Improvised early flood warning device as a learning material in teaching student’s preparedness for disaster risk management

Wilcon M. Erediano¹, Santiago E. Luna ², Amelia T. Buan, ², Rizalina G. Gomez ² Elesar V. Malicoban ²

¹Department of Science and Mathematics, Mercy Junior College, Tubod Lanao del Norte, 9209, Philippines
²Mindanao State University- Iligan Institute of Technology, Iligan City 9200, Philippines

Corresponding authors’ e-mail address: wilcon.erediano@g.msuit.edu.ph, santiago.luna@g.msuit.edu.ph, amelia.buan@g.msuit.edu.ph, rizalina.gomez@g.msuit.edu.ph, elesar.malicoban@g.msuit.edu.ph

Abstract. This study is an assessment and utilization of improvised warning device in developing students’ preparedness on disaster risk management. The study aimed to examine the performance of the respondents through learning activities. The improvised warning device was fully functional as rated by the experts. A sample of 36 Grade 8 students with 15 male and 21 females was used in this study. Working in teams, students make decision and share information about typhoon behavior and preparedness for disaster risk management. Results showed that the students developed their preparedness on disaster risk management, analysed behaviour of typhoons and potential risk and understand weather pattern. Thus, students learned to measure rainfall using the improvised warning device. Students also have learned the use of the device as all groups had shown exemplary performance. The students perceived that the activities made them become knowledgeable of disaster risk management. Based on the results of the study, the researcher recommends utilizing the improvised warning device in laboratory activity in teaching Typhoon: Awareness and Preparation

1. Introduction

For an effective teaching and a more concrete process, a school must provide not only discussion input but also the equipment for the laboratory activities that are aligned to the K-12 curriculum. However, classrooms of most public schools lack these materials to promote hands-on learning in science. As a result, the learners only grasp the procedural knowledge but not the experience. The use of improvised materials has been a great help to the teacher in making science concepts comprehensible to students. This pertains to the use of alternative materials producing a device to facilitate learning whenever the lack of standard materials and teaching aid come along the way. This study is guided with the questions on the functionality of the improvised warning device, ratings and recommendations of the experts, utilization of the improvised warning device as a learning material and the perceptions of the students on the use of improvised warning device in laboratory activities. This is limited to the improvised rain gauge instrument as an early flood warning device and is defined in implementing it as a learning material in developing students’ preparedness and disaster risk management for students in Lanao del Norte National Comprehensive High School located in Baroy, Lanao del Norte.

Active learning is perceived as a radical change from traditional instruction which refers to the robust research finding that learning is more durable and lasting when students are cognitively engaged in the learning process [4]. Active learning increases examination performance [3]. Active learning...
classrooms promote students’ academic engagement and learning outcomes [5], [6], [7]. Controlling for all relevant demographic and aptitude related variables, the active learning classroom improved students’ engagement in the learning process. It manifests the students’ potentiality to outperform final grade expectations, resulting in improved learning outcomes; and affects teaching-learning activities even when the instructor attempted to hold these activities constant.

The act of improvising and building a device from unusual components in an ad-hoc fashion is termed as Improvisation. This is the use of alternative materials to produce a device to facilitate learning whenever there is a lack of standard materials and teaching aids to support learning. The use of improvised materials has been a great help to teacher to make science concepts comprehensible to students [1], [8], [9]. Improvised instructional materials enlivened and brought about competitiveness to students to learn as stimulated. This provides total involvement, enthusiasm, excitement and enjoyment of the lesson. Utilization of improvised instructional material improves students’ achievement and enhances students’ cognitive, psychomotor and affective domain. Improvised material as a teaching aid in a science class supplements teachers’ oral explanation with students’ visible experiences. It enables students to actively involve intellectually, physically and perceptually in the learning process. Concrete experience helps them developed their intellect showing variation of students’ performance due to the use improvised material [2], [10].

2. Research Design

This is a descriptive research which determines the functionality of the improvised warning device in determining the development of students’ preparedness on disaster risk management. This study also includes qualitative data in utilizing the improvised warning device in science classroom which were obtained from the respondents using questionnaires. Quantitative data, on the other hand, were obtained from the results in testing the functionality of the warning device.

