

Development of SSI-based Module to Aid in Teaching Genetic Engineering and Improving the Conceptual Understanding and Decision-making Skills of Students

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Abstract

Socioscientific issues (SSI) are open-ended, multifaceted social issues with conceptual links to science. SSI education is aimed at attaining functional scientific literacy. This study sought to develop an SSI-based module that will help improve the conceptual understanding and decision-making skills of students. It also sought to address the gaps in scientific literacy and in the lack of integration of SSIs in the teaching of science. The study made use of the ADDIE Model as its research design and followed the five stages of instructional model for SSI-based education by Eilks (2010) in the development of the module. The needs assessment survey on teachers and students revealed that genetic engineering is a hard topic and there is a lack of learning materials and laboratory activities. The developed module underwent evaluation by a panel of experts. With a mean of 2.44, the over-all rating of the panel of experts on the module is Very Satisfactory. Thus, the developed SSI-based module is ready to be implemented. The comments and suggestions of the panel of experts were used to improve the developed module.

Keywords: SSI-based module, Genetic Engineering, Decision making

1. Introduction

In the process of teaching and learning science, it has been recorded that students in the Philippines have been performing poorly in national and international assessments as seen in the results of PISA 2018, TIMSS 2019, and the yearly NAT, thus, lowering the level of scientific literacy among students. Scientific literacy consists of the knowledge and understanding of the scientific concepts and processes required for personal decision making, participation in civic and cultural affairs and economic productivity (Mohapatra, 2013). In general, science as a subject taught in every school should support the development of scientific literacy (Turiman, Omar, Daud and Osman, 2012; Yuenyong and Narjaikaew, 2009).

One way to make sure that the development of scientific literacy is being supported is to improve the conceptual understanding and decision-making skills of students. To support the development of scientific literacy, improve the conceptual understanding and decision-making skills of students, the researcher would like to integrate socioscientific issues (SSI) in teaching science concepts. SSIs are open-ended, multifaceted social issues with conceptual links to science. Students who participated in SSI-based learning experiences have demonstrated gains in understanding of science ideas (Dawson and Venville, 2013; Sadler, Romine and Topçu, 2016), nature of science (Lederman, Antink and Bartos, 2014); and scientific practices, such as modeling (Peel, Zangori, Friedrichsen, Hayes and Sadler, 2019; Zangori, Peel, Kinslow, Friedrichsen and Sadler, 2017) and argumentation. Studies have found out that teachers do not usually make use or omit entirely the integration of sociocientific issues in teaching science concepts. Three notable explanations for teachers' omission of SSI-focused activities from their classrooms are: teachers' unfamiliarity, lack of experience, and/or discomfort with an SSI-focused teaching approach (Sadler, Romine and Topçu, 2016; Saunders and Rennie, 2013); teachers' limited access to SSI-focused curricular resources (Sadler, Romine and Topçu, 2016); and discrepancies between teachers' perceptions of SSI and the philosophical basis of the pedagogy (Hansen and Olson, 1996; Sadler, Romine and Topçu, 2016).

Thus, the aim of this study is to develop a module that is integrated with socio scientific issues to promote scientific literacy, improve students' conceptual understanding, and further develop their decision-making skills.

1.1 Objectives of the Study

This study would like to address the gaps on the poor scientific literacy of students and the lack of integration of socioscientific issues in the teaching of science. The study specifically sought to achieve the following objectives:

1. Assess the needs of senior high school science teachers and students to better teach Genetic Engineering.
2. Develop an SSI-based module to aid in teaching genetic engineering.
3. Evaluate the developed SSI-Based module.

2. Methodology

This study followed the Analysis-Design-Development-Implementation-Evaluation (ADDIE) model (Bates, 2014) as its research design as seen in Figure 1 below.

