade and Section: _______________________________ Date: ________________

Names of Members:
____
____
____
____

The Curve!

Projectile Motion in Action

Objectives:

a. Describe the path of an object in projectile motion.
b. Differentiate the horizontal and vertical motions of a projectile.

Material:

- Laptop Computer (PHET Simulation)
- Activity Sheet

Procedure:

1. Using the given laptop, open the projectile motion application in the PHET Simulation.
2. Using the PHET Simulation, explore the behavior of a moving object in a projectile motion by manipulating the given variables reflected in the table below.
3. Set the following initial parameters before starting the simulation; gravity at 9.8 m/s^2; the mass of the object to 1kg; diameter to 0.1meter; no air resistance.
4. Start the simulation by manipulating the angles and initial velocity specified in the table below. Use the measuring tool to determine the time, range, and height of the projectile.
5. Record all results in the allotted column in the table below.
6. Answer the given guide questions.

Angle	Initial Velocity	Time it takes to reach maximum height (in seconds)	Total Time of Flight (in seconds)	The Maximum Height (in meters)	The Range (in meters)
30^{o}	25m/s				
30^{o}	30m/s				
60^{o}	25m/s				
60^{o}	30m/s				

Guide Questions:

1. How do you compare the difference in the motion of the object in a projectile in terms of the total time it takes for the object to reach the maximum range and height provided by the given angular variation?
2. Which angle obtained the highest height? Explain why.
3. Which angle obtained the maximum range? Why?
4. What do you think will happen if the initial velocity is increased? What happens to the range and total time of flight?
5. What are some real-life situations that need our knowledge of projectile motion? Support your answer.

The Lesson Plan After the Lesson Study Cycles

Republic of the Philippines
Department of Education
Region IX, Zamboanga Peninsula
Division of Pagadian
Pagadian City

CURRICULUM and INSTRUCTION DIVISION

LESSON PLAN ON PROJECTILE MOTION
Grade IX - Science

Content Standard	**Performance Standard**
The learners demonstrate an understanding of projectile motion, impulse and momentum, and conservation of linear momentum.	*The learners shall be able to propose ways to enhance sports related to projectile motion.*

I – LEARNING COMPETENCY:

Describe the horizontal and vertical motions of a projectile.

- **Code: S9FE-IVa-34**

Objectives:

a. Describe the path of an object in projectile motion.
b. Differentiate the horizontal and vertical motions of a projectile.
c. Solve problems about projectile motion.
d. Appreciate the use of projectile motion in real life.

II – LEARNING CONTENT:

- **Subject Matter – PROJECTILE MOTION**
- **Quarter and Week: Quarter 4, Week 1**
- **Materials:**
  - Smart TV
  - Laptop
  - Activity Sheets
  - Manila Paper

- **Sources:**
  Offline:
  Learning Materials in Grade IX Science Quarter 4 Module 1
  Online:
  - https://www.youtube.com/watch?v=V6l58mLIg50
  - https://phet.colorado.edu/sims/html/projectile-motion/latest/projectile-motion_en.html

III – LEARNING PROCEDURE:

PRELIMINARIES/ELICIT (5 Minutes)

- **PRELIMINARIES***:*
  - Prayer
  - Checking of arrangement of learners to address students with special needs like those who have problems in hearing and seeing to be transferred in front.
  - Short clean-up

- **ELICIT:**
  - To elicit the students' prior knowledge about projectile motion, play a video showing the different games from Palarong Pambansa 2018, and after playing the video, ask the following questions to the students:

  - **Guide Questions:**
    1. In which games can you observe motion in both horizontal and vertical dimensions?
    2. How will you describe the path traveled by the ball?
    3. In a free throw, what factors must be considered by a player when attempting to shoot the ball?

ENGAGE (10 Minutes)

- Introduce the subject matter – Projectile Launched at an Angle
- Call two students and let them stand on opposite sides of the room. Let one student throw a crumpled paper at the other student on the other side. Let the student draw the path of the crumpled paper on the board.
- Ask the following questions to the students:
  1. *What do you think is the term that we use to describe this path?*
  2. *Can you point the maximum height that the ball reached in the drawing?*
  3. *Can you point out the distance traveled by the ball in the horizontal dimension?*
  4. *How will you adjust the angle to obtain maximum height? Maximum horizontal distance?*
  5. *What have you observed with the time it takes for the object to move upward and as it moves downward?*
- Allow the students to read the lesson objectives.
- Introduce the subject matter.