2.1 Subjects and Locale of the Study

This study was conducted in one of the public high schools in Lanao del Norte. There were 36 student respondents enrolled during S.Y. 2016-2017 selected through purposive sampling.

2.2 Data Gathering Procedure

The procedure of gathering data consisted of: a) Construction of the improvised warning device; b) Testing the device’s functionalities; c) Experts’ evaluation of the device; d) Development of learning activity and; e) Implementation phase. Results have shown that the improvised warning device was efficient and effective during the test on the actual scenario and the implementation period. Each component; rainfall measuring component, alarm system, and power supply system were tested and rated as fully functional by the experts. The improvised warning device was utilized as a learning material by the respondents. It helps students to developed preparedness and disaster risk management in their laboratory activity allowing them to have hands-on experience with the device. The improvised warning device was adapted from the rain gauge commercially found online. The researchers improvised the device that is capable to compete with the available rain gauge in the market when it comes to its basic functions as well as on its economic significance. The researchers added some features like semi-automated water level sensor in the inner measuring tube, water-level light indicators, sound alarm, and power supply system comprised with 12V rechargeable battery and solar panel with the aid of the charge controller.

All parts of the rain gauge were adapted from the 8-inch non-recording standard rain gauge. The alarm system was constructed with the help of the experts. An electrical circuit was designed as reference. It consisted three main parts namely: water level sensors, water-level light indicators and, sound alarm. The power supply system consisted also three main parts and these are solar panel, solar charge controller and rechargeable battery. The system was planned by the researchers to be not dependent on the commercial electric power supply and become available all the time especially during catastrophe when power outage is highly possible. To evaluate all components of the improvised device, the researchers made a rating scale. The device’s components made as categories in the scale were divided into three main groups: rainfall measurement, alarm system and power supply system. Also, there were descriptions provided that corresponds to the degree of choice of the evaluator. After the initial testing of the device, revision of the design, as well as its evaluation from experts a test on actual scenario was conducted.
For a day, the rain gauge was mounted on field with several considerations like surrounding vegetation or establishments. The researchers recorded amount of rainfall/precipitation as well the response of the alarm system and the condition of the power supply system. Laboratory activity, user manual, and assessment tools, constructed and used by the researchers during the implementation phase went through critiquing and evaluating process by the science experts. In choosing the Content Standard; it was the targeted K to 12 Curriculum with a learning competency: “Demonstrate understanding of formations of typhoon”. Activities included in the designed laboratory activity were based on already-existing similar topics. These were adapted and compiled to come up with a laboratory activity which fits the topic. All instructions needed for the operation of the improvised were stated in the manual such as system setup and operating the system. Also, safety tips before, during and after were provided in the manual. Aside from these, the rationale of the study was given as an introductory part of the manual. Assessment were created to guide the researchers as they rate performances of the students like behaviour during the implementation phase. Also, these tools are used to know the perception of the students towards the activities provided by the researchers. Some assessment tools made were rubrics and rating scale with corresponding interpretation on the results after being tallied. The instructional materials and the device were prepared ahead the implementation phase. On the first day, the researchers gave a lesson discussion. On the second day, the discussion continued and the device with its parts, functionalities and manual was also introduced to the students. On the third day, group activity was conducted where the students had themselves grouped and each member was given a task. After the group activity, learning log, self-assessment and peer assessment were given to the students to be answered.

3. Findings and Interpretations

The improvised warning device (see figure 1a) has three main parts. (1) Rainfall Measuring Component measures the rainfall that the device receives. The inner measuring tube can hold up to 2.5 inches of water measurement or approximately 103 cubic inches of water. When water level reaches more than that level, the overflow can receives spilled water which can contain water volume at approximately 19,302 cubic inches of water. (2) Alarm system water level sensors, water-level light indicators and buzzer. Water level sensors are placed inside the inner measuring tube. As water reaches each level of the sensors, it triggers the light indicators to light up. (3) Power supply system is composed of 10w/12v solar panel, 12v7.2Ah GLA Rechargeable battery and solar charge controller. All measurements specified by the researchers were met. Also, water level in the measuring tube can be monitored easily using simple circuit.