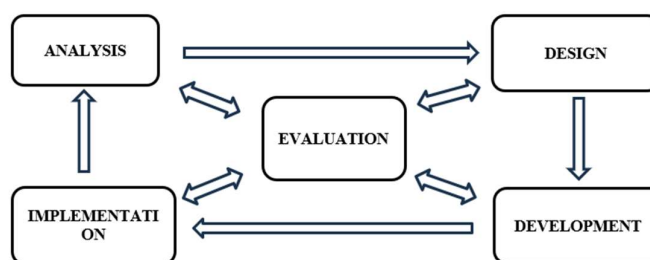


Figure 1. The Analysis-Design-Development-Implementation-Evaluation (ADDIE) Model.

The respondents of the study were Senior High School Science Teachers, Grade-12 STEM students and a panel of experts, who were chosen through purposive sampling. The research instruments that were used in the study are the following: Needs Assessment Survey Questionnaire for Teachers, Needs Assessment Survey Questionnaire for Students, SSI-Based Module and Rubric for the Developed SSI-Based Module.

The process of data gathering for this study followed the stages of the ADDIE Model [10]. Under Analysis, the following steps were undertaken: The researcher first selected the socioscientific issue (SSI) that was the focus of the module. For this study, the issue on genetically modified organisms (GMOs), cloning, and gene therapy were selected. This was followed by the identification of the topic related to the SSI. The topic genetic engineering was selected. After identifying the SSI and the topic of the module, the researcher conducted a needs assessment survey on senior high school science teachers and Grade-12 STEM students. This was done to determine the needs of both teachers and students when it comes to the teaching and learning of the topic genetic engineering and to determine the awareness of teachers on socioscientific issues.

Under Design, the making of the SSI-based module occurred. The five stages of instructional model for SSI-based education by Feierabend and Eilks (2010) was chosen to be followed in the development of the module. The parts of the module included the following (1) Problem Analysis, (2) Clarification of Science, (3) Refocus on Social Scientific Issues, (4) Roleplaying Task, and (5) Meta-Reflection. The researcher then formulated the lesson objectives aligned with the science K-12 curriculum. The next stage, Development, took place. The learning resources were determined and the researcher embedded the needed content and activities into the module. After doing so, the module underwent validation and evaluation by a panel of experts. The research instruments were then revised according to the results of the validation and evaluation.

On the data analysis of the study, the responses on the needs assessment survey were analyzed through thematic analysis. The mean rating was computed for each criterion from the ratings made by experts on Science and SSI on the developed SSI-based module.

3. Results and Discussion

3.1 Needs Assessment Survey on Science Teachers

Prior to the conduct of the study, a needs assessment was administered to the science teachers handling Genetic Engineering in two schools in Iligan City, namely, Iligan City East National High School and Iligan City National High School. This was done to gather information on the needs of the teachers on the topic Genetic Engineering and find out if they have experience with integrating SSIs in their lessons.

Table 1. Summary of Responses on the Needs Assessment for Science Teachers on Genetic Engineering and the SSI-Based Approach.

Themes	Codes	Mentions	Sample Utterances
Problems Encountered in the Teaching-Learning of Genetic Engineering	Difficult Topic	2	NAS-T1: “Genetic Engineering is particularly a difficult topic according to my students.”
	Hard Terminologies	1	NAS-T4: “It was hard to introduce this topic because there are many terminologies that the students have not yet encountered.”
	Lack of learning resources and opportunities	2	NAS-T4: “Lack of textbook; Difficult topic to discuss; Limited teaching/ laboratory hours”
Coping Techniques	Utilization of multimedia	2	NAS-T1: “Students nowadays learn effectively when their auditory-visual processes are being utilized in the learning process. I introduced many video presentations for them to grasp the concept of genetic engineering.”
	Detailed discussion of the topic	1	NAS-T2: “To address these problems, I had to mix the traditional lecture type of approach and match it with novel learner-centered activities that allow the learners to explore the topic.”
	Employ laboratory activities	1	NAS-T4: “Choose simple lab activities.”
	Research on the topic	1	NAS-T5: “Research and use up-to-date materials that are appropriate in the teaching-learning process.”
Pedagogical Approaches Employed	Collaborative learning	1	NAS-T1: “I always incorporate collaborative learning in teaching for the learners to understand the value of cooperation and teamwork. Whenever possible, I let my learners do experimentation for them to experience the concepts themselves.”
	Laboratory activities	1	NAS-T3: “I use simple laboratory activities.”
	Traditional method	1	NAS-T4: “For students that has a hard time analyzing concepts, I use traditional method.”
	Advanced learning with guidance	1	NAS-T5: “Students that are advanced compared to others are encouraged to learn concepts on their own but with guidance.”
Familiarity with the SSI-Based Approach in Teaching	Familiar with the SSI-based approach	4	NAS-T1: “I think SSI approach is a method where teaching Science is used to relate to the social context which are scientifically and socially relevant. For instance, after the students learned about Genetic Engineering, I tasked them to create an infographic containing the advantages and disadvantages of Genetic Engineering to humans.”

