Formulating Refreshment Drink Activity Utilizing STEM Education for Grade 8 Learners

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Abstract. This article is a qualitative study using literature review to create a lesson plan in STEM education. The lesson plan employs the pedagogy of purposeful design and inquiry. This proposes combining elements of design, art, geography and marketing into the disciplines in scientific inquiry of the STEM education in order to further strengthen it. The embedded lesson plan focused on identifying and solving social issues while hitting as many as possible learning competencies along the way. This lesson plan will serve as a contextualize application of learning competencies in Grade 8 Integrated science: biology, chemistry and physics as well as mathematics’ topic on statistics and social sciences’ topic on local geography. This study also include innovation and humanities so students learn skills such as communication, marketing and entrepreneurship. This will also be implemented with the goal of steering students’ interests towards a career in STEM and developing more 21st century as well as life skills that they can use in the future. The student activity in this lesson plan will be assisted and evaluated by the teacher through questions that are framed to encourage deep thinking about the concepts integrated in the activity and how it would be used to produce quality product that would solve the social issue presented at the beginning of the lesson.

1. Introduction
In the 1990s, STEM education has been born in the US but up until now, misconceptions and misinterpretations are still being dealt with. By definition, STEM education means "pedagogical applications based design and engineering technology for teaching content and practice in science and mathematics education with the content and practice of educational technology and engineering with simultaneous". [1]

STEM education was defined as “the teaching and learning of the content and practices of disciplinary knowledge which include science and/or mathematics through the integration of the practices of engineering and engineering design of relevant technologies. [2]

From the aforementioned definition, STEM education has been defined and redefined according to the context of how it is being used in school, in the classroom setting, in the education system and even in different countries. It has also been variably defined from a person’s perspective to another and teachers as well as administrators are not exempted to this. In the Philippines, STEM as a tract in senior high school is on its pioneering years. Since then, greater emphasis on these fields and for
improvements in the quality of curricula and instruction efforts is being paved. [4]Numerous new instructional materials, programs, and specialized approaches are emerging. While most of these initiatives addressing one or more of the STEM subjects separately are good, there are also increasing calls for emphasizing connections between and among the subjects.

Advocates of more integrated approaches to K–12 STEM education argue that teaching STEM in a more connected manner, especially in the context of real-world issues, can make the STEM subjects more relevant to students and teachers. This in turn can enhance motivation for learning and improve student interest, achievement, and persistence. And these outcomes, advocates assert, will help address calls for greater workplace and college readiness as well as increase the number of students who consider a career in a STEM-related field.[3]

In a goal to bridge the gap between the specialized and separate subjects in science, technology, engineering and mathematics and provide students learning experience with integrated STEM disciplines, this study proposes the use of the embedded lesson plan.

2. Developing STEM Education Learning Activities
The lesson plan of formulating refreshment drink activity utilizing STEM education will bring students to practice STEM knowledge as clarifying in the Table 1. The STEM education activities were developed on concept of Context-based STEM education learning approach which the STEM education learning activities should provide not only the ways of investigation and solving problem but also a real world problem solving. Regarding on Sutaphan and Yuenyong [5], 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. The lesson plan could be highlighted as the table 2.

| Table 1 STEM Education that the students will learn from the STEM education activity |
|-------------------------------|-------------------|
| STEM                          | Contents and skills                        |
| Science (S)                   | Diseases resulting from nutrient deficiency and ingestion of harmful substances (Biology), Elements, compounds, and mixtures (Chemistry), energy gain (Physics), seasons (Earth Science), Geographic location and ethnomedicine (Social Science) |
| Technology (T)                | Methods, techniques, materials              |
| Engineering (E)               | Design, control, and process analysis, the use of engineering process |
| Mathematics (M)               | statistics and marketing                     |

| Table 2 Lesson Plan on Refreshment-Making Based on STEM Education Learning Approach |
|-------------------------------|---------------------------------------------------------------|
| STAGE                         | ACTIVITY                                                                                                                                 |
| 1. Identification of social issues | 1. Ask the students to perform a ROLE PLAY on “What they are going to do during hot summer days?”  
2. Processing: “What are the common issues/problems that you can see from the role play?”  
3. Let the students focus on the social issue on refreshment vs. nutrition.  
4. Observe the School Canteen: “What are the common refreshments bought by the students?” |
Table 2 (Cont’)

