Enhancing Earth Science Activities on Tracking Typhoon Using 21st Century Learning Design Rubric

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ABSTRACT

In the 21st century, STEM education plays a vital role in preparing learners for real-world challenges by fostering critical skills such as collaboration, knowledge construction, and skilled communication. However, traditional Earth Science instruction often lacks interactive and technology-driven approaches that effectively engage students. This study aims to enhance Earth Science activities in Grade 8 learners on tracking typhoons by integrating the 21st Century Learning Design (21CLD) Rubric, to address these gap in current educational practices. Specifically, it incorporates real-time weather visualization tools to improve students' conceptual understanding of typhoon movements within the Philippine Area of Responsibility (PAR). Using a descriptive research design, three Earth Science activities were assessed and evaluated by six in-service science teachers and 36 pre-service teachers. In-service teachers, selected for their expertise in Earth Science and 21CLD Rubric, assessed effectiveness, while pre-service teachers participated in enhancement phase 2 using a structured assessment tool. Due to feasibility, pre-service teachers conducted a more extensive evaluation, providing feedback on instructional design, organization, language, and content. They recommended adding a standardized rubric and refining clarity and structure to improve the activities further. Collaboration and Skilled Communication. Significant improvements were observed across the 21CLD skill dimensions due to structured collaboration, deeper engagement, and refined communication strategies. Initially, unclear group-based instructions hindered participation. Enhancements, such as group tasks, role each member, and peer discussions, fostered active involvement and shared responsibility in tracking typhoons. For Skilled Communication, students were able to report their output in class more effectively. As a result, Activities 1, 2, and 3 showed remarkable progress, with Collaboration and Skilled Communication ratings rising from "Poor" to "Excellent." Overall, these refinements confirm the activities' effectiveness in skill-building, meeting or exceeding retention 21CLD standards. This study emphasizes the importance of student-centered, technology-enhanced learning in Earth Science education. The findings contribute to Sustainable Development Goal 4 (Quality Education) by improving instructional quality and SDG 13 (Climate Action) by fostering disaster preparedness and climate resilience. The study recommends integrating real-time simulation tools and collaborative learning frameworks in science education to equip students with 21st-century competencies essential for addressing environmental challenges. The findings of this study may further extended to other Earth Science topics.

Keywords: STEM Education, 21CLD Rubric, Earth Science, Tracking Typhoons, Sustainable Development Goal (SDG), Climate Resilience, Technology Integration in Science Education, Real-time Weather Simulation

INTRODUCTION

In the 21st century, education systems globally are undergoing significant transformations to prepare learners for the complexities of an interconnected world. Central to this transformation is the development of essential skills such as communication, collaboration, and knowledge construction, which are critical for fostering deeper learning and equipping students to tackle real-world challenges (Prettyman et al., 2012; Carpenter & Pease, 2013). These skills not only promote self-directed learning and resilience but also enable students to take on

leadership roles, build trust, and refine their ideas through peer interaction (Warin et al., 2016).

However, despite the growing recognition of their importance, many educational systems, including the Philippines' K to 12 program, continue to rely on traditional teaching methods that prioritize rote memorization over interactive, learner-centered approaches (Dela Cruz & Agustino, 2020). This gap is particularly evident in Earth Science education, where misconceptions and a lack of emphasis on 21st-century skills hinder students' ability to engage meaningfully with scientific concepts such as typhoon tracking (Nallano et al., 2022; Romero et al., 2019). Addressing these challenges is crucial to achieving Sustainable Development Goal (SDG) 4, which emphasizes inclusive and equitable quality education and the promotion of lifelong learning opportunities for all.

This study seeks to bridge the gap between traditional teaching methods and the need for innovative, skill-enhancing approaches in Earth Science education. By focusing on the Grade 8 learning competency of "tracking typhoons within the Philippine Area of Responsibility (PAR) using maps and tracking data," the research aims to integrate 21st-century learning design (21CLD) principles—communication, collaboration, and knowledge construction—into the curriculum. The adoption of the 21CLD Rubric, a framework developed by SRI International and Microsoft Partners in Learning, offers a structured pathway to create engaging, hands-on activities that foster critical thinking and problem-solving skills (Nallano et al., 2022). This approach not only addresses prevalent misconceptions about typhoon tracking but also aligns with SDG 13 (Climate Action) by enhancing students' understanding of natural disasters and their preparedness for climate-related challenges. Ultimately, this study aspires to transform Earth Science education into a dynamic, interactive experience that equips learners with the skills and knowledge needed to thrive in a rapidly evolving world.

Objective of the Study

The main objective of this study is to enhance earth science activities on tracking typhoon using 21st century learning design rubric for Grade 8 students. To attain the general objective, it aims to:

1. Evaluate the existing Grade 8 Science activities on Tracking Typhoon using the 21st Century Learning Design Rubric.

2. Enhance the activities by applying the 21CLD Rubrics and incorporating feedback from evaluators' comments and suggestions.

METHODS

This study employed a descriptive research design. This approach allowed for a comprehensive analysis of the subject matter, combining numerical data to identify trends and patterns with qualitative insights that captured participants' experiences and perspectives (Creswell, 2014; Tashakkori & Teddlie, 2010). By integrating both methods, the study aimed to provide a richer, more nuanced understanding of the research topic, enhancing the validity and depth of the findings (Flick, 2018; Bryman, 2006; Robson, 2011).

The study was conducted at a distinguished private school, accredited, and located in the heart of Momungan, Baloi, Lanao Del Norte, Philippines established in 2004. This institution was notable for having the largest student population among private schools in the area and being the first private school founded in Baloi, Lanao del Norte, Philippines.

Data Gathering Procedures

Figure 1. Flowchart of the Data Gathering Procedure

Assessment Phase

Six (6) in-service science teachers, selected for their expertise in Earth Science education and familiarity with the 21st Century Learning Design (21CLD) framework, assessed three (3) existing typhoon tracking activities from the Grade 8 Learner Material provided by the Department of Education (DepEd). The evaluation was conducted using the 21CLD Learning Activity Rubric, which assessed the activities based on three key skill dimensions: Collaboration, Knowledge Construction, and Skilled Communication.