Themes	Codes	Mentions	Sample Utterances
	Not familiar	1	NAS-T4: “Not familiar but as I searched it, it will definitely help both teachers and students in critical thinking.”
Benefits of introducing SSIs in the teaching-learning process.	Awareness of global issues	1	NAS-T1: “Yes, introducing SSI in lessons not only teaches our students the different contexts of Science but also its impacts and relevance to the society. It will help not just the students but also the teachers to be aware of global issues.
	Understanding the lesson through relevant happenings in the community	1	NAS-T2: “I agree because students better understand a lesson or a concept especially if they are given examples that are really happening in the community or in the surroundings.”
	Teaching through the use of relevant information	2	NAS-T3: “Yes, it will be easier for the teachers to introduce the topics because of its relevance.” NAS-T4: “Yes, it will encourage teachers to use relevant information in their lesson materials.”
	Improve the teaching-learning process	1	NAS-T5: “Yes, it is very important since this also encourages students to think and analyze that could greatly improve the teaching-learning process.”

As shown in table 1, five (5) themes were determined on the answers provided by science teachers on the needs assessment questionnaire. The themes are the following: Problems Encountered in the Teaching-Learning of Genetic Engineering, Coping Techniques, Pedagogical Approaches Employed, Familiarity with the SSI-Based Approach in Teaching, and Benefits of introducing SSIs in the teaching-learning process. The teachers found genetic engineering to be a hard topic due to the difficult terminologies and lack of learning resources. To address this problem, they made use of multimedia and simple laboratory activities as well as research on the latest information on the topic.

3.2 Needs Assessment Survey on Students

Prior to the conduct of the study, a needs assessment was administered to two sections of Senior High School students under the STEM strand of Iligan City East National High School and Iligan City National High School. This was done to gather data on the needs of the students on the topic of Genetic Engineering.

Table 2. Summary of Responses on the Needs Assessment for Students on Genetic Engineering.

Themes	Codes	Mentions	Sample Utterances
Definition of Genetic Engineering	Manipulation and modification	24	NAS-S3; NAS-S6; NAS-S19; NAS-S26; NAS-S31; NAS-S32; NAS-S36; NAS-S41; NAS-S53: “Genetic Engineering is to design and manipulate genetics for innovation.” NAS-S38: “Genetic Engineering is the process of genetically modifying