As shown in figure 1b, the overall circuit diagram shows different parts of the device like transistors, LEDs, buzzer and resistors. From the designed electrical circuit, 5 wires were placed inside the tube. Four of these wires were for the sensors. 330 ohms resistors were used to limit the current that goes into the loads. The wire from the base of the transistor was placed at the level to be indicated. Five more other circuits were connected in the actual device that indicated additional loads. Each wire indicated the following levels: 7.5 mm, 10 mm, 15 mm, 16 mm, 25 mm, 30 mm, 31 mm 32 mm and 34 mm.

![Figure 1a. Actual Improvised Warning Device](image-url)

![Figure 1b. Overall Electrical Diagram](image-url)
This initial test was conducted to test if the two different containers, container 1 and 2, placed near the rain gauge during rain. Based on the data gathered, the improvised warning device yielded similar results with the two different containers. The first container collected 286.5 cm$^3$ volume of water. The second container had 287 cm$^3$ volume of water. Similarly, the rain gauge also collected 286 cm$^3$ volume of water in its overflow can. The depth of the water collected was measured using a ruler which resulted into data of 0.90 cm approximately for all three containers. A very small amount of differences have been recorded. From the overflow can, water from each container was individually poured into the inner measuring tube to test whether the measuring tube records the same data with the overflow can. All containers had the same data for the volume of water which is 286, approximately. After computing the volume in the measuring tube, the depth was also recorded using a calibrated dipstick which gathered figures 12, 12.5 and 12 for the three containers. The discrepancy of figures was accounted for the pouring/transferring of water from one container to another. Also, rounding off of figures has been done. From these data, the rain gauge had the same amount rainfall collection as with the two other container.

### Table 1. Test of Rainfall Measurement Accuracy

| Container No. | Volume of Water in Overflow can (cm$^3$) | Water Level Measurement (cm) | Volume of water in Measuring tube (cm$^3$) | Calibrated Water Level Measurement (mm) |
|---------------|-----------------------------------------|------------------------------|-------------------------------------------|----------------------------------------|
| 1             | 286.5                                   | 0.90                         | 286                                       | 12                                     |
| 2             | 287                                     | 0.90                         | 286                                       | 12.5                                   |
| Rain Gauge    | 286                                     | 0.90                         | 286                                       | 12                                     |

Researchers had a 1-day data recording. As shown in table 2, the 24-hour precipitation of the day was recorded along with the response of the alarm system on the precipitation level and the capacity of power supply system during the test, the solar panel, solar charge controller and battery worked well. These components were mounted on ideal locations in the testing site. Conditions like exposure of solar panel to sunlight and appropriate temperature for the battery and solar charge controller were considered during the test. The device collected a total of 12.5 mm of water from the rain which started at about 5 in the afternoon up to 10 in the evening. The water level triggered up to the second yellow LED. However, the amount of precipitation collected during the test on actual scenario was not significant enough to trigger sensors to light up all LEDs including the buzzer.

### Table 2. Actual Precipitation Measurement Test

| Rain Category/Remarks | Color of the LED indicated | Precipitation Level (mm) |
|-----------------------|----------------------------|--------------------------|
|                       |                            | 8 AM-5 PM | 5 PM-8 AM | Total |
| Measurement           | Yellow                     | 0         | 12.5      | 12.5  |

Furthermore, the researchers carefully simulated rainfall measurement to support the data. The simulation was done in a controlled environment where conditions like wind disturbance and vegetation within an area were eliminated.