Enhancement Phase 1

Revision I

The revision process, guided by in-service evaluation, incorporated feedback on knowledge construction, collaboration, and skilled communication, ensuring continuous improvement through structured evaluation phases and three key revisions to enhance the effectiveness of typhoon tracking activities.

Enhancement Phase 2

Revision II

In Revision II, the evaluation process incorporated both in-service and pre-service validation using adapted and modified rubrics. In-service teachers assessed the enhancements using the 21CLD Rubric, where the revised activities successfully met the criteria for knowledge construction, collaboration, and skilled communication. However, minor grammatical errors and punctuation issues were still noted, requiring further refinement to enhance the quality of the learning activities. Additionally, the Validation of Learning Activity Sheets Rubric, adapted from Laurel, C. D. (2022), was utilized to assess instructional effectiveness.

In the Pre-Service Validation Phase, pre-service teachers evaluated the activities. Pre-service teachers were selected as evaluators instead of in-service teachers due to feasibility and availability. Conducting the study with pre-service teachers was more practical since they were more accessible and had a larger sample size (36 participants) compared to in-service teachers, using a specialized tool focusing on Part A: Instructional Design and Organization and Part B: Language, Content, and Format. While the enhancement passed the evaluation, pre-service teachers suggested incorporating a rubric to standardize assessment and recommended further revisions to improve clarity, structure, and overall quality. These insights contributed to the continuous refinement of the learning activities, ensuring alignment with instructional standards and learner needs.

RESULTS AND DISCUSSIONS

Enhancement of the Activities

Table 1 Evaluation of the Existing on Tracking Typhoon

ctivities	**21st Century Skills Employed**	**Mean**	**Descriptor**
Activity 1 "Plotting the Philippine Area of Responsibility (PAR)"	Collaboration	1.17	Poor
	Knowledge Construction	1.50	Poor
	Skilled Communication	1.00	Poor
Activity 2 "Tracking a Tropical Cyclone"	Collaboration	1.17	Poor
	Knowledge Construction	1.17	Poor

	Skilled Communication	1.17	Poor
Activity 3 "Dissecting a Tropical Cyclone"	Collaboration	1.17	Poor
	Knowledge Construction	3.67	Very Good
	Skilled Communication	1.67	Poor

Note:

Mean Rating Descriptor for Collaboration and Knowledge Construction is categorized into five class boundaries. Ratings from 4.20 to 5.00 are described as "Excellent" and should be retained. Ratings between 3.40 and 4.19 are considered "Very Good" and must be retained. Scores from 2.60 to 3.39 fall under "Good" and should also be retained. Ratings within 1.80 to 2.59 indicate "Needs Improvement" and are recommended for revision. Finally, scores from 1.00 to 1.79 are classified as "Poor" and should be revised.

Mean Rating Descriptor for Skilled Communication, four class boundaries are used. A rating between 3.25 and 4.00 is considered "Very Good" and should be retained. Ratings from 2.50 to 3.24 are labeled as "Good" and should also be retained. Scores within 1.75 to 2.49 suggest "Needs Improvement" and should be revised. Lastly, ratings from 1.00 to 1.74 are categorized as "Poor" and are recommended for revision

Table 1 shows In-service science teachers evaluated the 3 activities the evaluation of the original activities on tracking typhoons reveals significant improvements in fostering 21st-century skills, particularly in collaboration and skilled communication. Activities 1 and 2 received consistently poor ratings across all skill categories, indicating their ineffectiveness in engaging students and promoting meaningful learning. Meanwhile, Activity 3 showed in knowledge construction, receiving a "Very Good" rating, but still lacked effectiveness in collaboration and communication. These findings suggest that the current activities need revision, with a particular focus on incorporating interactive and technology-enhanced strategies to improve engagement and teamwork.

The findings highlight critical implications for enhancing learning activities to better develop 21st-century skills among Grade 8 learners. Activities 1 and 2 received "Poor" ratings across all dimensions, demonstrating their ineffectiveness in engaging students in meaningful interactions, problem-solving, or knowledge application. Although Activity 3 received a "Very Good" rating for Knowledge Construction, it still lacked emphasis on Collaboration and Skilled Communication. These results emphasize the need for comprehensive revisions to ensure that learning activities address multiple dimensions of 21CLD, preparing students for real-world challenges.

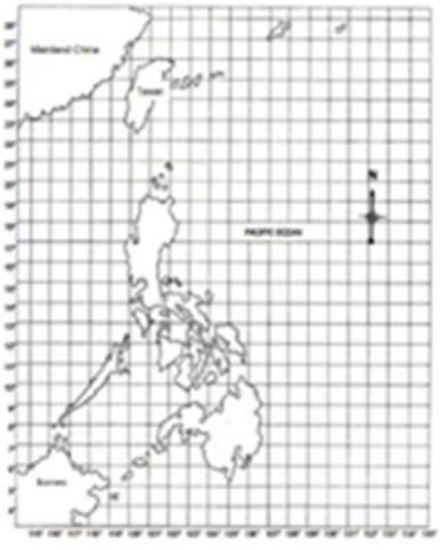
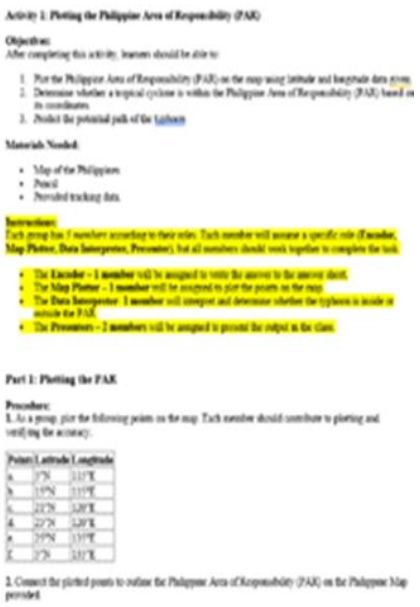
The poor ratings for collaboration highlight the need for redesigning activities to include group discussions, reporting the output, and technology-driven approaches that encourage teamwork and shared problem-solving (Trilling & Fadel, 2009). Similarly, the consistently low scores in skilled communication indicate that students may not have sufficient opportunities to articulate their ideas effectively. Integrating structured dialogues, reporting activities, and guided reflections could enhance students' ability to express their understanding (Gee, 2008). The strong performance of Activity 3 in knowledge construction suggests that certain instructional approaches within this activity are effective. By analyzing and adapting these successful elements, educators can refine other activities to ensure deeper learning and engagement (Bransford et al., 2000).