Themes	Codes	Mentions	Sample Utterances
			organisms to upgrade specific functions of the organisms which will then improve their performance and efficiency of doing certain tasks/activities.”
	Creation of new organisms	15	NAS-S36: “Genetic Engineering nowadays is rampant because of the booming technology which the scientists creates new type of organism that can benefit the world/ecosystem that can cause imbalance in the world/ecosystem.”
	Focused on genetics and the DNA	6	NAS-S21: “Genetic Engineering for me is all about studying/focusing in genes like how it works, develop, inventing things that is related in these studies.” NAS-S24: “The group of applied techniques of genetics and biotechnology used to join together genetic material especially DNA from one or more species of organism.”
	Utilization of technology to alter the genetics of organisms	15	NAS-S7; NAS-S11’ NAS-S28; NAS-S41; NAS-S42; NAS-S43; NAS-S59: “Genetic Engineering is a process that uses technologies that is laboratory-based to alter the DNA makeup of an organisms.” NAS-S8: “Used to refer to methods of recombinant DNA technology.”
Problems encountered	Complex topic	33	NAS-S3; NAS-S6; NAS-S7; NAS-S9; NAS-S32; NAS-S38; NAS-S39: “Difficult for me to analyze and understand how it is done.” NAS-S11: “I’m having hard time learning about the process of techniques since it applies the genetics and biotechnology.”
	Does not have an idea.	7	NAS-S33; NAS-S34; NAS-S40; NAS-S45: “I did not get to learn about genetic engineering.”
	Confusing.	3	NAS-S21: “Learning the process can be a little confusing and tricky.”
	Slow in learning.	2	NAS-S10: “Slow learner.” NAS-S60: “It takes time and focus when doing experiments.”
Coping Techniques	Further research	16	NAS-S21: “I made some research to deepen my understanding on the process.” NAS-S46: “I look for another PPT’s online to find an easy explanation.”
	Watching videos on the web.	8	NAS-S6: “By watching videos about genetic engineering to help me visualize the processes of genetic engineering.”

Themes	Codes	Mentions	Sample Utterances
			NAS-S15: “By relying on virtual simulations.”
	Dedicate more time to studying	26	NAS-S9; NAS-S34: “I studied and recalled the proper process of the DNA structure.”
	Asking help from peers and experts	10	NAS-S10; NAS-S28; NAS-S50; NAS-S58: “I’ve coped up with these difficulties by asking to my classmates regarding the topic.” NAS-S16: “Collaboration with experts in this field.”
Recalling the process of Genetic Engineering	About different biological techniques	13	NAS-S5; NAS-S9; NAS-S18; NAS-S19: “Yes, the process of genetic engineering that I can recall are: gene splicing, artificial selection, and cloning.”
	Unable to recall	21	NAS-S10; NAS-S12; NAS-S32; NAS-S51: “No, I forgot the process.”
	The topic was not introduced	14	NAS-S11; NAS-S20; NAS-S50; NAS-S56: “No, our teacher wasn’t able to teach us about genetic engineering things.”
	Field of Biotechnology that manipulates genetic material	10	NAS-S7; NAS-S26; NAS-S37; NAS-S54: “I learned that genetic engineering is a field of biotechnology that involves manipulating genetic.”
	Undergo steps to arrive a certain product	2	NAS-S40: “The process is composed of 3 steps. First, isolation of DNA fragments. Second, the insertion of an isolated DNA fragment. Third, the growth or a recombinant vector.” NAS-S41: “It starts with splicing a part of the DNA of a certain organism and inverting it into an organism with changed physical properties.”
Familiarity with GMOs	Associates it with the transfer of genes from one organism to another.	13	NAS-S5; NAS-S7; NAS-S46; NAS-S47: “Yes, Genetically modified organism called transgenes organism since genes are transferred form one organism to another.” NAS-S53; NAS-S54: “Transferring one gene to another (transgenic organisms)”
	Not familiar.	16	NAS-S3; NAS-S19; NAS-S21; NAS-S23; NAS-S48; NAS-S51; NAS-S59: “No, I can’t remember GMOs being discussed.”
	Organisms that had their genetics modified.	26	NAS-S6; NAS-S13; NAS-S16; NAS-S30; NAS-S55: “Yes, GMOs are plants, animals, and microorganisms whose genetics are modified for other uses such as consumption wherein an unwanted

