Local-based lesson on hydrologic cycle with environmental education integration: Designing learners ideas through STEM

Maria Theresa G. Tadena¹*, Monera A. Salic-Hairulla²

¹Department of Science and Mathematics Education, College of Education, Mindanao State University –Iligan Institute of Technology, Iligan City 9200, Philippines

²Department of Science and Mathematics Education, College of Education, Mindanao State University –Iligan Institute of Technology, Iligan City 9200, Philippines

*Corresponding author’s e-mail address: mariatheresa.tadena@g.msuiit.edu.ph

Abstract. Seeing STEM education in a new light that seeks in helping learners use the local environment as a vehicle for developing understanding on various environmental issues. Providing adequate STEM and environmental education will make everyone appreciate their relationship with the environment which lead to environmental awareness and in developing a sustainable future. This study aimed to develop a local-based lesson on environmental education. Local-Based Lesson on Environmental Education was developed for integration to science lessons among grade 8 learners and was designed in a meaningful way that the integration process would just blend smoothly. STEM education strategies are utilized and applied by the learners in performing the activity embedded in the developed local-based environmental lesson. Through this, it developed the learners' capacity in bringing their role as solution makers towards the pressing environmental issues in their local community. Using STEM strategies the learners have shown positive response to the developed lessons and were able to provide and design possible solutions in addressing local environmental issues. This implies that the application of STEM strategy in learners’ activity have developed the learners creative ideas in addressing environmental issues in their own community and improved their STEM knowledge and skills.

1. Introduction

The world in general faces environmental crisis and our country in particular is also in a verge of environmental degradation. There is no denying of the urgency of global and local environmental issues. In the Philippines, the pressing environmental issues include mining, climate change, solid waste management [1] and pollution specially plastic-related pollution [2] that made our country as the third worst plastic polluter of the world’s oceans. Indeed, there is a dire need of environmental awareness on every aspects of the environment so as to produce socially responsible citizens [3]. In spite of the government’s effort in promoting environmental awareness through Republic Act 9512, which mandates the promotion of environmental awareness through and by integrating environmental education, the country still ranked at 82nd among 180 countries on its Environmental Performance Index in 2018 based on nation’s performance to address high-priority environmental issues [4]. This is
supported by the statement of [5] that various environmental laws have been released in the last decade in the Philippines but awareness about content and objectives of these environmental laws remains too low.

Moreover, the Department of Education in compliance with R.A. 9512, issued DepEd Order No.52, s. 2011 on “Strengthening of Environmental Education in Public and Private Schools.” According to [6], promoting environmental awareness is considered a crucial goal in the context of contemporary education. Environmental Education teaching could be a promising step in addressing local environmental challenges. According to [7] as cited by [8], this can be achieved through formal education by integrative approach which combines or unites Environmental Education materials into a particular subject like science. As asserted by [9], that science is a subject which offers opportunities for fostering environmental awareness and science teachers are best agents in facilitating students to be involved in making solutions on environmental issues.

However, the study of [10] stressed that integration of environmental education in school curricula is not sufficient while studies of [11, 12] emphasized that inadequate teacher preparation and lack of expertise in the subject matter hinders the implementation of Environmental Education.

The development of ready-to-use teaching-learning materials could fill in the gaps in the integration of environmental education. This prompted the researcher to develop a local-based learning material that can be readily integrated and contents are based on the local environment.

On the other hand, seeing STEM education in new light that seeks in helping learners deal with complexity and splendour of the environment as well as looking to use the local environment as a vehicle for developing understanding aspects of the science curriculum. There is a need to shift from seeing environment as a focus for considering science concepts to seeing a STEM education as one which seeks to help learners understand various environmental issues in the context of their lives, and their lives in the context of environmental issues [13]. Providing students with real-world problems and asking them to brainstorm solutions will bring their higher order thinking skills into play [14] and providing adequate STEM and environmental education will make everyone appreciate their relationship with the environment which lead to environmental awareness and in developing a sustainable future [15]. Biogeochemical Cycles, where hydrologic cycle belonged, is one of the Four Principles of Sustainability. The four interconnected principle of sustainability are derived from learning how nature has sustained a variety of life forms on earth for about 3.56 billion years [16]. This explains that the only way to control environmental issues is to create sustainable development strategies and continue to instill to every learner and everyone in the community environmental conservation methods.