The poor performance in most skills underscores the need for educators to integrate innovative strategies such as project-based learning, peer collaboration, and technology-enhanced tools to create a more engaging and skill-oriented environment. Prior research supports this approach, with Saavedra and Opfer (2012) highlighting the importance of collaboration and critical thinking, while Voogt et al. (2013) emphasized real-world applications and peer interaction for skill development. In the Philippine context, Bernardo et al. (2020) found that teamwork and problem-solving activities significantly improved student engagement, reinforcing the necessity of revising Activities 1 and 2. Additionally, Dede (2010) advocated for the use of technology, such as simulations and

collaborative platforms, to enhance participation and communication, which could help address the "Poor" ratings in Skilled Communication

Following the evaluation done by the evaluators, the following changes are done to enhance the activities.

Table 2 Enhancement of Activity 1:" Plotting PAR"

Before	Comments and Suggestion	Action Taken
Activity 1 **Plotting the PAR** **Objectives:** After performing this activity, you should be able to: 1. read map, 2. given the latitude and longitude of a tropical cyclone, tell if it has entered the Philippine Area of Responsibility, and 3. explain what is meant when a typhoon has entered the Philippine Area of Responsibility. **Materials Needed:** map of the Philippines and vicinity pencil **Procedure:** 1. Plot the following points on the map below (Figure 2). Points / Latitude, Longitude a. 5°N, 115°E b. 15°N, 115°E c. 21°N, 120°E d. 25°N, 120°E e. 25°N, 135°E f. 5°N, 135°E Q3. Where did Sendong form? Q4. When did Sendong enter the PAR? Q5. When did Sendong leave the PAR? Q6. In what direction did Sendong move?  Figure 2. Map of the Philippines and vicinity	**COLLABORATION** ¬ "It is not indicated in the instructions for the activity whether it should be done in groups or individually." (E1) "It is much needed to be clear enough if it is an activity by (individual, dyad or triad)." (E2) **KNOWLEDGE CONSTRUCTIONS** "Add HOTS questions" (E4) **SKILLED COMMUNICATIONS** "Allow them to report or present their results. The class to improve communication skills" (E3) "Encourage group discussion after the activity to allow students to share their results and findings" (E4) " Used colour Philippine Map "(E2)	

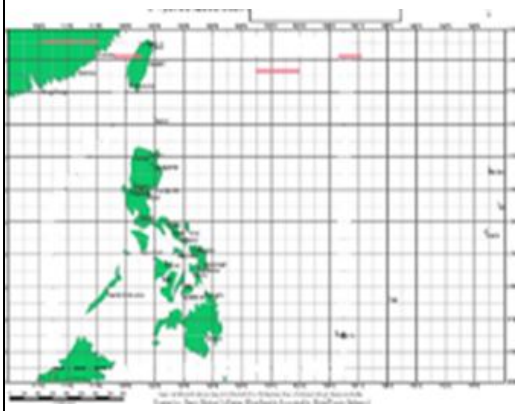
		Part 2: Analyze the Typhoon within the PAR Use the coordinates below to determine if the typhoon is inside or outside the PAR: Typhoon Location / Latitude / Longitude Typhoon A / 13°N / 130°E Typhoon B / 16°N / 118°E Answer the following questions. 1. Is Typhoon A within the PAR? If yes Why? 2. Is Typhoon B within the PAR? If yes, why? 3. Based on your plotted points. Predict the potential path of Typhoon B based on its location near the PAR. What actions should be taken if it enters the PAR? 3. The 2 presenters will give 3 minutes to present the output and report their answers to the questions given. 

Table 2 highlights suggestions to improve Activity 1: "Plotting PAR" by focusing on collaboration, knowledge building, and communication skills. Reviewers pointed out that the instructions do not clearly state whether the activity should be done individually or in groups, which could cause confusion. Evaluators also recommended adding higher-order thinking questions to encourage deeper learning. To enhance communication skills, they suggested allowing students to present their results and discuss their findings with classmates. Additionally, using a colored Philippine map was advised to make the activity more visually engaging. These improvements aim to make the activity clearer, more interactive, and more effective for students.

Table 3 Enhancement of Activity 2 “Tracking Typhoon”

Before	**Comments and suggestions**	**Action Taken**
Activity 2 **Tracking a tropical cyclone** **Objectives:** After performing this activity, you should be able to: 1. determine if your location is in the path of a tropical cyclone, given the latitude and longitude position and 2. explain why PAGASA regularly monitors when a tropical cyclone is within PAR. **Materials Needed:** map with the PAR (from Activity 1) tracking data pencil	**General Remarks:** “It would be nice to have an interactive ONLINE map tool. This would allows students to visually see and locate typhoon positions”. (E4)	

Questions:

1. Where did tropical storm Sendong start to form?
2. When did tropical storm Sendong enter the PAR?
3. When did tropical storm Sendong leave the PAR?
4. In what direction did tropical storm Sendong move?

Procedure:

1. Use the latitude and longitude (lat-long) in the table below to track the location of Sendong. Plot each lat-long pair on the map with the PAR.

