

Original Paper

The 2030 Agenda for Sustainable Development: How to Get Students Involved?

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Abstract

This paper shows a novel way to work with the UN's Agenda for the 2030 Sustainable Development Goals, implementing a project based approach in a chemistry high-school course. The integration of inquiry-based learning, as well as the project based strategies, allowed students to develop multicultural skills that are crucial for becoming a global citizen. What is more, it provided the opportunity to integrate the scientific method and improve scientific writing by submitting a paper at the end of the project.

Keywords

sustainable development goals, project-based learning, inquiry-based learning, multicultural skills, global citizens, scientific writing, agenda 2030

1. Introduction

If we want our students to take action in this globalized world, teachers should be able to target everyday issues and link them to school curricula through a series of engaging activities that will not cover only the theoretical aspects of the subjects, but that will actually engage them in current global issues. As part of the chemistry class, students are supposed to review concepts of sustainability which tend to be quite redundant nowadays. Experiential education is key to involve students in real world problems for developing specific skills that will in turn lead to gain knowledge. Project-Based Learning (PBL) enables students to observe and interact, benefitting from discoveries and experiments. More importantly, with the teacher acting as a facilitator, students are able to transform themselves through the learning process (Efstratia, 2014). PBL provides students with the opportunity to take responsibility for their own learning process by comprehending and structuring information. By using this approach,

students work cooperatively with the aim of producing concrete products (Ergul, 2017).

Moreover, project based learning allows for positive interdependence to take place, which is a basic component of collaborative learning. In such scenario, individual success depends on the overall success of a group, given by the frequent use of relevant social skills, promoting interaction among participants and personal responsibility to achieve the group's goals (Laal, 2013). Laal, Geranpaye, and Daemi (2013) propose that by working as a group, individuals are strengthened in the process since members gain greater individual competency by trying to achieve a common goal.

Since students belong to a multicultural program, it was decided to approach the topic by carrying out a one-semester project in which students integrated inquiry based learning in order to develop specific multicultural skills by focusing on the United Nations Goals for Sustainable Development. Mexico has been involved in pursuing these goals since 2016—the national indicators per goal can be reviewed in Sistema de Información de los Objetivos de Desarrollo Sostenible (<http://agenda2030.mx/ODSopc.html?opc=lis&ti=T&obj=0&idioma=es#/lis>).

There are five main multicultural competencies included in the PrepaTec Multicultural competency model. Multicultural Social and Emotional Learning is related to cultural identity, cultural sensitivity and well-being. Multicultural knowledge is used to understand general and specific cultural knowledge through experiences, perspectives and resources. Multicultural skills are required to interact effectively with people from different backgrounds and adapt to multicultural environments. Multicultural communication allows people to communicate effectively when interacting with others. Multicultural engagement enables people to take action as global citizens (Petro & Pineda, 2017).

As suggested by Frydychova (2013), students are required to possess well-developed academic skills, including extracting key information from scientific texts, taking notes and writing scientific papers. Based on this, students were required to submit a paper with the highlights of the project as the final product. The basic components of a scientific paper were taken from Meo, as suggested in MEO's Fish Bone Model (2018).

By practising Inquiry-Based Learning (IBL), students are in contact with something that resembles what real scientists do and actively participate in producing knowledge by going through the different stages: orientation, conceptualization, investigation, conclusion and discussion (Bardone, 2017; Pedaste, 2015). One advantage of the inquiry-based learning is that students are not led to experimentation step-by-step where the focus is to complete experiments rather than understanding the process in depth. In contrast, IBL leads to more meaningful and permanent knowledge (Bayram, 2013). Studies have also shown that IBL lessons proved to be more enjoyable and relevant compared to traditional classes and stimulating for students' motivation towards science (Suduc, 2015).

2. Method

2.1 School Context

One hundred and seventy four students with an average age of 16 to 17 years old participated in the project, all enrolled in the subject “Matter and Sustainability” which belongs to third semester of high-school at Prepa Tec, Campus Estado de México. All of the students belong to the multicultural program.

2.2 Inquiry Cycle

The steps presented by Pedaste (2015) were followed to complete the inquiry cycle. As part of the orientation stage, students were presented with the United Nations 2030 Agenda. Teachers were in charge of introducing the goals, as shown in image 1, briefly describe what each objective was about and involve students in giving examples related to specific actions that could lead to meeting the objectives. After this, students were randomly divided in teams of 5 and one objective was assigned to each team.



Figure 1. UN Sustainable Goals for the 2030 Agenda

During the conceptualization step, students came up with a research question that was focused on the UN objective and they wrote down a hypothesis. Students were offered (but not limited to) the following options for the project: experiments, models, campaigns or community action.