2. Theoretical Background
The fundamental postulate of contextual learning otherwise known as context-based learning is it must be somehow connected with real world characteristics for it to make sense to the learners [17]. This practical context enables learners to connect symbolic learning content like concepts and principles to the real world referents. According to the Theory of Contextual learning, learning occurs only when learners process new information or knowledge in such a way that it makes sense to them in their frame of reference like their own inner world of memory, experience, and response [18]. This approach to learning and teaching assumes that the mind naturally seeks meaning in context--that is, in the environment where the person is located--and that it does so through searching for relationships that make sense and appear useful. In this sense, the use of local-based terms and examples like using local species of fish to teach fish species diversity to the learners can be an effective strategy in meaning making for the components of such concept is found on the environment where the person is located. According to [19], when students can relate the concepts they have learned to real-life situations, it means that they have inserted the context learned to the actual situation and transformed it as life experiences and encourage positive attitude towards learning science.
3. Methods
Local-based lesson on hydrologic cycle and environmental education is a developed video lesson on hydrologic cycle portraying one of the world’s ancient lakes and the largest lake in Mindanao, the Lake Lanao complemented with an integration of environmental education that focuses on the environmental issues in the local community. Through this study it is hoped to increase environmental awareness and to recognize the roles of the learners as they participate in solution making to the environmental issues in their own community. Most students feel that their ideas are valuable if they are given chance to participate in solution making activity particularly when it comes to the environmental issues, although they are working in a community level this will eventually pave the way to their more participation not only in national environmental problems but world problems like climate change.

It is designed in this study how local-based lessons on environmental education and STEM education can be integrated in a meaningful way. The developed instructional materials on environmental education for integration in teaching hydrologic cycle was implemented to Grade 8 learner-respondents of Marawi City National High School, Marawi City, Philippines. Learners activity that is embedded in the developed instructional material used the documented local activities in the community that can affect the hydrologic cycle and the environment. The learners used the STEM strategy collaboratively by giving their solutions to the identified local environmental problems. With the teachers assistance, learners will apply STEM strategy as they think, create or design their ideas to formulate positive solutions that address the environmental issues by answering the following questions:

1. How can you solve the environmental issue assigned in your group? What can you do at school, at home and at the community?
2. How can these solutions prevent the negative impact of this environmental issue to the water cycle?

Local activities documented on the community that can affect the water cycle and the environment were deforestation, urbanization, irrigation and river damming and vegetation clearing.

The students were guided by the teacher on how to apply STEM strategy in their activity. By doing their activity, the learners learned different concepts (Science), and as they formulate solutions, their creativity skills and technology skills developed (Technology), eventually they can design even better solutions (Engineering) and may include calculations and approximations regarding numerical effects if there will be any (Mathematics).

| STEM      | CONTENTS AND STRATEGIES                                                                 |
|-----------|----------------------------------------------------------------------------------------|
| Science   | Concept of hydrologic cycle (water cycle)                                             |
|           | Concept on environmental conservation and awareness                                   |
| Technology| This may contain the methods, techniques, materials used as part of the students possible solution to the case (environmental issue) that they are going to present. |
| Engineering| This may include the design and creation the learners suggested, build as part of their proposed solution. |
| Mathematics| This may include any numerical computation if there is any.                            |