Date: 13-19 DEC 2011
Tropical Storm Sendong (International name: Washi)

Month/Day/Time	Latitude (°N)	Longitude (°E)
12/13/06	6.00	145.10
12/13/12	6.40	143.30
12/14/18	6.00	141.70
12/14/00	5.90	140.60
12/14/06	6.20	139.00
12/14/12	6.70	137.70
12/14/18	7.00	136.30
12/15/00	7.20	134.30
12/15/06	7.60	132.30
12/15/12	7.70	130.80
12/15/18	7.50	129.10
12/16/00	7.40	128.10
12/16/06	8.00	126.80
12/16/12	8.40	125.50
12/16/18	8.50	123.80
12/17/00	9.10	122.40
12/17/06	9.20	121.50

2. Connect the plotted points. The region within is the Philippine Area of Responsibility or PAR. It is the job of PAGASA to monitor all tropical cyclones that enter this area.

Q1. If a typhoon is located at 15°N, 138°E, is it within the PAR?

Q2. How about if the typhoon is at 19°N, 117°E, is it inside the PAR?

COLLABORATION

"It is not indicated in the instructions for the activity whether it should be done in groups or individually." (E1)

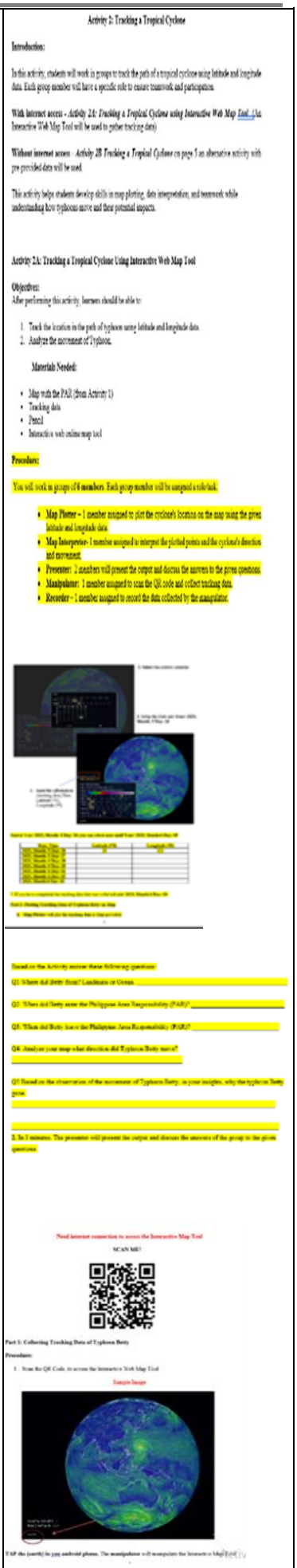
"Students could collaborate by sharing tasks like plotting points, interpreting results, or discussing their location relative to the cyclone's path." (E2)

KNOWLEDGE CONSTRUCTION

"The activity primarily focuses on applying knowledge (reading latitude and longitude) and practicing technical skills (plotting). While Useful, this does not constitute deep knowledge construction, as students are not required to generate new ideas or insights. To enhance this, the activity could ask students to analyze the path and predict**"** (E2)

SKILLED COMMUNICATION

"The activity doesn't explicitly require students to communicate their findings in a sophisticated way. If students only plot points and answer questions in written form, the communication is fairly basic." I suggest to question to analyze the potential path of typhoon (E2)



Activity 2: Tracking a Tropical Cyclone

Introduction:

In this activity, students will work in groups to track the path of a tropical cyclone using latitude and longitude data. Each group member will have a specific role to ensure teamwork and participation.

With internet access - *Activity 2A: Tracking a Tropical Cyclone using Interactive Web Map Tool* (An Interactive Web Map Tool will be used to gather tracking data)

Without internet access - *Activity 2B Tracking a Tropical Cyclone* on page 5 an alternative activity with pre-provided data will be used.

This activity helps students develop skills in map plotting, data interpretation, and teamwork while understanding how typhoons move and their potential impacts.

Activity 2A: Tracking a Tropical Cyclone Using Interactive Web Map Tool

Objectives:
After performing this activity, learners should be able to:

1. Track the location in the path of typhoon using latitude and longitude data.
2. Analyze the movement of Typhoon.

Materials Needed:

- Map with the PAR (from Activity 1)
- Tracking data
- Pencil
- Interactive web online map tool

Procedure:

You will work in groups of 6 members. Each group member will be assigned a role/task.

- Map Plotter - 1 member assigned to plot the cyclone's location on the map using the given latitude and longitude data.
- Map Interpreter- 1 member assigned to interpret the plotted points and the cyclone's direction and movement.
- Presenter: 2 members will present the output and discuss the answers to the given questions.
- Manipulator: 1 member assigned to scan the QR code and collect tracking data.
- Recorder - 1 member assigned to record the data collected by the manipulator.

Based on the Activity answer these following questions:

Q1. Where did Betty from? Landmass or Ocean

Q2. When did Betty enter the Philippine Area Responsibility (PAR)?

Q3. When did Betty leave the Philippine Area Responsibility (PAR)?

Q4. Analyze your map what direction did Typhoon Betty move?

Q5 Based on the observation of the movement of Typhoon Betty, in your insights, why the typhoon Betty goes

2. In 3 minutes. The presenter will present the output and discuss the answers of the group to the given questions

Need internet connection to access the Interactive Map Tool

SCAN ME!

Part 1: Collecting Tracking Data of Typhoon Betty

Procedure:

