Learners' Engagement in Disaster Readiness and Risk Reduction (Drrr) Utilizing Stem-Based Learning Activities

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ABSTRACT

STEM learning activities aided students to learn science, technology, engineering, and mathematics. This encouraged learners to develop the scientific skills and attitudes in dealing with disasters and make them engage in the teaching and learning process in DRRR. This study aims to determine learners' engagement in disaster readiness and risk reduction (DRRR) utilizing stem-based learning activities. A quantitative method was used using an engagement questionnaire scale. Results revealed that the developed STEM-based learning activities show significant impact to learners' learning engagement on DRRR (2 tailed= 0.007; α =0.05). The collaboration and teamwork involved in disaster-related activities help students gain a deeper understanding of real-life situations. By working together, students become more innovative and learn to create prototypes based on scientific principles to address disaster-related issues in school. This hands-on, contextualized approach empowers students to develop solutions that directly impact their lives. The various stages of STEM-based learning activities further engage students, making the learning process more meaningful and effective. The activity encourages students to improve their planning skills by testing and refining prototypes. Through self-reflection and peer feedback, students can enhance their ideas and create better solutions. STEM-based learning becomes more effective when students are actively engaged in DRRR process. Teachers play a key role in ensuring that the stages of the activity are followed, helping students achieve their learning objectives and produce improved prototypes.

Keywords: Learning engagement, Disaster Risk Reduction and Readiness (DRRR), STEM activities

INTRODUCTION

Learning engagement is the process by which a learner uses both their emotional and cognitive capacities to complete a learning activity. Students' learning outcomes is evident in the students' learning achievement, higher-order thinking skills, and motivation. STEM education constitutes the most promising teaching and learning innovation [1]. The vast literature focusing on the design of STEM learning experiences highlights the importance of situating these activities in real-world context. Further activities that are connected with societal issues engage students in the application the knowledge of science for when making decisions about topics related to disasters, pollution, environmental issues, biotechnology, health, cosmetics, ecosystem, energy, market, commerce, and designing some technological products. Similarly. in integrated STEM problem solving, besides scientific investigations and explanations, students are also required to understand constraints, design optimal solutions within specific parameters and even to construct prototypes. For students to learn the ways of speaking, doing and being as they participate in integrated STEM problem solving in schools in a meaningful manner, students could benefit from these experiences [2] and engaging learners in the community through fieldtrips and placement [3].

However, the availability of learning materials that is relevant and fit to the learners' need is a challenge among educators. Learning engagement has difficulty in employing design thinking and lacking a framework for adopting the critical thinking process remains a barrier [4]. Likewise, the materials to be used, group works conducted by the teachers, classroom arrangement and management, time management, appropriateness to children's level, identifying and expressing the problem, activity planning and implementation, and implementing STEM education serves as a barrier [5].

This study aims to determine the SHS students learning engagement in Disaster Readiness and Risk Reduction (DRRR) through the utilization of the STEM-based learning activities.

METHOD

A Quantitative method was used using a survey on the learners' engagement questionnaire scale adapted and modified from Wang, et al. (2016) and used to assess the engagement of the students in DRRR before and after the implementation of the STEM-based learning activities. This was divided into two parts. The first part is the cognitive engagement which has eight (8) statements while the second part is the emotional engagement which was composed of ten (10) statements. It is a 4-point Likert scale questionnaire which includes four options without a neutral choice namely:

1 = never

2= sometimes

3= often

4 = always

This instrument was pilot tested to determine its internal consistency, that is, how closely related each item to the group. The Cronbach Alpha was computed which resulted to 0.730 which means the test has a good internal consistency.

As for the development of STEM-based learning activity. The researcher incorporated the data gathered from the pre-development phase for these served as the basis on how the STEM based activities were developed. This is the stage where a battery of revisions was made based on the validator and experts' comments and suggestions both in content and pedagogy. However, all STEM based learning activities are anchored from the Most Essential Learning Competencies (MELCS) in the K to 12 curriculums of the Department of Education (DepEd). Then, the developed instructional material will put into test. This will measure its workability after its validity and reliability has been addressed. It is in this phase also where the Learning Activities influence on the learners' engagement will be determined.