4. Results and Discussion
The learners worked collaboratively in their specific groups with a slight assistance from the teacher and are active in the presentation and discussion of their answers. Their results were collated and presented in the table below.
Table 2. Students’ activity output on how they can solve the environmental issues in their community

| What is the case? | Where? | How? |
|-------------------|--------|------|
| Deforestation     | At school | • organizing for a tree planting activity  
|                    |         |   • giving of short talk during students assembly on deforestation and how can we students help reduce its effects in the environment.  
|                    | At home  |   • suggesting to the local government for an ordinance to have a tree in every household.  
|                    |         |   • Creating a garden design even to small vacant spaces  
|                    | At community | • organizing for a community campaign by posting tarpaulin on the harmful effects of deforestation in the environment  
|                    |         |   • developing a short video on the harmful effects of deforestation to be played in a public plaza of the city.  
| Urbanization      | At school | • Information campaign on the effects of concrete surfaces and water run off  
|                    | At home  | • encouraging every home to choose having a grass lawn or a partially concreted lawn than a fully concreted ground.  
|                    |         | • drainage and canals should be partially concreted, the bottom part should not be concreted to give way for water to get back to the ground  
|                    |         | • designing the ground using bricks  
|                    | At the community | • Taking part in the community projects regarding environmental conservation.  
|                    |         | • Suggesting to the local government for a nature park in the community  
|                    |         | • Creating for an information campaign material in the community for the conservation of forested lands.  
|                    |         | • Designing drainage systems that allow water to get back to the ground easily.  
| Improper waste disposal | At school | • Making compost pit as a school project.  
|                    |         | • Segregating trash  
|                    |         | • Video-showing on adopting waste conversion like plastic wastes into something useful  
|                    |         | • Applying ideas on recycling waste materials into decors and other useful crafts  
|                    | At home  | • Applying waste segregation  
|                    |         | • Minimizing plastic use  
|                    |         | • Recycling of waste materials  
|                    | At the community | • Helping the community leaders in designing a waste management project  
|                    |         | • Designing a recycling process for the community  


Table 3. STEM strategies applied based on the outcomes of the activity

| Case 1 Deforestation | Stem Strategies learned |
|----------------------|------------------------|
| science              | • Concept of hydrologic cycle  
                       | • Trees absorbed water from their roots and release water vapor when they transpire producing a localized humidity. This water vapor then evaporates into the atmosphere where it accumulates before precipitating back to the Earth as rain |
| technology           | • Making short video depicting the effect of deforestation in the community |
| engineering          | • Creating a garden design on limited spaces at home  
                       | • Designing environmental campaign material |
| mathematics          | • Counting the number of trees that will grow if every student plants a tree. |

| Case 2 Urbanization | Stem Strategies learned |
|---------------------|------------------------|
| science             | • The effects of concrete surfaces in the normal cycling of water  
                       | • The effects of water run-offs |
| technology          | • Using of bricks as ground cover, as walkway and even in garage. |
| engineering         | • Designing drainage system that water can easily penetrate back to the ground  
                       | • Designing a nature park  
                       | • Creating a campaign material |

| Case 3 Improper waste disposal | Stem Strategies learned |
|--------------------------------|------------------------|
| science                        | • Concept on waste segregation and recycling  
                       | • The effects of garbage to the ground water |
| technology                     | • Video showing on how to adopt plastic waste conversion |
| engineering                    | • Making compost pit  
                       | • Recycling waste materials into useful crafts and decors  
                       | • Designing recycling process for the community |

Findings in other studies showed that challenging tasks or questions can be utilized to stimulate students to use STEM to find solution to a problem as the purpose of STEM education lies in understanding how STEM knowledge can be utilized to solve real-life problems [20, 21].

On the other hand, findings on the study conducted by [22] revealed that localized and contextualized learning materials are more acceptable to the respondents. [23] affirmed on the effectiveness of using contextualized and localized teaching in which the overall performance of the learners showed a proficient level that implies that there was significant improvement in their performance in science using localization and contextualization approach in teaching science. [8] in his study in developing a learning model for integration of environmental education claimed that integration of environmental education materials in science subject matter effectively improved students’ knowledge of the environment.

5. Conclusion

The researchers have developed local-based lesson on hydrologic cycle and environmental education which were implemented through integration, designed learners activity where STEM strategies are applied, and implemented to the grade 8 junior high school learners of Marawi City National High
School in Northern part of Mindanao, Philippines. The learners have shown positive response to the developed instructional materials and were able to provide and design STEM strategies possible solutions in addressing local environmental issues in their own community. It therefore improved the learners STEM knowledge and skills.

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