1. Scan the QR Code, to access the Interactive Web Map Tool

Sample Image

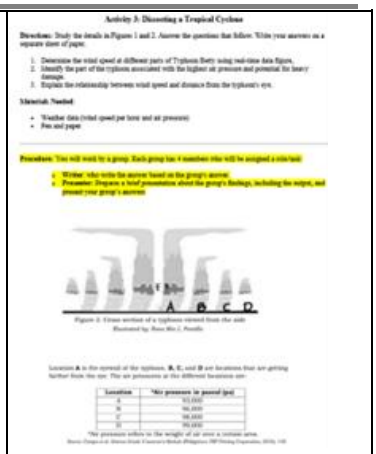
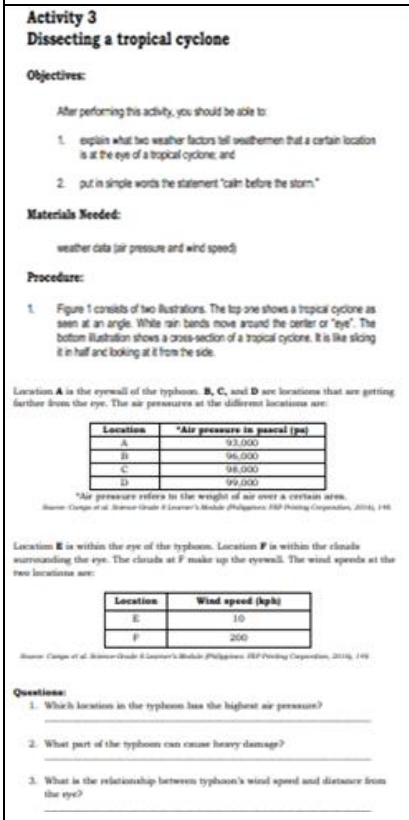
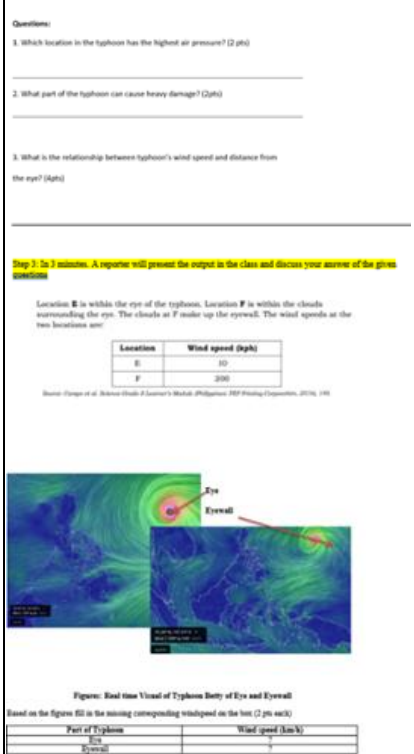
		

Table 3 outlines suggested improvements for Activity 2: "Tracking Typhoon," focusing on making the activity more interactive, collaborative, and engaging. One key suggestion was to incorporate an interactive online map tool to help students visually track and locate typhoon positions. In terms of collaboration, reviewers noted that the instructions do not specify whether students should work individually or in groups. They suggested allowing students to share tasks such as plotting points, interpreting data, and discussing locations relative to the typhoon's path.

For knowledge construction, it was pointed out that while the activity helps students practice technical skills like reading latitude and longitude, it does not encourage deeper learning. To address this, it was recommended that students analyze the typhoon's path and make predictions. Lastly, in skilled communication, the activity mainly involves written responses, limiting students' ability to express their findings in a meaningful way. A suggestion was made to include questions that encourage students to analyze and discuss the potential path of the typhoon. These enhancements aim to make the activity more interactive, thought-provoking, and communicative.

Table 4 Enhancement of Activity 3 "Dissecting Typhoon"

Before	**Comments and Suggestion**	**Action Taken**
	**COLLABORATION** *"It is not indicated in the instructions for the activity whether it should be done in groups or individually."* (E1*).* "*Students could divide tasks such as analyzing different aspects of the tropical cyclone (air pressure, wind speed) and then come together to share findings."* (E2*)* *Encourage students to work together and share their ideas and insights*" (E4). "*Assign roles to each of the group members*." (E3)	

	SKILLED COMMUNICATION "*Communication could be enhanced if students are asked to present their findings to the class, write a report, or simulate a weather briefing where they explain these phenomena to a general audience. This would allow them to demonstrate their understanding while practicing clear and structured communication*"(E3)	

Table 4 presents suggestions for improving Activity 3: "Dissecting Typhoon", with a focus on enhancing visual aids, collaboration, and communication skills. One general recommendation was to add visual aids or colored images to make the activity more engaging and easier to understand.

For collaboration, reviewers noted that the instructions do not specify whether the activity should be done individually or in groups. They suggested that students could divide tasks, such as analyzing different aspects of a tropical cyclone (e.g. wind speed), and then share their findings. Encouraging teamwork and assigning specific roles to each group member were also recommended to improve participation and efficiency.

In terms of skilled communication, reviewers suggested that students should present their findings, write reports, or simulate a weather briefing to explain their observations. This approach would help students develop their ability to communicate complex scientific concepts clearly and effectively. These enhancements aim to make the activity more interactive, structured, and engaging for students.

Evaluation from In-service Teachers

Table 5 Mean Ratings of the Enhanced Activities

Activities	**21st Century Skills Employed**	**Mean**	**Descriptor**
Activity 1 "Plotting the Philippine Area of Responsibility (PAR)"	Collaboration	5.00	Excellent
	Knowledge Construction	4.20	Excellent
	Skilled Communication	3.60	Very Good
Activity 2 "Tracking a Tropical Cyclone"	Collaboration	4.60	Excellent
	Knowledge Construction	4.40	Excellent
	Skilled Communication	3.60	Very Good
Activity 3 "Dissecting a Tropical Cyclone"	Collaboration	4.60	Excellent
	Knowledge Construction	4.20	Excellent
	Skilled Communication	3.60	Very Good

Note: Mean Rating Descriptor for Collaboration and Knowledge Construction 4.20 – 5.00 Excellent, 3.40 – 4.19 Very Good, 1.80 – 2.59 Needs Improvement 1.00 – 1.79 Poor. **Mean Rating Descriptor for Skilled Communication** 3.25 – 4.00 Very Good 2.50 – 3.24 Good, 1.75 – 2.49 Needs Improvement 1.00 – 1.74 Poor

Table 4.5 shows the results of the mean ratings for the enhanced activities demonstrated a high level of

effectiveness in fostering key 21st-century skills, including Collaboration, Knowledge Construction, and Skilled Communication. Each activity received "Excellent" ratings for Collaboration and Knowledge Construction, indicating that these skills were well-developed through the activities, with no changes needed in these areas. Skilled Communication, while rated slightly lower at "Very Good" across all activities, still met the retention criteria, suggesting that communication skills were effectively addressed but could have benefitted from minor enhancements. Overall, the consistently high ratings across these skills confirmed that the enhanced activities successfully engaged students in valuable skill-building, with all components meeting or exceeding the standards for retention.