Ethical Consideration

To ensure respect of privacy, a full consent and assent of the respondents will be sought. After the approval of the consent and assent form, the study is then carried on. Privacy of the respondents in the study was protected and their identity was kept confidential. This is in accordance with the privacy policies of the research. Ethical considerations presumed that the anonymity of the respondents is ensured.

FINDINGS

STEM-based Learning Activities in Flood Disaster

The developed STEM-based learning activities underwent revisions based on the comments and suggestions of the panel of experts. This is to ensure the quality of STEM-based learning activities in DRRR particularly on the topics of flood and earthquake in school setting. The visions given by the panel of experts were incorporated in the STEM-based learning activities as shown in table 2.

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Table 2. STEM-based Learning Activities in Flood Disaster

STEM- Based Learning Activity **Topic: Flood** **Title: Designing a School Sustainable Drainage System (SuDS)** Target Grade Level: 11 Time Frame: 1 hour and 40 minutes Learning Objectives: At the end of the lesson students must be able to; 1.understand flood as a result of hydrometeorological disaster 2.mitigate the effect of flood as disaster by designing a prototype of the potential solution. 3.evaluate and design appropriate flood control during rainy days through sustainable drainage system.	
STAGE	**ACTIVITY**
Identification of social issues (5 minutes)	**1. Social Issue:** Present Pictures of floods occur in Initao taken from Municipal Disaster Risk Reduction Municipal Office. Show video clips on the effect of flood to the community. **2. School Concern:** Initao National Comprehensive High School is prone to flood during rainy days. This is due to schools' location near the seashore, creek, and low-lying land area. Raise the question to the students "How can you help the school in mitigating the risk of flooding in the area?" **3. Product:** School Sustainable Drainage Systems (SuDS) prototype. Students will be asked to make an engineering design of school SuDS that can reduce the risk of flooding in school through managing rainfall and at the same time protecting plants and animals' species around school premises.
Identification of potential solution (10 minutes)	1. Students and teachers share the cost analysis in developing School Sustainable Drainage Systems (SuDS) prototype. 2. Students may discuss their possible design considering the different capital: physical, financial, social/technology and human capitals. **Physical** – Does the School Sustainable Drainage Systems (SuDS) serves the purpose of collecting the rainfall and use it in a sustainable way? **Financial** – Are the materials to be used affordable and readily available? **Social/Technology** – What technology is used in the design of School Sustainable Drainage Systems (SuDS)? **Human** – How safe is the School Sustainable Drainage Systems (SuDS) to students, teachers, and staff in school?
3.Need for knowledge (10 minutes)	1. Inquiry activities for students learning scientific concepts will be tackle to unlock terms difficulty encountered by the students. 2. Problem-Based Learning will be used as a strategy to emphasize the role of students in the learning process. Students will be able to solve complex real-world problems such as designing a SuDS in school premises in mitigating flood and reduce its risk to individual. They will interview experts in the Municipal Disaster Risk Reduction Management Office (MDRMMO) where they gain necessary information about Sustainable Drainage Systems (SuDS). 3. The students may take into consideration the information they gather in order to build up the idea on designing Sustainable Drainage Systems (SuDS) in school. The students' knowledge on different fields will help them in completing their task;