Themes	Codes	Mentions	Sample Utterances
	Combining two different species.	5	NAS-S31; NAS-S34: “Yes, we tackled about it.” NAS-S45: “When humans tamper with the DNA and combine it with another”
Familiarity with cloning	Duplication of traits of an organism.	22	NAS-S5; NAS-S17; NAS-S54: “Yes, this is like a species have a same look, structure, or like duplicated.”
			NAS-S7; NAS-S19; NAS-S32; NAS-S55; NAS-S56; NAS-S60: “Cloning is the process of replicating an organism down to its very exact copy.”
	Creation of an exact copy of an organism.	30	NAS-S40: “It is a technique scientist use to make exact genetic copies of living things.” NAS-S4; NAS-S16: “Yes, a single cell is removed from a parent organism and an entire individual is grown from that cell.”
	Unfamiliar with cloning.	8	NAS-S35; NAS-S36: “No, I am not familiar with it.”
Familiarity with gene therapy	Unfamiliar with gene therapy.	39	NAS-S11; NAS-S12; NAS-S18; NAS-S20; NAS-S23; NAS-S25; NAS-S27; NAS-S28; NAS-S32; NAS-S43; NAS-S44; NAS-S49; NAS-S50; NAS-S56; NAS-S57; NAS-S58; NAS-S59: “No, it hasn’t been tackled/ part of our competencies in our lesson genetic engineering.”
	Modification of genes.	5	NAS-S4; NAS-S47: “Yes, it modifies or manipulate the gene or alter the living cells’ biological property.”
	Insertion of good genes.	11	NAS-S5; NAS-S7; NAS-S30; NAS-S34; NAS-S45: “Yes, cause when the genes are cut out and good gene are inserted. Viruses are used to insert good genes.”
	Treatment of diseases.	5	NAS-S8; NAS-S36: “It involves the use of genes to treat or prevent disease.” NAS-S19: “Gene therapy is a treatment of genetic disorder or to provide a specialized disease-fighting function.”

As shown in table 2, seven (7) themes were determined on the answers provided by senior high school students on the needs assessment questionnaire. The themes are the following: Definition of Genetic Engineering, Problems Encountered, Coping Techniques, Recalling the Process of Genetic Engineering, Familiarity with GMOs, Familiarity with Cloning, and Familiarity with Gene Therapy. A number of the students were able to define genetic engineering. The problems that they encountered included the following, complex topic, confusing, slow in learning, and a lack of opportunity to explore the topic. To cope with these problems, the student perform research, watch videos on the web, and dedicate extra time to their studies.

3.3 Parts of the Developed Module

The development of the SSI-based module followed the five important stages in an SSI-based lesson according to Eilks (2010). Socioscientific issues (SSIs) were specifically integrated into the module in order to support the development of scientific literacy among student by improving their conceptual understanding and decision-making skills. With that, learners would be given the opportunity to explore the issues in our society, establish the relatedness of these issues to scientific concepts, and make informed decisions regarding these issues. The five important stages are the following:

1. Problem Analysis. Students will identify and describe the controversial issue present in the activity given to them.

2. Clarification of Science. This presents to the students the chosen science concept which is one of the foci of the developed module. It will contain information and activities that will provide learning to the students.

3. Refocus on Social Scientific Issues. Students will engage in activities that will establish the interrelationship between the SSI and the science concept. It will provide further clarification on the relatedness of the issue and the science concept. This stage will allow the students to judge both sides of the issue, use their moral reasoning and decision-making skills, come up with solutions, and develop their moral values.

4. Roleplaying Task. In this stage the students will be grouped and will be tasked to present a scenario based on the roles assigned to them. The researcher will provide guide questions that will be the basis of the task.

5. Meta-reflection. Students will discuss with the teacher what they have learned from the activities about the SSI and science concepts using guide questions. The researcher then formulated the lesson objectives aligned with the science K-12 curriculum.

3.4 Evaluation on the Developed SSI-Based Module on Genetic Engineering

Prior to the conduct of pilot testing, the developed SSI-Based Module underwent evaluation by a panel of experts composed of SSI experts and science educators. A scoring rubric adopted from the study of Foulk, Sadler and Friedrichsen (2020) was utilized, which contained the following components Focal Issue, Learning Objectives, Science Content, Social Connections, Assessment, Information Communications Technology (ICT), and Closure.

