A project-based learning approach for engaging undergraduate students in UN SDGs using GIS

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Abstract

The paper presents project-based learning conducted within a Geographic Information System (GIS) course offered to senior-level undergraduate students enrolled in the civil engineering program at the German University in Cairo (GUC) during the academic semester of Spring 2022. Project-based learning enables students to achieve competencies that meet modern society needs in relation to monitoring and assessing world countries attainment of the United Nations Sustainable Development Goals (UN SDGs). The United Nations Economic and Social Council (ECOSOC) established the United Nations Committee of Experts on Global Geospatial Information Management (UN GGIM) in July 2011, where the UN GGI mandates were identified as a motivation for conducting project-based learning with the GIS course by the author. The emphasis in project-based learning was on; SDG 11 on Sustainable Cities and Communities, and SDG 13 on Climate Action. A Model of United Nations (MUN) students' group at the university provided a simulated UN General Assembly at the end of the project-based learning activities. During this Assembly, students enrolled in the GIS course, playing roles of country delegates, delivered to the Assembly their GIS analyses and findings on the current status of SDG 11 and SDG 13 at the end of the project-based learning. The success of the project-based learning in achieving its objectives, along with engagement and interest shown from both GIS enrolled students and MUN group have resulted in plans to conduct another project-based learning during Spring 2023.

Keywords: Project-based learning; geographic information systems (GIS); geospatial information; UN SDG.

1. Introduction

Many studies have proposed project-based learning for achieving competency, where students are active learners; integrating knowledge, skills, and values (De los Ríosa, el al, 2010). Problem-Based Learning (PBL) is a teaching method in which complex real-world problems are used as the vehicle to promote student learning of concepts and principles as opposed to mere presentation of facts and concepts. In addition to course content, PBL can promote the development of critical thinking skills, problem-solving abilities, and communication skills" (Center for Excellence in Learning and Teaching, 2022).Project-based learning allows students to acquire newly knowledge based on what they learned earlier. Power (2019) has indicated that student engagement and collaboration allow for the consolidation of such new acquired knowledge. Upon the successful implementation of a project-based learning, examples of competencies that could be achieved are; teamwork, risk-taking, accountability, problem-solving, innovation, critical thinking, and communication skills.

The study presented herein is concerned with making the students aware of the benefits of geospatial information in support of sustainable development. Student awareness of the use of geospatial information and the development of their technical skills and capabilities in handling geospatial information is considered within a project-based learning approach. United Nations Sustainable Development Goals (UN SDGs) indicators are practicable objectives for an academic course. The objectives of a GIS course taught by the author at the university to senior undergraduate students were lately augmented. Course objectives included awareness of UN SDGs. Early in 2015, prior to the project-based learning implementation, the UN SDGs related topics and themes were discussed through lectures and case studies relating to GIS and UN SDGs. Low student engagement was detected in this important topic, namely, UN SDGs. More recently during academic year 2021-2022.

The author considered project-based learning approach to further engage students in UN SDGs, and make them more aware of the importance of the use of geospatial information and the implementation of geospatial analyses tools and techniques when assessing UN SDGs indicators worldwide. Project-based learing may be categorized into three "closely related teaching techniques: case studies, role-plays, and simulations", (Center for Excellence in Learning and Teaching, 2022). The author selected role-plays which is most fitting for a UN General assembly, where students play the roles of country delegates.

2. Project-based Learning in GIS Course

2.1. About the course

The course in the context of this paper is related to Geographic Information System (GIS) for Civil Engineering Applications. GIS is a system designed to; collect, store, handle, analyze, manage, and present spatially georeferenced data; i.e. referencing data to geographic locations on the earth, commonly known as geospatial data. Further, GIS links tabular attribute textual and numerical data with a GIS geospatial database. Through querying the GIS geospatial database, users would be able to; spatially analyze, manage large datasets, and display information in a map-like and other graphical representations for better insight and in support for decision-making processes. (Dempsey, 2001).