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	Chemistry – water quality, run-off water quantity, amenity and biodiversity benefits, and mitigation and adaptation of climate change. **Mathematics** – Measurements of the dimension of the different pipes being used in the prototype. Basic knowledge in slope. **Arts-** Designing an aesthetic SuDS in school wherein it helps sustain life in the area. **Economics**- Profitable cost benefits of having SuDS in school.
Decision-making (10 minutes)	1. Students will be group by 6 in each group. Through fish bowl method, a group 1 to 4 are group through draw lots to have a fair distribution of each group members. 2.. Each group of students will present their ideas on what they plan to do for their output. 2. The other groups will ask questions and give suggestions and comments to further improve and enhance the idea presented by each group. 3. Each group will be asked to finalize design in Sustainable Drainage Systems (SuDS) prototype in school. Incorporating the suggestion given before starting to design their SuDS.
Development of prototype or product (40 minutes)	Students will create a prototype on Sustainable Drainage Systems (SuDS). Learners will collect information on the possibility of making the prototype. Each group will plan a design on how they will construct a drainage system that can reduce the effect of flood. In this section, students will apply the concepts of runoff, measurement of pipes, and slope to create the prototype. Each group will provide an illustration/drawing on their design of the drainage. During the activity, the students will document every step through pictures, videos and write down important observations. The following questions will guide the students during the activity: 1. What did you consider in coming up with the design of your prototype? 2. What factors did you consider in deciding the materials to be used and the design of your prototype? 3. What are the advantages of your design over other designs? 4. What step in your experiment do you find difficult to perform? What did you do to overcome such difficulty? 5. What step in your experiment do you find easy to perform? Why? 6. Did you enjoy the activity? Why or why not? 7. What values you have learned from the activity?
	1.To test the efficiency of the prototype, an artificial rain through water sprinkler is pour over in their SuDS design prototype to see to it that water will flow slowly going to the drainage system. 2. Students prototype maybe tested by their peers and teacher in DRRR, and if possible, by the people from the community. Tell them to collect the feedback especially on what works and what did not. 3. Based from gthe feedback they received, students will be given the chance to revised and improved their prototype. Science- flood as a natural hazard. Technology-selection and use of materials. Engineering-design of School Sustainable Drainage System (SuDS). Mathematics- calculate the budget materials use to build school SuDS .

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Test and Evaluation of the solution (15 minutes)	3.The finished products will be presented each group. During the said activity, there will be an open forum as a venue where students and experts can ask questions and give suggestions to further improve the quality of their prototype.
Socialization and completion decision stage (10 minutes)	Each group will present their design products in social media platform to share their school SuDS design product in solving the flood issue in school premises. 1.Teachers' may invite an engineer, the head of DRRR unit in the municipality, and the school principal to evaluate the design prototype of the students. 2. Students will have an exhibit wherein they will showcase their design product which will be evaluated by the engineers, DRRR teacher, and school principal.

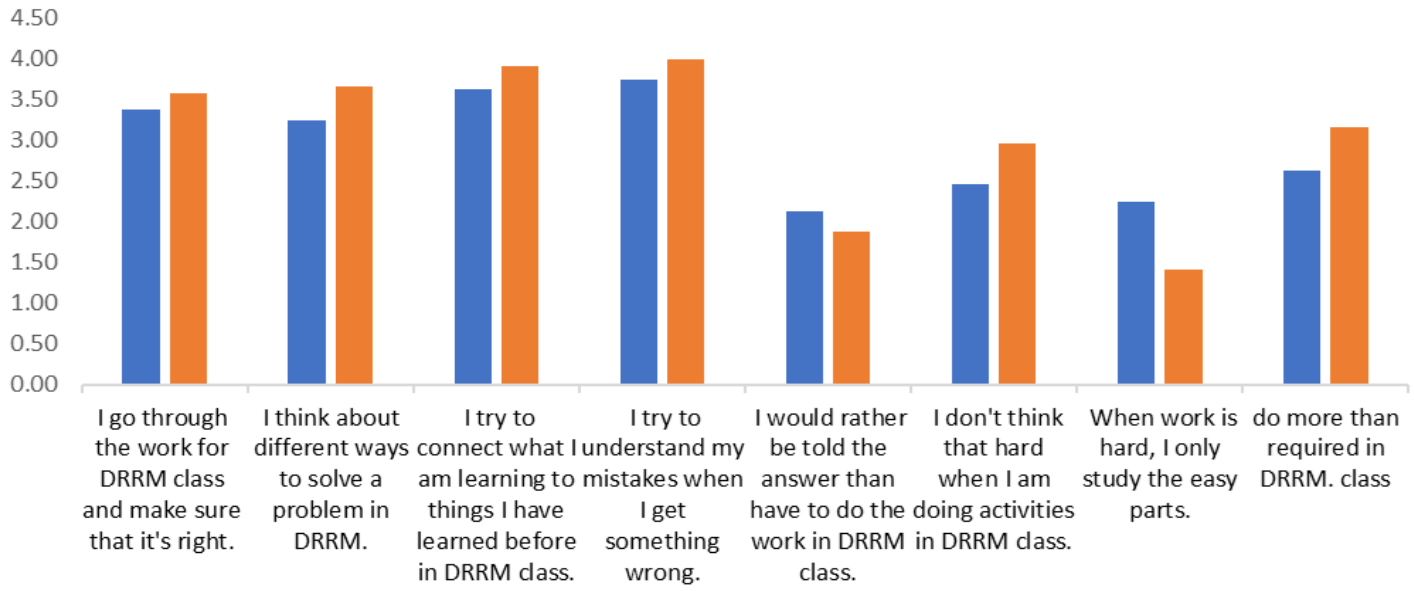
STEM-based learning activities follow the STEM education teaching approach consists of 7 stages. These include (1) Identification of social issues, (2) Identification of potential solution, (3) Need for knowledge, (4) Decision-making, (5) Development of prototype or product, (6) Test and evaluate the Solution, and (7) Socialization and completion decision [6]. On a curriculum that engages students in STEM and promotes instructional strategies that challenge students to innovate and invent. Students are required to demonstrate their understanding of STEM disciplines in a work-based and contextualized environment [7].