The enhanced activities fostered "Excellent" ratings across the (21CLD) skill dimensions by incorporating structured collaboration, deeper knowledge construction, and improved communication strategies. A specific example of an improved skill is Collaboration. Initially, the activities lacked clear group-based instructions, leading to poor engagement. The enhancements introduced group tasks, role assignments, and peer discussions, allowing students to take shared responsibility in tracking typhoons. As a result, Activity 1, "Plotting the Philippine Area of Responsibility (PAR)," saw a significant improvement, increasing its Collaboration rating from "Poor" (1.17) to "Excellent" (5.00).

Similarly, Skilled Communication improved through the addition of presentation tasks and structured discussions, where students were required to explain their findings. This enhancement increased communication ratings from "Poor" to "Very Good" (3.60) across all activities, ensuring that students could effectively articulate their analyses of typhoon movements. Overall, these refinements created a more interactive, student-centered learning experience, aligning with the goals of STEM education and Sustainable Development Goals (SDG 4 and SDG 13).

Learners are also required to produce extended communication and required to provide supporting evidence (Microsoft Partners in Learning, 2012). This means that the enhancement done on the original activities from the DepEd Grade 8 Science Module on Tracking Typhoon will help students improve and attain the required 21st Century skills and performance in science (Barquilla and Cabili, 2019). As reiterated by Koşer (2022), students' potential will be developed as their skills develop, allowing them to be better prepared for school and social life. Likewise, future life skills are viewed as an important factor that contributes to students' academic success. Enhanced activities will also help them improve their conceptual on the topic.

Evaluation Result from Pre Service Teacher

Table 6 Evaluation Result from Pre Service Teachers

Criteria	**Activity 1**		**Activity 2**		**Activity 3**	
A. Instructional Design and Organization	**Mean**	**Description**	**Mean**	**Description**	**Mean**	**Description**
1. Learning objectives are anchored on the MELCs.	5.00	E	4.81	E	4.60	E
2. Learning objectives are appropriate sub tasked for the lesson.	4.48	E	4.42	E	4.55	E
3. The learning activity provides an appropriate introduction on what learners are expected to do and learn in the lesson.	4.51	E	4.42	E	4.31	E
4. The learning activity provides an activity, task or complementary material	4.71	E	4.54	E	4.60	E

that will enhance the learners' understanding of concepts.						
5. Questions allow for development of higher order thinking skills.	4.77	E	4.68	E	4.77	E
6. The directions are clear and concise.	4.65	E	4.62	E	4.57	E
7. The directions for the activity are simple and guides learners understanding.	4.65	E	4.51	E	4.60	E
OVERALL MEAN RATING	**4.68**	**E**	**4.57**	**E**	**4.57**	**E**

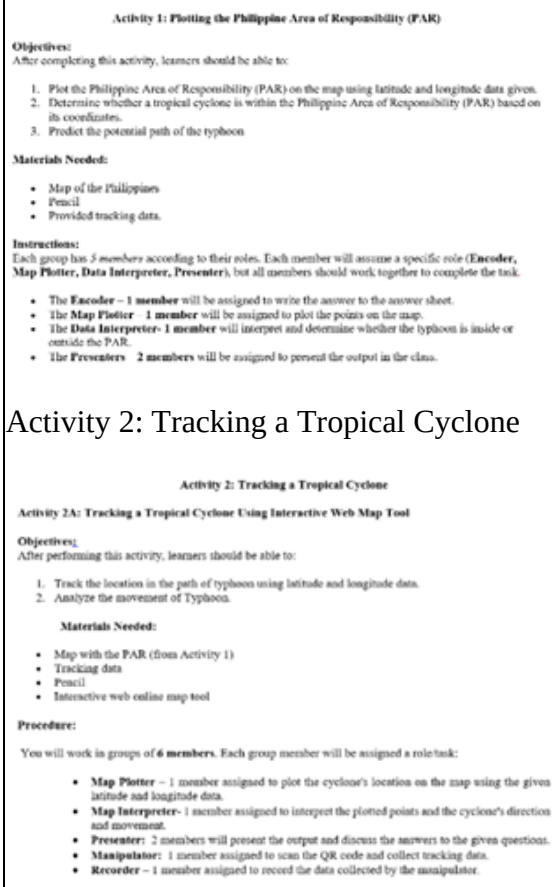
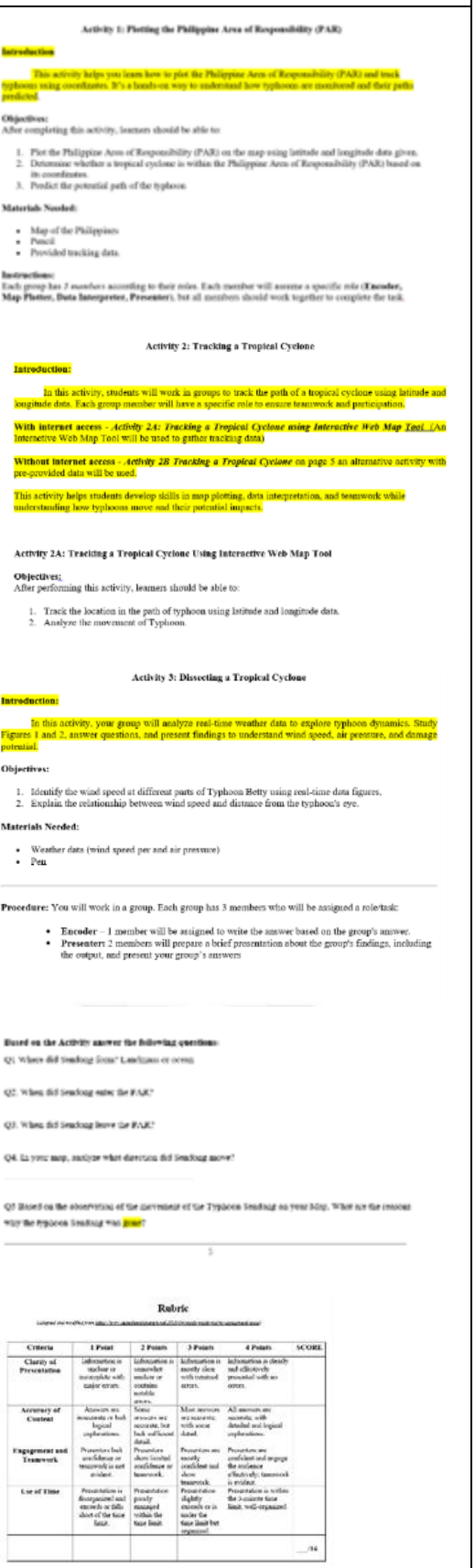
Criteria	**Activity 1**		**Activity 2**		**Activity 3**	
B. Language/ Content/ Format	**Mean**	**Description**	**Mean**	**Description**	**Mean**	**Description**
1. The learning activity uses vocabulary that are within learners' understanding.	4.65	E	4.48	VS	4.61	E
2. The length and structure of sentences are appropriate to the learners.	4.71	E	4.71	E	4.65	E
3. The learning activity is free from grammatical, factual and computational errors.	4.65	E	4.54	E	4.60	E
4. The learning activity is free from violation of social content guidelines	4.85	E	4.85	E	4.88	E
OVERALL MEAN RATING	**4.72**	**E**	**4.65**	**E**	**4.69**	**E**