| STAGE                          | ACTIVITY                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Identification of          | 5. Let the students make a diagram from their gathered observations in the School Canteen:                                                                                                                                                                                                                                               |
| social issues                  | REFRESHMENT NUTRITIONAL VALUE/RISK (Let the students identify the substances that pose risk to human health) QUANTITY x COST                                                                                                                                                                                                           |
| 6. The teacher then states the | 1. Students and teachers share the cost analysis in the design of their refreshment products.                                                                                                                                                                                                                                             |
| topic: “If students are FOOD  | 2. Students may discuss their possible design on the refreshments regarding on the five capitals: physical, financial, social/technology, human and natural capitals. Physical – Students can interview or ask help/tap people from food manufacturing companies within their area, tap university resources like Fablab, PRISM, IDEYA.                                                                                   |
| TECHNOLOGISTS, how can they   | Financial – reducing the cost                                                                                                                                                                                                                                                                                                           |
| design a product/refreshment   | Social/Technology – Material selection using appropriate materials, find ways to solve the problem, collaboration with local agencies and manufacturers.                                                                                                                      |
| with the healthiest benefits   | Human need – The safety of food and its nutritional value, palatability of the product, aesthetic aspect, cheaper cost                                                                                                                                                                                                                 |
| using organic ingredients      | Natural – The use of organic ingredients available in the community, utilization of local raw materials                                                                                                                                                                                                                              |
| available within the          |                                                                                                                                                                                                                                                                                                                                           |
| community?                     |                                                                                                                                                                                                                                                                                                                                           |
| 2. Identification of          | 1. Based on the plausibility of the manufacturing of a refreshment product with higher nutritional value and cheaper capital and higher palatability to the consumers. Financial – marketing and accounting strategies, Physical – design of product packaging, analysis of nutritional value, food preservation, food manufacturer, Social – sources for the natural products and raw materials within the community.                                                                 |
| potential solution             | 2. Plan the formulation of the refreshment products, including the formula, composition, raw materials, additives                                                                                                                                                                                                                 |
| 3. Need for knowledge          | 3. Do an activity on the different mixtures and formulas of the refreshment product.                                                                                                                                                                                                                                                       |
|                               | 3.1 Pre-activity homework: ask the students to bring the needed ingredients for the refreshment they are to make                                                                                                                                                                                                                       |
|                               | 3.2 Activity proper – making a sample of the refreshment product The teacher should provide students with different glasswares and laboratory apparatus for the activity                                                                                                      |
|                               | 3.3 Doing a taste test of the product                                                                                                                                                                                                                                                                                                      |
| STAGE                     | ACTIVITY                                                                 |
|--------------------------|---------------------------------------------------------------------------|
| 3. Need for knowledge    | 3.4 Revision of the product                                              |
|                          | 4. Teacher and students discuss the content integration of the activity  |
|                          | using questions.                                                         |
|                          | Examples:                                                                |
|                          | Why did you choose to make this refreshment product?                     |
|                          | Why did you choose to use the raw materials on your refreshment product?  |
|                          | Why do you think this refreshment product is a good substitute of the    |
|                          | commercial products?                                                     |
|                          | Do you think students your age would buy this product? Why?              |
|                          | 5. The teacher discusses and processes the activity and the answers of   |
|                          | the students using the following concepts:                               |
|                          | Biology: Diseases resulting from nutrient deficiency and ingestion of     |
|                          | harmful substances                                                       |
|                          | Chemistry: Elements, compounds, and mixtures                             |
|                          | Physics: Energy                                                          |
|                          | Earth Science: Wet and dry seasons                                       |
|                          | Social Science: Geographic location, ethnomedicine                       |
|                          | Mathematics: Statistics and probability                                  |
| 4. Decision-making       | 1. After the students have the knowledge and education activities. The   |
|                          | teacher assigns each group to design their final product.                |
|                          | 2. Students work on the design, marketing, raw materials, final formula  |
|                          | of the product.                                                          |
| 5. Development of the    | 1. Students formulate the refreshment product by using all the materials |
| product                  | needed.                                                                   |
|                          | 2. Students can bring local /raw material that can be used as refreshment|
|                          | product.                                                                 |
|                          | 3. Sample refreshment product                                             |
| 6. Test and evaluation   | 1. The students will be asked on the aspects of the possibility of the   |
| of the solution          | product. They need to test the following issues:                         |
|                          | 1. Is the use of local raw materials for the refreshment product         |
|                          | comparable to the commercial product its terms of:                       |
|                          | a. Nutritional Value                                                     |
|                          | b. Energy gain                                                           |
|                          | c. Material suspension and homogeneity of the mixture                    |
|                          | d. raw material availability                                             |
|                          | e. possible ingestion of harmful substances                              |
|                          | 2. Is the product salable?                                               |
|                          | a. probability of buying the product                                     |
|                          | b. appeal to customer                                                    |
|                          | c. availability of consumption throughout the year (seasons of the year) |
|                          | d. packaging material and sanitary process                               |
|                          | e. Cheap                                                                 |
|                          | 3. How can you promote this product?                                     |
Table 2 (Cont’)

| STAGE                                           | ACTIVITY                                                                 |
|------------------------------------------------|--------------------------------------------------------------------------|
| 7. Socialization and completion decision stage. | 1. Conduct a free taste in school vicinities. Solicit feedbacks.          |
|                                                | 2. Design a brochure/leaflets to promote the product.                     |
|                                                | 3. Modify the product based on the feedbacks.                            |
|                                                | 4. Conduct a project proposal for the conduct at the school level.        |