The investigation stage was divided in two parts. The first one lasted one month, in which only two fifty minute sessions from class time were devoted. By the end of this phase, students delivered a draft with the following components: research question, main objective, introduction (which consisted in a brief theoretical support to their specific topic), justification (in which they explained the impact of their topic at a national and global scale and their point of view on the matter), hypothesis, variables, methodology (including required material and steps to follow) and a brief description on how they would obtain data for the project. The second part lasted two months (again, two fifty minute sessions

were devoted to this) and it consisted in carrying out the experiment, model, campaign or action as well as obtaining data and evidence through pictures or videos. With these, they were required to write an article (which led to the conclusion stage from the inquiry based model) in which results (including data presentation and analysis), discussion, conclusions and team work were assessed. Team work was assessed by an online submission through Google Drive in which each member's contribution was checked by using the history changes tool. The checklist and rubric for both the draft and the final delivery are shown below. Two final sessions were used so that each team could present the findings to the rest of the group, which led to the final discussion stage.

| Descriptor | No (0 points) | Yes (10 points) |
|--|---------------|-----------------|
| Project is delivered through a drive file, uploaded to the corresponding forum in Blackboard. | | |
| Cover follows CREA guidelines. | | |
| An objective is described with verb, object and condition. | | |
| Introduction related to topic is included (one page long). | | |
| Project is justified according to students' own view and research. | | |
| Hypothesis is given, with dependents and independent variables clearly defined. | | |
| Methodology is described through a flux diagram. | | |
| Data obtention is described, and charts to be used for data collection are sketched. | | |
| There is evidence of students participation in the project (every student has to sign in using his/her itesm account; changes tool will be used to track interventions). | | |
| Required sources are documented in APA format. | | |
| Total | | |

Figure 2. Checklist for Evaluating the Draft

| Descriptor | Does not meet requirements (0) | Below expectations (10) | Sufficient (15) | Outstanding (20) |
|----------------------|--|---|--|---|
| Format | Article's format does not follow guidelines. | Format is incomplete Length of the article is not enough Two or more requested sections are omitted | Format required is followed, but length is not enough or one of the requested sections is omitted. | Title, abstract, introduction, results, conclusions and references are included. Article is divided in two columns and has between 3-5 pages. |
| Results and analysis | Charts or graphs that back up obtained results are not included. | Charts and graphs are not properly labelled. Chosen graphs are not representative of the collected data. There is no evidence of deep analysis regarding the obtained results, or contrast to what students expected. | Results are presented through charts and graphs properly labelled. There is no evidence of deep analysis regarding the obtained results, or contrast to what students expected. | Results are presented through charts and graphs properly labelled. Results are discussed based on the introduction and justification. Data is backed up with research. |
| Conclusions | No conclusions are included. | Conclusions are not related to results, hypothesis and objective. | There is an attempt to conclude, but conclusions are not related completely to objectives and hypothesis. | Obtained results are related to objectives and hypothesis. |
| Team work | There is no evidence of team participation. | There is an unbalanced distribution of work. One or more members did not participate in writing the article. | Despite the fact that every member participated, work is not distributed evenly. | There is evidence of active participation of every member. |
| References | No references are included. | Only one reference of each source is included: Book Digital library paper Magazine Reliable internet source | Number of requested sources is complete, though APA format is not followed. | All references are reported in APA, including a minimum of 2: Books Digital library papers Magazines Reliable internet sources |
| Total | | | | |

Figure 3. Analytical Rubric for Evaluating the Article

3. Results

As a result, the following projects were developed:

- **Reforestation:** It consisted on a reforestation campaign in which students were invited to participate. The team contacted a non profit organization in their community, organized volunteers and ended up planting 240 trees in a session. Besides writing the article, they recorded a video as part of the campaign evidence (<https://youtu.be/R6umKDocHMg>). The objective worked on this one was 15 “life on land”.



Figure 4. Students Participating in the Reforestation Campaign

- **Aquaponics:** Students developed a system in which crops were nurtured by fish waste found in water, and at the same time fish were benefitted. Their idea was that the aquaponic system would reduce the amount of resources needed for growing food and at the same time it would decrease the carbon footprint derived from transport and the use of fertilizers.

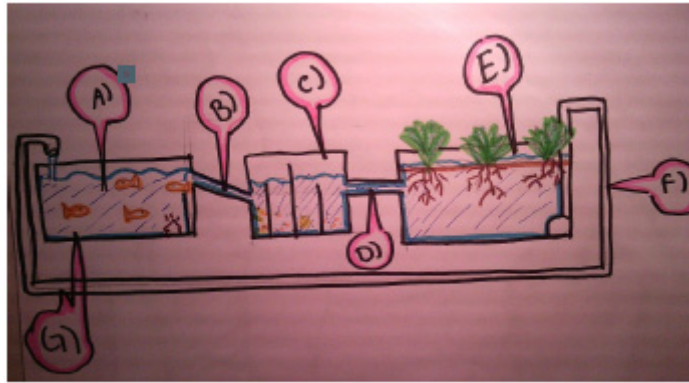


Figure 5. Proposal for the Aquaponic System

- **Green Tec:** Students conducted a study of the amount of resources used in their school. They focused on modern and reliable energy for everyone, which is one of the Agenda 2030 goals. After figuring out electricity consumption, they proposed different actions that would reduce energetic use at school, and they carried out an awareness campaign so that the community would use electricity in a wiser way.
- **Imperium, Sustainable city in a developing Country and Making a more sustainable city:** These three projects addressed the Sustainable Cities and communities goals. Their aim was to build a 3D model (two physically, the other sketched by using autocad) in which different elements of sustainability were incorporated. Some of the issues considered were waste disposal, green areas availability and green energy.