Table 3. Panel of Experts Rating on the SSI-Based Module

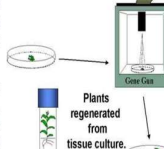
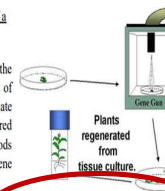
	SSIM-E1	SSIM-E2	SSIM-E3	MEAN	DESCRIPTION
A. Focal Issue	2.33 ^c	3 ^c	3 ^c	2.78	Very Satisfactory
B. Learning Objectives	2.66 ^c	3 ^c	2.33 ^c	2.66	Very Satisfactory
C. Science Content	2.6 ^c	3 ^c	2.4 ^c	2.66	Very Satisfactory
D. Social Connections	3 ^c	3 ^c	2 ^b	2.66	Very Satisfactory
E. Assessment	2 ^b	3 ^c	3 ^c	2.66	Very Satisfactory
F. ICT	3 ^c	3 ^c	3 ^c	3	Very Satisfactory
G. Closure	3 ^c	3 ^c	3 ^c	3	Very Satisfactory
Average	2.65 ^c	3 ^c	2.67 ^c	2.77	Very Satisfactory
^a 0.00 - 1.00: Poor					
^b 1.01 – 2.00: Satisfactory					
^c 2.01 – 3.00: Very Satisfactory					







The scoring rubric was composed of a 0 – 3-point scale where 0 indicates the absence of the component, 1 means that it is implied, 2 means explicit, and 3 means exemplary. As seen in table 3, all of the components of the scoring rubric were rated Very Satisfactory by all of the panel of experts. Hence, the developed SSI-based module had an overall rating of Very Satisfactory. This served as an indication that the developed module is an acceptable learning material.

3.5 Comments and Suggestions of the Panel of Experts on the Developed Module

During the evaluation of the developed SSI-based module, the panel of experts provided comments and suggestions to improve the quality of the module. Their comments and suggestions served as the basis for the revision of the module.

Table 4. The Changes Made on the SSI-Based Module Based on the Comments and Suggestions of the Panel of Experts.

Comment and Suggestion	Old Version	Revised Version
“SSIM-E3: Do not limit students’ answers and allow them to express their thoughts in a way that reflects their true reasoning, decision-making, and argumentation skills.”	<p>Let's Analyze</p> <p>1. From the articles that you have read, what controversial issue(s) is emphasized?</p> <p>2. Is the issue observable in your community? Were you aware about the issue? Briefly explain.</p>	<p>Let's Analyze. <u>You may answer the questions in English, Filipino, or the vernacular.</u></p> <p>1. From the articles that you have read, what controversial issue(s) is emphasized?</p> <p>2. Is the issue observable in your community? Were you aware about the issue? Briefly explain.</p>
“SSIM-E1; SSIM-E3: It is important to cite any references for figures/ images embedded in the module.”	<p>Step 4: Transformation, inserting the gene into the cells of a crop plant.</p> <p>The process of transformation involves the insertion of the desired transgene (gene of interest) construct into cells of the recipient plant species. In this process, scientists isolate tissue or cells from the cultivar (a cultivated plant with desired traits) they wish to transform and use one of several methods to insert the transgene into the tissue or cells.</p> <p>Two commonly used transformation methods include Agrobacterium tumefaciens-mediated transformation, microinjection, electroporation and biolistics transformation (aka gene gun). The biolistics method involves the use of high pressure to propel tungsten or gold beads coated with DNA of the gene construct into plant cells. Agrobacterium-mediated plant transformation make us of <i>Agrobacteria</i>.</p>  <p>Plants regenerated from tissue culture.</p>	<p>Step 4: Transformation, inserting the gene into the cells of a crop plant.</p> <p>The process of transformation involves the insertion of the desired transgene (genes of interest) construct into cells of the recipient plant species. In this process, scientists isolate tissue or cells from the cultivar (a cultivated plant with desired traits) they wish to transform and use one of several methods to insert the transgene into the tissue or cells. The transgene construct contains the following key features:</p> <ul style="list-style-type: none"> A promoter that acts to turn the gene on and off in the cell. A selectable marker that is used to select cells that successfully obtained the construct during the transformation process. A terminator sequence is included to mark the end of the transgene sequence for proper expression cells.  <p>Plants regenerated from tissue culture.</p> <p><small>Figure 10: Gene Gun Method. Source: https://artstate.pressbooks.pub/genobiotech/dna-engineering/</small></p>