According to the table 1, identification of social issues stage will be started by situation of summer in the Philippines is rather long and hot. Before presenting the lesson on Digestive System, the teacher presents a scenario to the students: A Hot Summer Day. The teacher then asks the students to do a role play on what they would usually do on a hot summer day. The students would probably focus on activities under the sun as well as some refreshments. In processing the role play, the teacher would ask students: What are the social issues that you can see in the role play? The students would probably answer different issues but with the mention of unhealthy refreshments, the teacher would then single-out refreshments and asks: What refreshments would usually sell on a hot summer day? The students’ answers may vary but would mostly include soda and sugary drinks. To test the students’ hypothesis, the teacher would group the students in 5 and assign them to observe in the school canteen and different stores nearby. This would be their homework for the whole week. Each group would observe the specific refreshment that people buy. In the worksheet given to them, the students are to list down the names of the refreshment, the nutritional value or health risk it contain as well as the cost which will computed by the total number of bottle sold on that drink for the whole week multiplied by the cost of each bottle. The students will then make an analysis on the issues concerning the refreshments. To solve the issue, the students will act as Food Technologist. They will be ask to design/formulate a refreshment drink made from natural and cheaper ingredients that can be found in the community with high palatability and aesthetic appeal to be a substitute to the unhealthy refreshments that most people avail.

Identification of potential solution, the teacher will create a new groupings of 8 members each. The students will be ask to brain storm on the product cost, design, market, packaging and formulation. They have to come up with a proper product proposal containing the five capitals: physical, financial, social/technology, human and natural capitals. To effectively do this, the teacher will hint the students some possible collaboration to help them with. For the Physical capital, the students may partner with local manufacturers, designers and agencies. They may write a letter to the Premier Research Institute of Science and Mathematics (PRISM) of MSU-IIT for their analysis on the nutritional value of the natural formula that they can come up with. They may also tap FABLAB Mindanao of MSU-IIT to help them with the design of the packaging and the prototype of their refreshment product. The IDEYA of MSU-IIT can also give them a hand on how to effectively start-up a business for their product as well as manage and market it. This would be their financial capital. For the social/technology capital, they may walk around the local market or the neighborhood community for raw materials that are readily available. They can also tap local food manufacturer to learn where they can buy cheaper goods and raw materials. The human need capital can be brainstormed using the data on their observation which could be the safety of the refreshment/health benefits, palatability and aesthetics appeal as well as cheaper cost. For the natural capital, the group must focus on keeping the ingredients and packaging as natural as possible. Using mostly organic and local raw materials.

Need for knowledge, based on the plausibility of the manufacturing of a refreshment product with higher nutritional value and cheaper capital and higher palatability to the consumers, the students must have the knowledge on what agencies, manufacturers or offices to tap. They need to gain knowledge on how to manage the production and marketing of the product, where to get the capital and how to promote and sell it. They also need to know the geographic location of the best raw materials that they need. For example, if they need to use lemon grass, lemon and honey, they need to know where they can find fresh produce within Iligan City. They have to gain knowledge design making. Their design
should have cultural, social and aesthetic appeal. Lastly, they need to have a background idea on the health benefits of the raw materials that they might use as well as the longevity of the ingredients so they can decide on the natural preservation that they should utilize. With all these things in mind, they have to formulate at least 3 natural combination of possible formula for their refreshment product. They have to bring the raw materials as a pre-activity. On the activity proper, the students will try formulating it in the lab. The teacher would provide the instruments and glassware. Trial and error method would be done on the three formula then it would be presented to the teacher. During presentation, the teacher would ask the following questions: Why did you choose to make this refreshment product? Why did you choose to use the raw materials on your refreshment product? Why do you think this refreshment product is a good substitute of the commercial products? Do you think students your age would buy this product? Why? The teacher will then process their answer as an integration to the following topics: Biology: Diseases resulting from nutrient deficiency and ingestion of harmful substances which is a learning competency under the topic on Digestive System. For Chemistry: Elements, compounds, and mixtures, siting the examples on harmful effects of some substances in commercial refreshments and the health benefits of natural substances found in the natural refreshments. In Physics, the integration will be on the Energy gain after being naturally refreshed by their drink. In Earth Science, the effects of the season to the growth of these natural products. In Social Science, the significance of the Geographic location to the growth and health of the natural ingredients as well as the ethno-medicinal effects of these ingredients. In Mathematics, Statistics would be integrated through their survey, their marketing strategies and feasibility study.