STEM-based learning activities provide students experience that is more competence when activities are focused on understanding STEM and are subject-based. Activities with a focus on enhancing interest will be experienced with more engagement and interest by students.

Students' engagement mainly focused on cognitive and emotional aspects of grade 11 SHS learners. Cognitive engagement involves the psychological investment of the student in the learning process. It is marked by the effort made by the learner to understand what is studied and to reach the highest levels of comprehension in a specific area of study. Emotional engagement refers to the experience of positively valence and energy-mobilizing emotions (e.g., interest) during a learning activity. Emotionally engaged students feel good and enjoy their involvement with the learning activity (i.e., work enthusiastically).

This is how they interact with the topic with interest and motivation. Accordingly, STEM activities enhanced students' engagement in learning [8,9].

Figure 1. SHS learners' Cognitive Engagement level in DRRR Before and After the STEM-Based Activity Implementation



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In the context of SHS learners' cognitive engagement, the highest mean rating is on the statement "I try to understand my mistakes when I get something wrong that garnered a mean rating of 3.75 and 4.00 respectively, indicating high cognitive engagement. SHS learners quickly recognized their misunderstanding especially on the concepts that are relevant to their daily living. Since DRRR subjects are given to STEM learners only, these students are inclined in science, technology, engineering, and mathematics concepts which they can relate to faster in their daily experience. SHS Learners show high cognitive engagement before and after STEM-based learning activities since they are active in class participation and cooperation that make them become a critic of their own mistakes if there are concepts that are misunderstood. Similarly, a learning-from-mistakes approach, combined with psychological safety measures, could be one of the possible solutions to achieving more effective learning [10]. When one does not view mistakes as a threat to self-esteem, but instead views them as an opportunity for learning, one will start to reap the benefits of learning-from-mistakes. Likewise, helping learners build and test their products (instead of just designing them on paper) allows a deeper self-regulatory reflection of learning achievements, and thus promotes a culture of constructive self-criticism in Engineering Design projects. Utilizing the engineering design process within STEM project-based learning significantly aids preservice technology teachers in enhancing their understanding of design thinking, particularly in identifying the problem, brainstorming solutions, modeling, and conducting feasibility analyses. Moreover, it is crucial to motivate teachers to delve deeper into the systematic principles of engineering design thinking and enhance their skills by integrating the engineering design process into STEM project-based learning [11].

The statement "I try to connect what I am learning to things I have learned before in DRRM class" garnered a mean rating of 3.63 and 3.91 respectively indicating a high cognitive engagement. SHS learners expressed connection to the concept they learned in the classroom in their real- life disaster experience. Learners tend to connect their concept ideas into application based on their daily living. This indicates further that engaging learners in the class enhances cognitive application and enhances learners' ability to think critically and act accordingly in times of disasters. Likewise, in connecting the real world to mathematical models that includes meaningful tasks which engaged students to transfer mathematics to real-world problems and situations were useful for their teachings, once they were experienced by the learners [12]. Similarly, strongly connected to 'work' were the concepts 'real world', 'real life' and 'group' with students requesting learning that was relevant, practical, and job- or career-related [13].