Figure 6. 3D Model of a Sustainable City

- **The red new green of ecology:** Students worked on how to reduce waste disposal from slaughterhouses as part of the Industry, Innovation and Infrastructure goal. They noticed that blood that comes out of the slaughterhouses can be a huge contaminant, since it is not regulated in Mexico. They carried out research on how they dispose waste products in other countries and organized a campaign in which they promoted *Ecoblood*, implemented by the European Community.
- **The potential of sea water, Cleaning water, cleaning our minds and Coffee filter:** Focusing on clean water and sanitation, there were three proposals. The first one was converting sea water into drinkable water by analyzing the feasibility of the method used in Israel. They compared growth in two plants, one irrigated normally and one with the saline solution. The second project carried out a survey on water use habits, in order to create awareness among people regarding the importance on taking care of water bodies. The last one was an experiment related to water pollution in which they created a coffee based filter to remove oil from water bodies.



Figure 7. Plant Watered with Saline Solution

- **It all adds up and Responsible consumption and production:** These campaigns focused on educating people in the community in regards of buying common practices and the 5Rs. Both teams conducted a survey to find out about the usage of plastic bags, garbage separation and disposal, recycling and common pollutants. An infograph and a presentation were created to raise awareness of how to reduce the ecological footprint.



Figure 8. Evidence of the Campaign

4. Discussion

Most students were aware of what sustainability represents, but through this project-based proposal, they not only acquired the corresponding concepts related to the topic. Instead, they were able to take full responsibility and do something about it, creating consciousness about the type of changes that are required to actually achieve the goals proposed in the Agenda 2030. This provided an excellent opportunity to reflect upon every day actions that we can do to reduce our negative impact in the planet and students were also willing to inform and involve the school community into most of the projects. One of the main goals of this project was to develop the multicultural engagement competency, since students were encouraged to take action and get involved with the sustainable goals. At the same time, creativity was fostered because students were free to choose the way in which they would impact their communities. The project was also an excellent opportunity to explore multicultural knowledge due to the fact that they had to explore what people were doing in other countries to achieve the sustainable goals and include it in the research. What is more, students reflecting on how their daily activities were affecting the planet allowed them to develop the multicultural social and emotional learning competency by gaining cultural sensitivity in terms of reducing their impact on the planet and assessing how their actions affected others.

As noted by Bardone (2017), Responsible Research and Innovation (RRI) was also relevant in the development of the project, since students had to look for authentic scientific papers to support their methodology, and research about similar projects that were carried out in different parts of the world. Moreover, RRI fosters citizens that are able to collectively take responsibility for science and scientific inquiry in and for society.

The main objective of asking students to submit a scientific paper was to develop academic writing skills. According to Eslava-Schmalbach (2013), papers should convey results in a way that the reader's understanding is facilitated. Through the discussion, students worked on the competencies in which results are contrasted in an investigation or experiment, and conclusions are communicated.

Most of the elements mentioned by Laal (2013) as part of collaborative learning were detected at

different stages of the process. Positive interdependence was shown in many situations where students needed for others to contribute in order to obtain tangible results. Needless to say, one of the evaluated elements was precisely team work as shown in the rubric above. Therefore, ensuring that everyone participated affected the grade of each member in the team. Interaction was needed to conclude the investigation, and negotiation was necessary for designing the experiment. Everyone was responsible for the article submission, so roles had to be assigned by team members and work was distributed accordingly. Social skills were developed at every stage of the project.

5. Conclusions

As can be seen, it is important to engage students in activities that enable them to take action. In order to achieve this, inquiry based learning can be coupled with project based learning so that the teacher assumes the role as a facilitator. With this intention, students become responsible for their own learning process, developing several multicultural competencies in the way. Both IBL and PBL provide the opportunity to work on multicultural social and emotional learning, multicultural knowledge, multicultural communication and multicultural engagement. With this in mind, integrating the Sustainable Development Goals established in the Agenda 2030 provides the perfect opportunity for students' involvement in world related issues. Additionally, by asking students to deliver a scientific article with their project results scientific literacy can be integrated as well. This in turn, enables teachers to carry out responsible research and innovation.

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