One of the courses that the author teaches at the university is a course on using GIS in Civil engineering applications, for the senior civil engineering students. The course introduces senior undergraduate civil engineering students to GIS in terms of; concepts of GIS, and practice GIS-based processes. First, students become familiar with types of geospatial data, such as; engineering surveys, digital maps, satellite images, and Global Navigation Positioning System (GNSS). Next, students use GIS-based geospatial analysis tools and techniques in relation to civil engineering tasks and applications, such as; terrain mapping and analysis, location selection, construction management, route planning, watershed analysis, and environmental impact studies. Students become familiar through hands-on activities with; capturing geospatial data and integrating it with attribute data as input to develop a GIS geospatial database, use GIS-based tools and analyses to query the geospatial database, and produce output depicting spatial relationships, patterns, and trends, using histograms, charts, photos, satellite images and thematic maps, for better insight and in support for decision-making processes

2.2. Motivation for the Selected Project-Based Learning

Geographic Information System (GIS) was recognized by the United Nations (UN) as an enabler in implementing and tracking progress on the UN's seventeen Sustainable Development Goals (SDGs), UN SDGs targets, and indicators. Further, it was stated that GIS and location are key technologies that enable counties to monitor and assess progress at local levels, and in worldwide setups (Brown, C. and C. Brigham, 2021)

The United Nations Economic and Social Council (ECOSOC) established the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) in July 2011, to further the cause of using geospatial information in sustainable development processes worldwide. UN GGIM adopted a Global Statistical Geospatial Framework (GSGF) as the basis for supporting efforts for combining geospatial and statistical information (Scott and Rajabifard, 2017).

The UN GGIM in 2019 specifically demanded using geospatial information and GIS-based analysis approach to improve the availability, quality, timeliness, and disaggregation of data to support the implementation of the new development agenda at all levels (FIG Task Force on FIG and SDGs (2019). In view of this important global drive that happens to overlap with the GIS interest in utilizing geospatial information, and as the instructor of a GIS course, the author decided to introduce a project-based to help civil engineering students become more aware of GIS potential contributions to UN SDGs, and have the students use their acquired GIS understanding and analyses skills, through role-playing, in project-based approach designed specifically to engage GIS enrolled undergraduate students in UN SDGs. Worth mentioning that over the years of course delivery, the use of GIS and geospatial addressed UN SDGs among topics covered by lectures and reports. However, the project-based approach presented herein was first introduced in this format in Spring 2022.

2.3. Description of the Selected Project-Based Learning

In Spring 2022, students enrolled in the GIS course were asked to form teams, and select countries, where they acted in role-playing mode as country delegates. Using GIS, students were to present as country delegates their respective GIS assessments of the selected SDG indicators to a simulated UN Session to be held at the end of the semester. The emphasis in the Project-based Learning was on; SDG 11 on Sustainable Cities and Communities (Make Cities inclusive, safe, resilient and sustainable) and SDG 13 on Climate Action (Take urgent action to combat climate change and its impacts). An appendix is given at the end of the study describing the tasks required fro students.

As course instructor, along with teaching assistants, we regularly met with students during project milestone activities. Occasional question and answer sessions were held for task clarifications and guidance through project-based learning activities during Spring 2022 semester. Each group of students selected a country from a short- list of nine countries (worldwide, namely; Belgium, Brazil, Chili, Denmark, Ecuador, Greece, Kenya, Mexica, and Norway). During the course, students were asked to role-play as country delegates, and be prepared at the end of the semester to present the report in a simulated UN General Assembly meeting. During the semester, students researched and collected geospatial data and conducted GIS-based analyses as the course progressed.

A Model of United Nations (MUN) at the university participated in the closing session of the project-based learning. MUN mirrors the mandates and activities of United Nations ECOSOC. Which made cooperating with MUN give a realistic environment for the project-based learning. Most student members of the current MUN were not enrolled in the GIS course, except for one student. MUN is considered one of the most popular and prestigious student activities in the university. MUN activities included simulating different UN functions and activities, to enhance MUN student members' personal, intellectual and social

skills of the Egyptian Youth. MUN provides hands-on experience to undergraduate students, and future leaders in the international area of diplomacy.

3. Results

Table 1 shows growing student interest and appreciation of the tasks related to the project. Early in the second week of the semesters just more that 55% of the students were engaged and had no inquiries or complaints, by the sixth week of the course the percentage of engaged students were over 70%. By the end of the course in the twelve week, and before the PBL group peresentations, all students were excited and were looking forward for presenting their work to other student groups. To date, I still hear from alumni words of appreciation about this PBL experience and its impact on their views of their roles of them as civil engineers.