### Table 3. Simulated Precipitation Measurement Test

| No. Of Trial | LED Color indicated | Sound Alarm | Prepared Water Volume (Graduated Cylinder) | Rain Gauge Measurement (using calibrated dipstick) |
|--------------|---------------------|-------------|---------------------------------------------|---------------------------------------------------|
| 1            | Yellow              | No          | 115 ml                                      | 7.5 mm                                            |
| 2            | Yellow              | No          | 150 ml                                      | 10 mm                                             |
| 3            | Orange              | No          | 210 ml                                      | 25 mm                                             |
| 4            | Red                 | No          | 420 ml                                      | 32 mm                                             |
| 5            | Red                 | Yes         | 650 ml                                      | 34 mm                                             |
The researchers prepared 5 different measurements of water using beakers. The measurements prepared were based on the measurements of the sensors also which was set to trigger. As each beaker was poured into the measuring tube, the alarm system was responsive where all measured simulated precipitation triggered the sensors to light up LED indicators. Water volumes 115 ml and 150 ml had a measurement of 7.5 and 10 mm respectively. Yellow was the color of the LED indicated. 210 ml water volume had a measurement of 25 mm with orange indicated color. Last volumes of water, 420 ml and 650 ml, recorded measurements equal to 32 mm and 34 mm respectively, with red indicated color. However, only the 34 mm measurement triggered the sound alarm to buzz. These data presents that the device was functional, in all components, as tested in simulated precipitation. The device was referred to the experts. Using a rating scale made by the researchers, the experts rated each material of the components of the device. Based on table 4, all materials were rated as fully functional. However, comments and suggestion were also solicited from them to support the claim.

### Table 4. Experts’ Evaluation of the Impromvised Warning Device

| Component                        | ET1 | ET2 | ET3 | ET4 | Mean | Description |
|----------------------------------|-----|-----|-----|-----|------|-------------|
| Rainfall Measurement             |     |     |     |     |      |             |
| a. Calibrated Dipstick           | 3   | 3   | 2   | 2   | 2.5  | Functional  |
| b. Internal Measuring Tube       | 2   | 3   | 2   | 3   | 2.5  | Functional  |
| Alarm System                     |     |     |     |     |      |             |
| a. Sound Alarm                   | 3   | 2   | 3   | 2   | 2.5  | Functional  |
| b. Light Alarm                   | 3   | 4   | 2   | 4   | 2.35 | Functional  |
| c. Water Level Sensors           | 3   | 3   | 2   | 3   | 2.75 | Functional  |
| Power Supply System              |     |     |     |     |      |             |
| a. Solar Panel                   | 4   | 4   | 4   | 4   | 4    | Fully Functional |
| b. 12V Chargeable Battery        | 3   | 2   | 3   | 2   | 2.5  | Functional  |
| c. Solar Charge Controller       | 4   | 4   | 4   | 4   | 4    | Fully Functional |

Below is a list of their comments and suggestions.

**Comments/Suggestions of Experts of the improvised device Calibrated Dipstick**

- “Not precise measurement” (ET1, ET3)
- “Use a graduated cylinder in measuring in fluid both part” (ET2)
- “Use a graduated cylinder to gather accurate measurement” (ET4)

**Water level Sensors**

- “Functional but needs improvement—use proper sensor” (ET1)
- “It is okay but next time try to use a true level sensor” (ET2, ET3)

**12V Rechargeable Battery**

- “It is not compatible with other equipment/components” (ET1, ET2, ET3, ET4)

As shown in figure 2, researchers followed the suggestions given by the evaluators after their rating. Too much supply could bust the LEDs, therefore as a solution; an 18 watts DC/DC converter was bought from online store to convert power from the 12V GLA Battery to 9V, since the load requires only 9V. Using a lower power supply will result into a weaker buzzing sound thus, enabling the researchers to obtain acceptable results and da
Figure 2. Before and After Suggestion

Table 5. Group Activity Scores

| Group | Score | Description |
|-------|-------|-------------|
| G1    | 47    | Excellent   |
| G2    | 50    | Excellent   |
| G3    | 51    | Excellent   |
| G4    | 55    | Excellent   |
| G5    | 51    | Excellent   |
| G6    | 52    | Excellent   |

The table above presents the result of all six (6) groups obtaining higher scores than the 75% passing score as most of the groups have acquired above 50 scores out of 57 total items. One of the groups, group 4, almost attained the highest possible score. Based on the rating scale for the group’s activity, all groups had shown excellent performances which indicated that the students have learned measuring the rainfall using the improvised warning device. This study was supported by [1] that utilization of improvised instructional material improves students’ achievement and enhances students’ cognitive, psychomotor and affective domain. Improvised material as a teaching aid in a science class supplements teachers’ oral explanation with students’ visible experiences. Results showed that achievement scores of students have better results with the use of improvised material. Concrete experience help them developed their intellect showing variation of students performance due to the use improvised material [2].