Note. 4.20-5.00 – Excellent (E) 3.40-4.19- Very Good (VG) 2.60-3.39- Good (G) 1.80 -2.59- Needs Improvement (NI)1.00-1.79- Poor (P)

The evaluation results from pre-service teachers indicate that the learning activities were highly effective, receiving predominantly Excellent (E) ratings across Instructional Design and Organization and Language/Content/Format criteria, with overall mean scores ranging from 4.57 to 4.72. The highest ratings were given to the alignment with MELCs (5.00) and adherence to social content guidelines (4.88), while one criterion under language received a Very Good (VG) rating (4.48). These findings align with Shulman (1987) and Anderson & Krathwohl (2001), who emphasize that well-structured instructional materials enhance student learning and cognitive development. Research by Voogt & Roblin (2013) and Laurel (2022) supports the role of clear instructional design in fostering engagement and comprehension. The results suggest that the materials can be effectively implemented in classroom settings, reinforcing their practicality and relevance while highlighting the importance of continuous validation to ensure their adaptability to diverse learning needs.

Revision II

Table 7 Pre service Teachers' Comments and Suggestions

Before	Comments	Action Taken
Activity1 1: Plotting the Philippine Area of Responsibility (PAR)  **Activity 1: Plotting the Philippine Area of Responsibility (PAR)** **Objectives:** After completing this activity, learners should be able to: 1. Plot the Philippine Area of Responsibility (PAR) on the map using latitude and longitude data given. 2. Determine whether a tropical cyclone is within the Philippine Area of Responsibility (PAR) based on its coordinates. 3. Predict the potential path of the typhoon **Materials Needed:** • Map of the Philippines • Pencil • Provided tracking data. **Instructions:** Each group has *5 members* according to their roles. Each member will assume a specific role (**Encoder, Map Plotter, Data Interpreter, Presenter**), but all members should work together to complete the task. • The **Encoder – 1 member** will be assigned to write the answer to the answer sheet. • The **Map Plotter – 1 member** will be assigned to plot the points on the map. • The **Data Interpreter- 1 member** will interpret and determine whether the typhoon is inside or outside the PAR. • The **Presenters – 2 members** will be assigned to present the output in the class. Activity 2: Tracking a Tropical Cyclone **Activity 2: Tracking a Tropical Cyclone** **Activity 2A: Tracking a Tropical Cyclone Using Interactive Web Map Tool** **Objectives:** After performing this activity, learners should be able to: 1. Track the location in the path of typhoon using latitude and longitude data. 2. Analyze the movement of Typhoon. **Materials Needed:** • Map with the PAR (from Activity 1) • Tracking data • Pencil • Interactive web online map tool **Procedure:** You will work in groups of **6 members**. Each group member will be assigned a role/task: • **Map Plotter** – 1 member assigned to plot the cyclone's location on the map using the given latitude and longitude data. • **Map Interpreter**- 1 member assigned to interpret the plotted points and the cyclone's direction and movement. • **Presenter:** 2 members will present the output and discuss the answers to the given questions. • **Manipulator:** 1 member assigned to scan the QR code and collect tracking data. • **Recorder** – 1 member assigned to record the data collected by the manipulator. Activity 3: Dissecting a Tropical Cyclone **Activity 3: Dissecting a Tropical Cyclone** **Objectives:** 1. Identify the wind speed at different parts of Typhoon Betty using real-time data figures, 2. Explain the relationship between wind speed and distance from the typhoon's eye. **Materials Needed:** • Weather data (wind speed per and air pressure) • Pen **Procedure:** You will work in a group. Each group has 3 members who will be assigned a role/task: • **Encoder** – 1 member will be assigned to write the answer based on the group's answer. • **Presenter:** 2 members will prepare a brief presentation about the group's findings, including the output, and present your group's answers **Based on the Activity answer the following questions:** Q1 Where did Sendong form? Landmass or ocean Q2. When did Sendong enter the PAR? Q3. When did Sendong leave the PAR? Q4. In your map, analyze what direction did Sendong move? Q5 Based on the observation of the movement of the Typhoon Sendong on your Map. What are the reasons why the typhoon Sendong was dissipate? 5	"There is no Introduction in each activities."(P3) "Make an introduction of the activity."(P16) "Change the word dissipate. Make it simple word to easily understands" (P35), (P17) "Must have rubric of each activity" (P1), (P4),(P19),(P29) "There are no rubrics" (P32)	 **Activity 1: Plotting the Philippine Area of Responsibility (PAR)** **Introduction** This activity helps you learn how to plot the Philippine Area of Responsibility (PAR) and track typhoons using coordinates. It's a hands-on way to understand how typhoons are monitored and their paths predicted. **Objectives:** After completing this activity, learners should be able to: 1. Plot the Philippine Area of Responsibility (PAR) on the map using latitude and longitude data given. 2. Determine whether a tropical cyclone is within the Philippine Area of Responsibility (PAR) based on its coordinates. 