The statement "I go through the work for DRRR class and make sure that it's right" garnered a mean rating of 3.38 and 3.58 before and after respectively. SHS learners make sure to perform DRRR activities correctly. With the exposure of the STEM-based activities, their engagement increased significantly indicating high cognitive performance in learning disaster risk reduction and readiness. The importance of implementing an integrated learning approach in the curriculum to enhance students' creative problem-solving skills in addressing complex natural disasters by utilizing strategies such as inquiry-based learning, technology integration, and interactions with stakeholders, students can enhance their creative thinking skills, improve their holistic understanding, and be prepared to tackle the complexities of challenges related to disasters [14].

The statement "When work is hard, I only study the easy parts" has a mean rating of 2.25 and 1.42. It was noted that before the implementation of the STEM-based activities, students' cognitive engagement was moderate in this statement. SHS learners do not have enough ideas on the importance of the STEM-based activities in learning disasters. However, when they are exposed to the STEM-based activities even if the work is hard, they are willing to do the task inside and outside the classroom and make them prepare in the future when disaster will strike in their area. Natural disaster education is not accomplished immediately in high school, it is progressively learned and mastered by students in the process of growing up [15].

The statement "I would rather be told the answer than have to do the work in DRRM class" garnered a mean rating of 2.13 to 1.88 before and after STEM-based learning activities indicating a low cognitive engagement in this statement. SHS learners want to do work in DRRR class rather than to listen to the answer without doing the actual concepts. This showed further that they wanted to discover the correct answer by their own project that simply gave the correct answer. Authentic learning among the SHS students in DRRR is evident since they are more likely to do hands-on activity through learning by doing. he intention behind designing and implementing knot working-type hybrid learning activities help foster more agentive learning for the future-oriented understanding of disasters and disaster preparedness among students [16].

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Figure 2. SHS learners' Emotional Engagement level in DRRR Before and After the STEM-Based Activity Implementation