Students’ Perceptions on the use of the Improvised Warning Device

The researchers asked the students their perception on the use of the device through learning log questions. The following statements are the answers of the students on the learning log and were grouped according to the similarities of their answers.

Learned to measure rainfall using improvised warning device.

“I learned how to use the improvised device in measuring the amount of rainfall an area receives in a given time period”. (S2)

“I learned how to know the measurement of water level, to operate the device and to know the color of the LED”. (S9).

“I learned that water levels have corresponding LED light and they can be measured using the rain gauge”. (S11)

“What I learned from the activity, I was able to know how the rain gauge work and how it makes things easier to identify the possibility of the rainfall, since it was improvised”. (S16)
“I learn from the activity is how to detect flood and how to use the rain gauge for us to know the level of water”. (S17)
“In this activity, I learned how to use the improvise device and how it can us to be alert whenever there is a typhoon or a normal rain and the advantages and disadvanataged of the device” (S25)
“I have learned in this activity that rain gauge helps us measure the amount of water that falls in an area”. (S26)
“I learn from this activity is when the color of the LED is yellow, flooding is possible. If it is orange, flooding is threatening. And if it is red, serious flooding is expected in low lying areas”. (S27)

Analyzed behaviors of typhoons and its potential risks.

“It helps us on understanding on how we can be ready or it can give us information during the disasters that are coming.” (S3)
“The device will be helpful to a student like me, well to be ready and to share the knowledge I mentally receive”. (S8)
“It gives more knowledge about the weather and it will guide them on reducing or eliminating risks and casualties when disastrous typhoon and flood is about to strike”. (S10)
“As a student like me, the device is helpful for me to learn how to use the device and gives me more knowledge on how to understand weather patterns”. (S12)
“For me, the device is very helpful as a student like me because we can use the rain gauge easily for our lesson”. (S35)

Developed students’ preparedness on disaster risk management

“The advantages of this device is to measure, if flooding is possible or not in the exact where rainfall happens. This device may also help us to be ready of what will be happening before the typhoon”. (S4)
“I learned about how to use the rain gauge and how to measure the amount of rainfall in simplest way and how it will guide us on reducing or eliminating risks and casualties when disastrous typhoon and flood is about to strike or to come”. (S5)
“I learned that using this device can really help me when there is a typhoon coming. in fact it can raise awareness to everyone”. (S14)
“The improvised device makes people alert and prepared specially in low lying areas” (S12)
“I learned how to be prepared when there is flood and when to evacuate”. (S21) (S28)
“This device will let you know about the flood possibility if it is possible to flood, if flood is a threat or if serious flooding is expected”. (S34)

Based on the answers of the students on the learning log, they were able to learn how to use the improvised warning device and understand more the weather system in the Philippines which includes the topics; Typhoon formation and why Philippines is prone to typhoons. They also learned that through the device, they can monitor rainfall intensity in their locality over a short or an extended period of time. With the help of the PAGASA color-coded rainfall advisory, the device could send them signal if flood is possible in their area through the alarm system of the warning device. With these findings, it can be concluded that students have become knowledgeable of disaster risk reduction and management with regards to flood and typhoon, and have learned the different responses to these disasters based on the warning device.

4. CONCLUSIONS

After the implementation of improvised warning device in developing students’ preparedness and disaster risk management, the researchers come up with the following conclusions:

1) The implementation of the improvised warning device was useful and valuable to the students. The improvised warning device was fully functional showing its efficiency and effectiveness in developing students’ preparedness and disaster risk management;
2) Students have learned the use of improvise warning device as all groups had shown exemplary performance in the activity
3) The results showed that students were engaged in the laboratory activity. Thus, it increases students’ performance and preparedness on disaster risk management;
4) Students developed collaboration, cooperation and skills during the implementation.
Furthermore, it made them become aware and prepared of typhoons and its potential risk. Students have learned the different responses to these disasters based on the warning device. Through a group activity, students fulfill teams’ role and duties, make decisions and share information and;

5) With the use of the improvised warning device, the students learned to measure rainfall, analyze typhoon behavior and its potential risk and developed their preparedness on disaster risk management.

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