Linear Equations in Two Variables STEM Education Learning Activities: Developing the Household Power Consumption Calculator App

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Abstract. The lesson was developed with the collaboration of experienced teachers through brainstorming and small-group conference. Social issue about electric consumption usage and rate were identified as part of the lesson. The content and skills to be learned in this lesson aligned to the K-12 curriculum. The topics identified were linear equation in two variables for mathematics and renewable and nonrenewable sources of energy for science. In this unit, students develop a prototype of a mobile application that calculates actual household electric consumption. The application aims to help household units to closely monitor their electric consumption in order to lessen the said consumption and to promote household budget savings. The outcome of this lesson contributes to globe’s quest to fight against climate change and global warming since electric consumption of households will be lessened. The paper may has implication for STEM education.

Keywords: linear equation, K-12 curriculum, STEM education

1. Introduction

Educational institutions in the Philippines are gradually recognising the relevance of science, technology, engineering and mathematics (STEM) Education in supporting innovation and driving future economic growth. In a bid to increase the number of graduates who enroll in science and mathematics-related courses at the tertiary level, the K-12 programme now provides senior high school students with an option to pursue STEM-related fields through the academic track. To this end, significant activity is under way to boost students engagement in these subjects, and teacher quality[7].

Data from World Economic Forum shows that the quality of mathematics and education in the Philippines ranks among the lowest regionally, resulting in relatively low numbers of STEM graduates[7]. In addition, Cordero (2018) cited in his article about TIMSS 2003 results that ‘The Philippines’ scores were below the 400-level. (to pursue opportunities).

STEM education lesson plan may be framed to address a social issue in the community. Krug and Shaw (2016) added that science education reform initiatives have been mobilized as a response to national issue and economic downturns. STEM education prepare students for the professional dispositions required to succeed — and to innovate — in increasingly competitive and globalized 21st century ‘knowledge economies’[4].
It is deemed important to develop STEM Lesson plans for a more meaningful classroom experience of both the learners and the teachers. Exposing the learners to the society’s issues will help nurture their sense of community involvement as an individual of the society, and this STEM lesson plan can help cater this aspect. This study aimed to contribute to STEM teaching in mathematics classroom. Specifically, this study aimed to present the process of developing STEM lesson learning activity in teaching linear equation in two variables.

2. Developing STEM Education Learning Activities

Iterative process was employed in the designing of the lesson plan. The iterative process in designing the activities was developed regarding on Sutaphan and Yuenyong [11] the context-based STEM education learning approach as shown in Figure 1. The context-based STEM education learning approach included (1) Identification of social issues, (2) Identification of potential solution, (3) Need for knowledge, (4) Decision-making, (5) Development of prototype or product, (6) Test and evaluation of the solution, and (7) Socialization and completion decision stage. As the figure 1, the identification of social issues suggest teachers to bring social or technological issues to motivate students to develop some possible solutions. The 7 stages will allow students using applying scientific and other knowledge for designing the solutions, and provided the context of instruction requires solving a real-world problem or task through teamwork. And, students will have also chance to apply their scientific and other knowledge for problem solving in context of engineers, technology, or entrepreneurship [11].

Figure 1. Iterative Process in designing the STEM activity

The design of STEM activities started with the Identification of social issue. The social issue on “electricity consumption” in Mindanao was posted as a community problem to be solved in this activity. The second step is identification of potential solution to the problem. In this step students discuss the possible activities to be done on conservation of energy and identifying possible strategy to help household decrease the energy consumption of electricity at home. To support student’s investigation on conservation of energy, a mini lesson was conducted on describing the phenomenon using linear equation on two variables. Science class also discuss about conservation of energy. Brainstorm activity was done to set up their data collection on the electricity consumption at home. Working in groups, students will develop a prototype on an application in computing the electricity consumption of appliances used in the household. Mathematical equations supported with data will be presented by each group and get feedback from peers. The students will go back to the issue and reflect on their prototype. With this process, STEM experience is beneficial to the students in learning and in the building of confidence in math and science courses[8]. The activities of each stage will be clarified as following.
2.1 Activities in the Identification of social issue

The activities of identification of social issues were developed as the figure 2. In the first stage, the students are assessed of their awareness of the issue on the increase in the usage of the electric consumption as well as its rate. Next, the current situation of the electric supply in the Philippines will be presented in order to have a wide idea of the situation by comparing yearly consumption and analyzing the growth of the rate wherein different factors are considered. After this, contextualization follows where the topic is trimmed down to the local scenario. This gives the students a clear idea of the scenario that they will work with. This stage also provides the expected output of the students which is to make a mobile application that would allow them to compute the amount to be paid based on their consumption. Aside from computation, the students are also given the freedom to include some other portions in the application that they think would make it more interesting and appealing to the consumers (e.g. personal account, brief history, warnings, etc.)