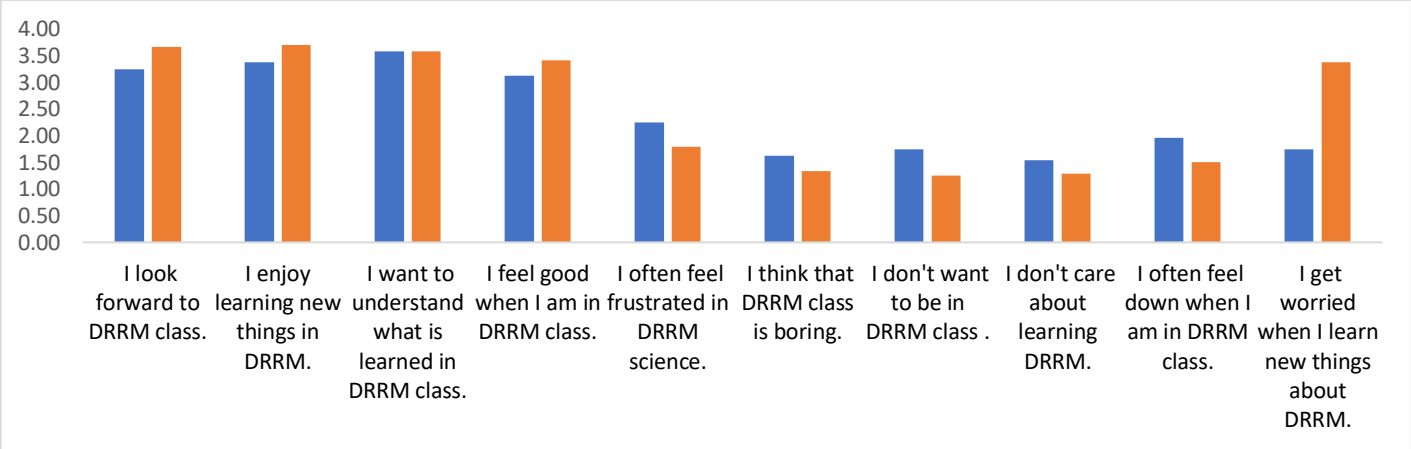

Figure 2 shows SHS learners' emotional engagement level in DRRR before and after the STEM-based activity implementation. The highest mean rating is on the statement *"I want to understand what is learned in DRRR class"*. Which garnered the same mean rating of 3.58 before and after STEM-based activity implementation that indicates high students' emotional engagement. SHS students show interest on the topic discussed in DRRR since it is a real-life application to their part. As a students' learning the concepts in DRRR make them become more equipped and prepared. Collaboration with the community and related institutions is a program in increasing understanding about a disaster. Schools faced several challenges in implementing disaster education programs in schools, such as the abilities of teachers and students, the material taught is still inadequate, and the approach/strategy used is still not optimal [17]. Likewise, the importance of disaster-ready schools becomes increasingly clear in this context, as disaster-ready schools play a crucial role in filling knowledge gaps and enhancing awareness related to preparedness and response in encountering disasters. Recognition of the potential occurrence of disasters and the significance of disaster education among respondents underscores positive steps in building a culture of preparedness [18].

"I enjoy learning new things in DRRR" garnered a mean rating of 3.38 and 3.71 before and after STEM-based activity implementation respectively indicating high emotional engagement among SHS students. Although there was a seemingly increase in their emotional engagement in DRRR after the implementation of STEM-based activity both fall under high emotional engagement.

The lowest mean rating is on the statement "I don't care about learning DRRM". garnered a mean rating of 1.54 and 1.29 before and after STEM-based activity implementation respectively indicating very low emotional engagement. This means that SHS learners care about the concept being taught to them. Showing interest and motivation. Likewise, the statement "I think that DRRM class is boring." garnered a mean rating of 1.63 to 1.33 before and after STEM-based activity implementation respectively indicating very low emotional engagement. SHS students find DRRR class interactive in which they can present their ideas in a meaningful manner through relevant experiences in life. This indicates more that DRRR is not boring at all, rather an interesting subject that embraced concepts in the real world. With this, DRRR contextualized learning materials were acceptable, applicable, and useful for the learners which help teachers teach the basic concepts and principles of disaster and offer opportunities for learners to learn fundamental principles of disaster preparation [19].

Table 1 Paired Sample Test Before and After the Implementation of STEM-based Learning Activities with the Students DRRR Learning Engagement

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
Learning Engagement	before – after	-1.66667	2.74522	0.56037	-2.82587	-0.50746	-2.974	23	0.007

H_o: There is no significant difference before and after the implementation of STEM-based learning activities with the students DRRR learning engagement.

Table 1 indicates that there was a statistically significant difference in students' engagement on DRRR before and after implementation of STEM-based learning activities (2-tailed=0.007; α =0.05). Given that the difference was statistically significant, the hypothesis that, "*There is no significant difference of SHS students' learning engagement before and after STEM-based learning activities implementation*" was rejected. It was therefore concluded that STEM-based learning activities have a positive influence on SHS students' learning engagement on DRRR concepts. SHS students learn and engage the topics of disasters because of the contextualization of the topic so everyone can relate and simply understand the concept better. On a novel adaptive storytelling model defined in the context of contextualization in the field of disaster education addresses both affective ("emotional") and cognitive ("informational") treatments, tailoring a natural disaster context [20]. Similarly, student engagement ("emotional and cognitive") was positively correlated to the academic performance of the [21, 22].

CONCLUSION

Learning engagement of the SHS students was significantly increased after the utilization of the STEM-based learning activities. Learners tend to engage meaningfully in the teaching and learning process because of the various stages of STEM-based learning activities. The activity provides a venue among students to become a better planner and even correct their planned ideas by testing their prototype if it works or not. Students and others may criticize their own work to produce a better solution to the problem by sharing their ideas and concepts to the class. In the end, a better output/prototype was produced.

RECOMMENDATION

SHS students learning engagement was enhanced after the implementation of the STEM-based learning activities wherein students are involved as actively in the learning process as possible. Evidence of learning engagement was enhanced using STEM-based learning activities thus, teachers must ensure the stages of the activities were followed in sequence to help the learner achieve the specified objective or desired outcome or prototype

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