Decision-making, after their presentation and processing of the activity, the students would be ready to create their final product. They can now decide which formula would they use, which ingredients is best and etc. They would then work on their final product design and proposal.

Development of prototype or product, this would be the development of the final product stage. Using the final formula, they would develop their final product and try to package it. They would produce 10 bottles at most for their promotion and marketing.

Test and evaluation of the solution, before the actual promotion activity, the students will be asked to have a product pitching. The teacher will ask them on the aspects of the possibility of the product by testing the following issues:

1. Is the use of local raw materials for the refreshment product comparable to the commercial product its terms of:
   a. Nutritional Value
   b. Energy gain
   c. Material suspension and homogeneity of the mixture
   d. raw material availability
   e. possible ingestion of harmful substances

2. Is the product salable?
   a. probability of buying the product
   b. appeal to customer
   c. availability of consumption throughout the year (seasons of the year)
   d. packaging material and sanitary process
   e. Cheap

3. How can you promote this product?

The product pitching would prepare the students to answer prospect costumer’s questions as well as to guide them to have the most effective and informative promotional campaign.

Socialization and completion decision stage, after they pass the product pitching, the students will then conduct the promotional campaign by doing a free taste within the school vicinity. They have to prepare a booth where students would have free taste of the refreshments which the ingredients are not yet revealed. The costumers are then asked to give feedback and reactions on the refreshments. The collected feedback will be their basis for the further refinement of
the product and final promotion and product proposal to be submitted to agencies that can support such ingenuity.

3. Conclusion
The lesson plan was created considering all the target learning competencies of different field/subjects in Grade 8 to maximize time, minimize workload of students and produce output that are ingenuine, authentic and of higher order thinking skills.

Conceptualizing STEM education inside the classroom in the Philippine setting is already ambitious while implementing it may be laborious and out of the ordinary. Nevertheless, this new definition and application of STEM education is both liberating and beneficial especially to students with wide-range skills and talents but are boxed to the norms of traditional STEM education. The skills that they can develop in these activities are important life skills that would not only equipped them for higher education but also prepare them for better employment. These kind of activities can also encourage them to take up STEM related courses in college and provide the nation with more work force passionate in STEM fields.

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Appendix

WORKSHEET
Activity 1: Formulating Refreshment Drink

Names: ___________________________ Date Started: _____________  
________________________________ Date Finished: _____________  
________________________________ Rating: _____________  
Group No. _____________

Objectives:
1. Determine the type of refreshment drink that people buy in stores and school canteen;
2. Compute the cost of refreshment drinks consumed in a day from the stores and school canteen;
3. Investigate the nutritional value and risks of the different substances and ingredients of most refreshments; and
4. Identify solution to the social issue observed.

Introduction:
According to Section 13 of Article 2 of the Healthy Beverage Options Act of 2011: “The State recognizes the vital role of the youth in nation-building and shall promote their physical, moral, spiritual, intellectual, and social well-being. It shall inculcate in the youth patriotism and nationalism, and encourage their involvement in public and civic affairs.” Thus, this Act prohibit schools from selling carbonated drinks inside the school premises and the school will be held liable if proven...
guilty of not following the said Act. Nevertheless, carbonated drinks and most commercial refreshments are still present inside school premises.

Social Issue:
Refreshment vs. Nutrition

Instruction:
Your group of 5 members will investigate the type of refreshments that people purchase in the school canteen as well as in stores near your house as well as its nutritional value, the risks it pose to the human health and the total cost spent to this refreshment in the whole week.

Task:
For this activity, to solve the social issue discussed in the past meeting, you will act as Food Technologists but each member of the group will be assigned to the following specific tasks:
1. Field Researcher (3 members) - the three of you will observe in the school canteen during breaks and in the stores within the neighborhood on the refreshment drinks that people usually buy. Write your findings in the table below.
2. Nutritionist (2 member) - the two of you will go to the library while the other group members are observing in the canteen. You may read books or browse the school’s internet resources for the common substances and ingredients of commercial refreshments that can be found in the canteen or nearby stores, their health benefits and risks they pose to the human health as well as the energy gain from this refreshments. Write your findings in your notebook.

Results and Findings

| Specific Name of the Refreshment | Nutritional Value | Health Risk | Cost (Quantity for 2 days x cost per bottle) |
|---------------------------------|-------------------|-------------|---------------------------------------------|
|                                 |                   |             |                                             |

Questions:
1. Which refreshment has the highest sales for 2 days?
2. What do you think are the factors that people consider in buying a refreshment drink?
3. What are the common substances that can be found in those commercial drinks?
4. Why do you think people still buy refreshments that has potential risks to the human health?
5. Do you think these refreshments are worthy of its costs? Why or Why not?

Conclusion:
What solution can you propose to address this social issue?