3. Predict the potential path of the typhoon. **Materials Needed:** • Map of the Philippines • Pencil • Provided tracking data. **Instructions:** Each group has *5 members* according to their roles. Each member will assume a specific role (**Encoder, Map Plotter, Data Interpreter, Presenter**), but all members should work together to complete the task. **Activity 2: Tracking a Tropical Cyclone** **Introduction:** In this activity, students will work in groups to track the path of a tropical cyclone using latitude and longitude data. Each group member will have a specific role to ensure teamwork and participation. **With internet access** - ***Activity 2A: Tracking a Tropical Cyclone using Interactive Web Map Tool*** (An Interactive Web Map Tool will be used to gather tracking data) **Without internet access** - ***Activity 2B Tracking a Tropical Cyclone*** on page 5 an alternative activity with pre-provided data will be used. This activity helps students develop skills in map plotting, data interpretation, and teamwork while understanding how typhoons move and their potential impacts. **Activity 2A: Tracking a Tropical Cyclone Using Interactive Web Map Tool** **Objectives:** After performing this activity, learners should be able to: 1. Track the location in the path of typhoon using latitude and longitude data. 2. Analyze the movement of Typhoon. **Activity 3: Dissecting a Tropical Cyclone** **Introduction:** In this activity, your group will analyze real-time weather data to explore typhoon dynamics. Study Figures 1 and 2, answer questions, and present findings to understand wind speed, air pressure, and damage potential. **Objectives:** 1. Identify the wind speed at different parts of Typhoon Betty using real-time data figures, 2. Explain the relationship between wind speed and distance from the typhoon's eye. **Materials Needed:** • Weather data (wind speed per and air pressure) • Pen **Procedure:** You will work in a group. Each group has 3 members who will be assigned a role/task: • **Encoder** – 1 member will be assigned to write the answer based on the group's answer. • **Presenter:** 2 members will prepare a brief presentation about the group's findings, including the output, and present your group's answers **Based on the Activity answer the following questions:** Q1 Where did Sendong form? Landmass or ocean Q2. When did Sendong enter the PAR? Q3. When did Sendong leave the PAR? Q4. In your map, analyze what direction did Sendong move? Q5 Based on the observation of the movement of the Typhoon Sendong on your Map. What are the reasons why the typhoon Sendong was dissipate? 5 **Rubric** (adapted and modified from http://www.teachnology.com/tutorials/teaching/rubrics/) Criteria / 1 Point / 2 Points / 3 Points / 4 Points / SCORE Clarity of Presentation / Information is unclear or incomplete with major errors. / Information is somewhat unclear or contains notable errors. / Information is mostly clear with minimal errors. / Information is clearly and effectively presented with no errors. Accuracy of Content / Answers are inconsistent or lack logical explanations. / Some answers are accurate, but lack sufficient detail. / Most answers are accurate, with some detail. / All answers are accurate, with detailed and logical explanations. Engagement and Teamwork / Presenters lack confidence or teamwork is not evident. / Presenters show limited confidence or teamwork. / Presenters are mostly confident and show teamwork. / Presenters are confident and engage the audience effectively; teamwork is evident. Use of Time / Presentation is disorganized and exceeds or falls short of the time limit. / Presentation poorly managed within the time limit. / Presentation slightly exceeds or is under the time limit but organized. / Presentation is within the 3-minute time limit, well-organized. __/16

Note: The actions taken are the highlighted in yellow

Table 7 shows the outlines the revisions made to the activities based on pre-service teachers' comments and suggestions. The main feedback center on the absence of an introduction for each activity, prompting the addition of introductory sections to Activity 1 (Plotting the Philippine Area of Responsibility), Activity 2 (Tracking a Tropical Cyclone), and Activity 3 (Dissecting a Tropical Cyclone). Another suggestion was to simplify the word "dissipate" to enhance clarity. In Activity 2, the term "dissipate" was replaced with "gone" on Page 5 to make the content easier to understand and better suited for learners. Additionally, several comments pointed out the lack of rubrics for the activities, leading to the inclusion of rubrics for each activity to clarify evaluation criteria and expectations. These revisions aimed to improve the clarity and comprehensibility of the activities, ensuring they better meet the needs of the learners.

CONCLUSION

This study shows how improving Earth Science activities, especially on tracking typhoons, using the 21st Century Learning Design (21CLD) Rubric can make a big difference. By enhancing the activities, Grade 8 students were able to build important skills like teamwork, critical thinking, and communication. These new activities included interactive tools, group tasks, and chances for students to share their findings, which connects to Sustainable Development Goal 4—ensuring quality education for everyone. The changes not only fixed problems in the original activities but also helped students understand science better and prepare for real-life challenges.

The study also connects to SDG 13 because it focuses on teaching students about typhoons and disaster preparedness. By using modern teaching methods and technology, the research highlights the importance of making learning more engaging and practical. This approach helps students work together, solve problems, and think critically about climate-related issues. It not only improves their understanding of Earth Science but also prepares them to take action in their communities to address climate challenges. In the end, this work provides a simple yet effective way to improve science education in the Philippines, supporting global goals for better education and climate action while helping students face the future with confidence.

The findings of this study may further extended to other Earth Science topics, such as climate change, geological hazards (e.g., earthquakes and volcanic eruptions), and oceanographic phenomena (e.g., El Niño and La Niña), where real-time data analysis and collaborative learning are equally valuable. Future research could explore how integrating 21st Century Learning Design (21CLD) principles with emerging technologies like AI-driven simulations or virtual reality enhances student engagement and conceptual understanding.

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