EXPLORE (10 Minutes)

- Emphasize that there are two coordinates usually used to describe projectile motion: horizontal and vertical axes. The horizontal distance traveled by the projectile is called the *range*. While the vertical distance, that is, the distance from where it was launched to the topmost point of its path, is called its *height*.
- Divide the class into 5 groups.
- Give the necessary data and instructions, then allow the students to manipulate the PhET interactive simulation about projectiles. In this activity, the students will learn how vertical motion differs from horizontal motion. They will also learn

that the launching position affects the trajectory (time of flight, height, and range) of a projectile given that the mass, initial velocity, air resistance, and acceleration due to gravity are constant.

- https://phet.colorado.edu/sims/html/projectile-motion/latest/projectile-motion_en.html

EXPLAIN (10 Minutes)

- Each group will be given time to present their output in front of the class.
- The teacher will take note of the presented misconceptions of the students during their output presentation to be addressed later during the elaborate part.

ELABORATE (15 Minutes)

- Introduce the equations used in describing the motion of objects moving in full projectile motion: time of flight, maximum height reached, and horizontal range.
- Show an example of solving a word problem about projectiles.
- Address the misconceptions during the presentation of answers.
- Let the students solve a word problem to prove their answers during the group activity.

EXTEND (5 Minutes)

- Allow the students to share their ideas on the uses and importance of projectile motion in real life.
- Give more examples of the uses of projectiles.

EVALUATE (10 Minutes)

Test A. (TRUE or FALSE)

1. The trajectory is the total horizontal distance acquired by an object as it propels into a projectile path.
2. The trajectory refers to the path of an object projected in space with an initial velocity at a given angle in the horizontal.
3. The angle that could allow an object to attain maximum range in a trajectory path is 45^o.
4. In a projectile motion, the time it takes for an object upward is not equal to the time for an object to reach downward.
5. In playing basketball the concept of a projectile is NOT vital in shooting the ball to the ring.

Test B (Problem-Solving)

6. A cannonball was fired at an angle of 60^o at the horizontal with an initial velocity of 25 m/s. Calculate the total time of flight of the cannonball as it is projected in the air, the maximum height the cannonball can reach, and the range the cannonball reached in the horizontal distance.

V – ASSIGNMENT:

Homework (short bond paper)

Solve the given problem:

A soccer ball was kicked by a boy at an angle of 40^{o} at the horizontal with an initial velocity of 30 m/s. Calculate the total time of flight of the ball as it is projected in the air, the maximum height the ball can reach, and the range the ball reached in the horizontal distance.

Group Number: __________Grade and Section: ________________________________
Date: ____________

Names of Members:
____
____
____
____

The Curve!
Projectile Motion in Action

Objectives:

c. Describe the path of an object in projectile motion.
d. Differentiate the horizontal and vertical motions of a projectile.

Material:

- Laptop Computer (PHET Simulation)
- Activity Sheet

Procedure:

1. Using the given laptop, open the projectile motion application in the PHET Simulation.
2. Explore the behavior of a moving object in a projectile motion by manipulating the given variables reflected in the table below.
3. Set the following initial parameters before starting the simulation; gravity at 9.8 m/s^2; the mass of the object to 1kg; diameter to 0.1meter; no air resistance.
4. Start the simulation by manipulating the angles and initial velocity specified in the table below. Use the measuring tool to determine the time, range, and height of the projectile.
5. Record all results in the allotted column in the table below.
6. Answer the given guide questions.

Angle	Initial Velocity	Time it takes to reach maximum height (in seconds)	Total Time of Flight (in seconds)	The Maximum Height (in meters)	The Range (in meters)
30^o	25m/s				
30^o	30m/s				
60^o	25m/s				
60^o	30m/s				

Guide Questions:

1. How do you compare the difference of the motion of the object in a projectile in terms of the total time it takes for the object to reach the maximum range and height provided by the given angular variation?
2. What are some real-life situations that need our knowledge of projectile motion? Support your answer.

Group Number: __________Grade and Section: ___________________________________
Date: _____________

Names of Members:
____
____
____
____

The Curve!
Projectile Motion in Action

Objectives:

a. Describe the path of an object in projectile motion.
b. Differentiate the horizontal and vertical motions of a projectile.

Material:

- Laptop Computer (PHET Simulation)
- Activity Sheet

Procedure:

1. Using the given laptop, open the projectile motion application in the PHET Simulation.
2. Explore the behavior of a moving object in a projectile motion by manipulating the given variables reflected in the table below.
3. Set the following initial parameters before starting the simulation; gravity at 9.8 m/s^2; the mass of the object to 1kg; diameter to 0.1meter; no air resistance.
4. Start the simulation by manipulating the angles and initial velocity specified in the table below. Use the measuring tool to determine the time, range, and height of the projectile.
5. Record all results in the allotted column in the table below.
6. Answer the given guide questions.