Comment and Suggestion	Old Version	Revised Version
“SSIM-E1: Let’s review activity” (Page 24), scaffold them by using jumbled words and then let them define that word.”	<p>Let’s Review</p> <p>Define the Image. Put a description beside the image in each item.</p> <ol style="list-style-type: none">    	<p>Let’s Review</p> <p>Unscramble and Define the Image. Unscramble the words beside each item to get the name of it or process. Put a description beside the image in each item.</p> <ol style="list-style-type: none"> 1. A S D I M L P  2. C O B I M R A N E N T A N D  3. T I N O P A G A R O P (L O N G N I C) 
“SSIM-E2: Increase roles in all three activities under roleplaying task.”	<p>ROLEPLAYING TASK</p> <p>This task will be done in groups. Divide the whole class into two groups. Each group will meet and discuss and plan with your members.</p> <p>In this group activity, one will play the role of a cancer patient who has to undergo gene therapy through CAR T-cell therapy and the other will play the role of a scientist. Each group must be able to:</p> <ol style="list-style-type: none"> 1. Describe the advantages and disadvantages of gene therapy. 2. Make a group decision whether you support it or you’re against it. Then provide your explanation. 3. Engage in a healthy discourse of ideas by presenting your answers on activity 2. Your performance group, will be graded according to the rubric provided in Lesson 1.1. <p>Let’s Work Together</p> <p>ACTIVITY 1: What role is your group playing? Put a check in the box.</p> <p><input type="checkbox"/> Patient <input type="checkbox"/> Scientist</p>	<p>ROLEPLAYING TASK</p> <p>This task will be done in groups. The whole class will be divided into three groups. Each group meet and discuss and plan with their members.</p> <p>In this group activity, one will play the role of a cancer patient who has to undergo gene therapy through CAR T-cell therapy, the other will play the role of a scientist, the last group will play the role of a counselor. Each group must be able to:</p> <ol style="list-style-type: none"> 1. On Activity 1, you will be tasked to describe the advantages and disadvantages of gene therapy as a patient. 2. On Activity 2, you are tasked to make a decision whether you support or you’re against gene therapy provide your explanation. 3. After answering activity 1, all groups are tasked to record a 3-5 minutes video presenting your answers on activity 1. Your performance, as a group, will be graded according to the rubric provided on page 19. <p>Let’s Work Together</p> <p>ACTIVITY 1: What role is your group playing? Put a check in the box.</p> <p><input type="checkbox"/> Patient <input type="checkbox"/> Scientist <input type="checkbox"/> Counselor</p>
“SSIM-E1: Write your reference in academic style (ex. APA)”	<p>REFERENCES</p> <ul style="list-style-type: none"> • https://astate.pressbooks.pub/genbiotech/chapter/genetic-engineering/ • https://www.britannica.com/biography/Cesar-Milstein • https://www.youtube.com/watch?v=OpU_C09eFyQ • https://www.youtube.com/watch?v=jAhP4daNFY • https://businessmirror.com.ph/2022/06/21/impact-of-gmo-in-the-philippines/ • https://asia.nikkei.com/Business/Agriculture/Philippines-stirs-controversy-with-genetically-modified-rice • https://sim.hms.harvard.edu/flash/2015/how-to-make-a-gmo/ 	<p>REFERENCES</p> <p>A new treatment for patients with blood cancer: how it works. (n.d.). Philstar.com. Retrieved https://www.philstar.com/other-sections/supplements/2023/02/08/2243214/new-treatment-patients-blood-cancer-how-it-works</p> <p>American Society of Gene & Cell Therapy. (2022, January 6). <i>Gene Therapy Basics ASGCT - American Society of Gene & Cell Therapy</i>. Patienteducation.asgct.org. https://patienteducation.asgct.org/gene-therapy-101/therapy-basics/</p> <p>Animation 27.1 Basic principle of recombinant DNA technology. (n.d.). Youtube. https://www.youtube.com/watch?v=OpU_C09eFyQ</p> <p>Beltran, M. (2021, September 27). <i>Philippines stirs controversy with genetically modified rice</i>. Nikkei. https://asia.nikkei.com/Business/Agriculture/Philippines-stirs-controversy-with-genetically-modified-rice</p> <p>BioNinja. (n.d.). <i>Gene Therapy BioNinja</i>. BioNinja.com.au. https://bioninja.com.au/standard-level/bio-genetics/35-genetic-modification-and-gene-therapy.html</p> <p>Britannica, T. Editors of Encyclopedia (2023, March 20). <i>Cesar Milstein</i>. Encyclopedia Britannica. https://www.britannica.com/biography/Cesar-Milstein</p> <p>BusinessMirror. (2022, June 21). <i>The Impact of GMO Crops in the Philippines</i>. BusinessMirror. https://businessmirror.com.ph/2022/06/21/impact-of-gmo-in-the-philippines/</p>
“SSIM-E3: Main objectives should have cognitive, affective, and psychomotor or domain.”	<p>WHAT WILL I LEARN FROM THIS MODULE?</p> <p>At the end of this module, you should be able to:</p> <ol style="list-style-type: none"> 1. Describe the process of genetic engineering. 2. Determine the applications of genetic engineering. 3. Identify issues present in each application of genetic engineering. 	<p>WHAT WILL I LEARN FROM THIS MODULE?</p> <p>At the end of this module, you should be able to:</p> <ol style="list-style-type: none"> 1. Describe the process of genetic engineering. 2. Determine the applications of genetic engineering. 3. Identify issues present in each application of genetic engineering. 4. Present the advantages and disadvantages of the applications of genetic engineering. 5. Reflect on the value of genetic engineering.