Figure 2: the activities of identification of social issues

| Stage                          | Activity                                                                 |
|-------------------------------|--------------------------------------------------------------------------|
| 1. Identification of social issues | 1. The teacher will ask the students if they are aware of the electric consumption in their respective household. |
|                               | 2. With their respective current usage, did it somehow affect their way of living?                                                   |
|                               | 3. The teacher will present a video on the current situation of the power supply in Philippines and, particularly, in Iligan City such as scheduled power interruption, increase in the rate of per kWh. |
|                               | 4. The teacher will then ask the students “If you have the capacity to create an app to calculate household monthly consumption, how are you going to design your app?” |

2.2 Activities in the Identification of potential solutions

The activities of identification of potential solutions were developed as the figure 3. In this part of the lesson, the teacher will divide the class into a group of at least 5 students. Each group will be provided a Household Power Consumption Form for them to complete- by choosing a household to monitor. The students will be tasked to collect data on the amount of power each of the selected-household electrical appliance and/or gadget consumes in kilowatts and record the average number of hours in a day each of the appliance and/or gadget is in use in reference to their monthly usage. They will then compute for the cost each of the appliance or gadgets consume in a month. In this manner, the students will be able to identify which of the appliance and/or gadgets contribute/contributes the most to the cost of the household power consumption.
Figure 3: the activities of identification of potential solutions

| STAGE | ACTIVITY |
|-------|----------|
| 2. Identification of potential solutions | 1. The teacher will ask the students to identify the electrical appliances used in their household and collect their electricity bill for the past 3 months.  
2. The students will discuss the reason/cause of paying that much for electricity consumption.  
3. Take the students to list down estimated kilowatt per hour for each of the electrical appliances.  
4. Determine that number of hours per day (in average for a month) each appliance is in use. |

2.3 Activities in the Need for knowledge

The activities of the need for knowledge were developed as the figure 4. The topic linear equations in two variables will be discussed and learned by students through inquiry based approach that will make use of a real life situation. A problem about De la Cruz’ family electric consumption will be presented. Prior to dividing them by groups, a short exchange of ideas on how the charging of electric consumption is being computed. The students will be given a KWL activity about conversion. Through the KWL activity, the teacher will be aware of their prior knowledge about computing electric consumptions. They will then be divided in groups and will be given time to come up with their solutions on how to compute the electric bill of De la Cruz family for one month. They will be asked to represent their answers algebraically. Through this activity they will be able to realize that algebraic concepts such as linear equations in two variables are present in real life situations. Their prior knowledge of basic calculation will help them arrive with different electric consumption with their respective rate; through these results, they can differentiate the input which serves as the independent variable and output which is the dependent variable. They will be able to read the trend and predict consumptions and rate depending on the given time.

This activity will also give them a chance to play the role as the head of the household and decide what they think is the best budget for their household and to figure out the best plan on how they can make the most out of the electric appliance that they want to operate. That is where they can practice evaluating linear equations in two variables.

Figure 4: the activities of the need for knowledge

| STAGE | ACTIVITY |
|-------|----------|
| 3. Need for knowledge | Mathematics : Mini – lesson on linear equations in two variables  
Physics : Lesson on Conservation of energy |
2.4 Activities in the Decision making stage
The activities of the decision making stage were developed as the figure 5. The students will compare their gathered data to the monthly power consumption based on the 3 months power consumption bills they have gathered. From this, the students will be setting up an equation to represent their power consumption, as well as the power consumption rates, depending on the variables such as time, power rate and appliance power consumed in kilowatts.

Figure 5: the activities of the decision making stage

| STAGE               | ACTIVITY                                                                 |
|---------------------|--------------------------------------------------------------------------|
| 4. Decision-making  | 1. investigate in respective households their electricity consumption.    |
|                     | 2. Set-up an equation for their solutions to the issue.                 |

2.5 Activities in the development of prototypes and products
The activities of the development of prototypes and products stage were developed as the figure 6. Each group will study how their formulated equations work by applying them to their respective selected household, and will compare each of their computed result to the three months power consumption bills they have gathered in the first part of the lesson for verification. When the formula is finally tested and proven accurate, the students will then use their equation to design an app that calculates household power consumption and consumption rates. This allow students to provide how the equation can be placed in the design.

Figure 6: the activities of development of prototypes and products stage

| STAGE                           | ACTIVITY                                                                 |
|---------------------------------|--------------------------------------------------------------------------|
| 5. Development of prototype or product | 1. The students will apply their equation to their household.         |
|                                 | 2. Each group will develop an app of their own design that calculates household power consumption and consumption rates. |

2.6 Activities in the test and evaluation stage
The activities of the test and evaluation stage were developed as the figure 7. Each group will present their formulated equation and show in class how their equation works by applying it to their household power consumption and by comparing their computed result to their gathered 3 months power consumption bills of their selected household. They will then present the design of their app ideal for a household power consumption computation for a month.
Figure 7: the activities of the test and evaluation stage

| STAGE         | ACTIVITY                                      |
|---------------|-----------------------------------------------|
| 6. Test and evaluation | * Present their designed Household Power Consumption App |

2.7 Activities in the socialization and completion of de stage
The activities of the test and evaluation stage were developed as the figure 7. Through class conference, the whole class will agree on which application will be the best among all the developed applications. This application will then be subjected to further improvement before it will be released to the public for free.

Figure 8: the socialization and completion of de stage

| STAGE         | ACTIVITY                                      |
|---------------|-----------------------------------------------|
| 7. Socialization and completion stage | *Amongst the design presented for the computation of monthly household power consumption rate, the class will decide which design is most comprehensive and convenient to use. |

3. Conclusion
Development of STEM Education Lesson plans requires a thorough process of planning. Some aspects to be considered during planning the lessons is the timely relevance of the activities incorporated in it. 21st century skills must also be embedded along with the objectives to ensure learners of a more meaningful experience on the lessons’ activities. And the context of activities must adhere to the society’s current needs in contrast to the traditional classroom setting. But it must be emphasized that the lessons should still be able to address the basic needs of the learners such as the knowledge and skills that are related to the subject matters of the lessons.

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