Angle	Initial Velocity	Time it takes to reach maximum height (in seconds)	Total Time of Flight (in seconds)	The Maximum Height (in meters)	The Range (in meters)
30^{o}	25m/s				
30^{o}	30m/s				
60^{o}	25m/s				
60^{o}	30m/s				

Guide Questions:

1. Which angle obtained the highest height? Explain why.
2. What are some real-life situations that need our knowledge of projectile motion? Support your answer.

Group Number: __________Grade and Section: ___________________________________
Date: ___________

Names of Members:
____
____
____
____

The Curve!
Projectile Motion in Action

Objectives:

a. Describe the path of an object in projectile motion.
b. Differentiate the horizontal and vertical motions of a projectile.

Material:

- Laptop Computer (PHET Simulation)
- Activity Sheet

Procedure:

1. Using the given laptop, open the projectile motion application in the PHET Simulation.
2. Explore the behavior of a moving object in a projectile motion by manipulating the given variables reflected in the table below.
3. Set the following initial parameters before starting the simulation; gravity at 9.8 m/s^2; the mass of the object to 1kg; diameter to 0.1meter; no air resistance; the height of the canon should be 0m.
4. Start the simulation by manipulating the angles and initial velocity specified in the table below. Use the measuring tool to determine the time, range, and height of the projectile.
5. Record all results in the allotted column in the table below.
6. Answer the given guide questions.

Angle	Initial Velocity	Time it takes to reach maximum height (in seconds)	Total Time of Flight (in seconds)	The Maximum Height (in meters)	The Range (in meters)
30^o	25m/s				
30^o	30m/s				
60^o	25m/s				
60^o	30m/s				

Guide Questions:

1. Which angle obtained the maximum range? Why?
2. What are some real-life situations that need our knowledge of projectile motion? Support your answer.

Group Number: __________Grade and Section: ___________________________________
Date: __________

Names of Members:
____
____
____
____

The Curve!
Projectile Motion in Action

Objectives:

a. Describe the path of an object in projectile motion.
b. Differentiate the horizontal and vertical motions of a projectile.

Material:

- Laptop Computer (PHET Simulation)
- Activity Sheet

Procedure:

1. Using the given laptop, open the projectile motion application in the PHET Simulation.
2. Explore the behavior of a moving object in a projectile motion by manipulating the given variables reflected in the table below.
3. Set the following initial parameters before starting the simulation; gravity at 9.8 m/s^2; the mass of the object to 1kg; diameter to 0.1meter; no air resistance.
4. Start the simulation by manipulating the angles and initial velocity specified in the table below. Use the measuring tool to determine the time, range, and height of the projectile.
5. Record all results in the allotted column in the table below.
6. Answer the given guide questions.

Angle	Initial Velocity	Time it takes to reach maximum height (in seconds)	Total Time of Flight (in seconds)	The Maximum Height (in meters)	The Range (in meters)
30^o	25m/s				
30^o	30m/s				
60^o	25m/s				
60^o	30m/s				

Guide Questions:

1. What do you think will happen if the initial velocity increases? What happens to the range, height, and total time of flight?
2. What are some real-life situations that need our knowledge of projectile motion? Support your answer.

Group Number: __________Grade and Section: ___________________________________
Date: ___________

Names of Members:
____
____
____
____

The Curve!

Projectile Motion in Action

Objectives:

a. Describe the path of an object in projectile motion.
b. Differentiate the horizontal and vertical motions of a projectile.

Material:

- Laptop Computer (PHET Simulation)
- Activity Sheet

Procedure:

1. Using the given laptop, open the projectile motion application in the PHET Simulation.
2. Explore the behavior of a moving object in a projectile motion by manipulating the given variables reflected in the table below.
3. Set the following initial parameters before starting the simulation; gravity at 9.8 m/s^2; the mass of the object to 1kg; diameter to 0.1meter; no air resistance.
4. Start the simulation by manipulating the angles and initial velocity specified in the table below. Use the measuring tool to determine the time, range, and height of the projectile.
5. Record all results in the allotted column in the table below.
6. Answer the given guide questions.

Angle	Initial Velocity	Time it takes to reach maximum height (in seconds)	Total Time of Flight (in seconds)	The Maximum Height (in meters)	The Range (in meters)
30°	25m/s				
30°	30m/s				
60°	25m/s				
60°	30m/s				

Guide Questions:

1. What can you say about the velocity as the object move upward and as the object moves downward?
2. What are some real-life situations that need our knowledge of projectile motion? Support your answer.