From the comments and suggestions of the evaluators on table 4, there were a total of six comments and suggestions. Comment and suggestion number 1, the previous activities where the students need to answer questions related to the activity the instruction was to only answer in English. Upon evaluation SSIM-E3 commented that students should be able to freely express their opinions when answering the questions. The addition of the instruction stating that the students are free to answer the questions in English, Tagalog, or Bisaya was how the module was revised. It was done so that the students would not find difficulty in stating their answers and it would allow them to discuss in detail their ideas.

For comment and suggestion number 2, SSIM-E1 and SSIM-E3 stated that all figures and images should contain the sources where it was originally from. The older version did not contain any description to the image and there were no links. The new version contained its proper description and link.

Comment and suggestion number 3 was about revising the activity found in page 24 of the module. The old version of the activity was perceived to be hard. The students would have difficulty naming the image and providing description. SSIM-E1 suggested that the name for the image should be jumbled and the students are tasked to unscramble the letters to obtain the answer. They were also tasked to give the description based from the unscrambled letters. For comment and suggestion number 4, SSIM-E2 suggested to increase the roles in the roleplaying task. To further integrate critical thinking and decision-making skills among students the roles in all of the roleplaying tasks in the module were increased. The role of a counselor and moral representative were added.

Comment and suggestion number 5 was about changing the way the references were presented in the module. SSIM-E1 suggested to present the references in an academic style, thus, the references followed the APA format. Lastly, comment and suggestion number 6 was about improving the main objectives of the developed module. The old version contained objectives which mostly covered the cognitive domain only. The new version included objectives under the psychomotor and affective domain. It is important for the objectives of an activity or lesson to cover all three domains to ensure that the learner develops holistically.

4. Conclusion

Derived from the findings and analysis of the results, Science teachers recognized Genetic Engineering as a hard topic to discuss. There is a lack of resources and laboratory activities to help in the discussion of the topic. The Senior High School students were found to have sufficient knowledge on genetically modified organisms and cloning but there is a lack of knowledge on gene therapy. They found Genetic Engineering hard to understand and more time is needed in studying on their own, making further research, and watching videos on the web.

It was also concluded that the developed SSI-based module was rated Very Satisfactory in all components by the panel of experts, and hence an acceptable learning material. From the comments and suggestions, the module needed to be revised in only a few aspects but overall, it was an engaging learning material.

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