Table 1. Growing student interest and appreciation of the tasks related to the project.

Manage	Week	Type	Title	CountView	Complaint
▼					
View Content	2/18/2023	Supplementary notes	integration-geospatial-information-statistical-sdg-indicators	55%	none
View Content	3/16/2023	Lecture slides	Lecture 6 Metadata - NSDI	73%	none

For the presentation of PBL group work, a simulated UN General Assembly was held, at the end of the semester during June 2022. An active working group of students known as Model of United Nations (MUN), cooperated. The venue for the in conclusion of the GIS project-based learning activities was held on campus, in a large rounded hall; with layout setup, the procession of the meeting, and document format exchange, method of addressing the Assembly, were as much as possible similar to UN General Assembly official sessions. Figure 1 presents the simulated UN General Assembly session.

Figure 1. The simulated UN General Assembly session

Over seventy students enrolled in CIG 1002 GIS for Civil Engineering Applications attended as country delegates. Each country delegate delivered oral reports, in UN SDG Country Report format, presentations supported by their GIS analyses findings on the current status of each of the nine countries. The MUN General Assembly was held for three hours. Each country delegate presented a short PowerPoint summarizing the SDG country report and findings. Each country delegate was handed a UN "Resolution Template" to complete and read to the Assembly. The event was recorded by the Media Production Center (MPC) for documentation and to be used to introduce the project in the coming semesters to more students. Figure 2 presents a group photo taken at the closing ceremonies of the event.

Figure 2. A group photo at the closing ceremonies of the event

4. Conclusions

The project-based learning presented herein enabled students to independently collect new knowledge, and present it in written and oral formats that are novel to them as country delegates during the simulated UN sessions. Hence, enhancing their technical capabilities and soft skills , addressing one of the critical mankind challenges; namely, achieving UN SDGs. Further, the project-based learning enhanced engineering students' engagement and awareness of UN SDGs. As well as, encouraged students through critical thinking to relate UN SDGs to their engineering major, provided a platform for meaningful collaboration among the teams of students enrolled in the course, and fostered cross-discipline between engineering students with interest in GIS course and students with MUN student members with backgrounds from other majors. More interesting was that the project-based learning stimulated interest of civil engineering students in MUN. Owing to the success of the project-based learning implementation in the GIS course, and interest of the MUN student members at the university, plans are currently being made to conduct another project-based learning during Spring 2023 semester within the next GIS course delivery, with a new batch of

students and new country delegates, ultimately working with new student country delegates adressing simulated UN General Assembly.

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Appendix: Tasks Required from Students

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CIG 1002 GIS in Civil Engineering   Assigned 17 May 2022

Spring Semester 2022

A Brief UN SDG Country Report
On Current Status With Focus On Geospatial Data
(Emphasis on SDG 11 and SDG 13)

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Introduction:

The scientific literature delineates numerous benefits of geospatial information in support of sustainable development. Accordingly, the presence of geospatial information within the United Nation Sustainable Development Goals (SDG) should provide more quantifiable measures to the SDG indicators. The United Nations Global Geospatial Information Management (UN GGIM) adopted a Global Statistical Geospatial Framework (GSGF) as basis for supporting efforts for combining geospatial and statistical information. (Baraka, 2021).

https://fig.net/resources/proceedings/fig_proceedings/fig2021/papers/ts08.2/TS08.2_baraka_10997.pdf

Requirements:

Accordingly, you are asked to prepare brief country report, and make a presentation during the GUC MUN (Model of United Nation) on Thursday, 2 June 5:00 – 8:00 pm. (location to be announced). The country SDGs report will be limited to SDG 11 and SDG 13 goals, with focus on the role of the geospatial data.

Instructions:

1. You will be divided into 10 groups based on your tutorials. (Check GUC CMS)
2. Each group will select ONE "country" to represent, from country pool list assigned to each group. (Check GUC CMS)
3. The representative and co-representative of each group will notify by email Prof. Moustafa Baraka, of the country selected by his/her group, no later than Wednesday 18 May, 2022, 5:00 pm
4. As a group you will work together, prepare and upload online your country SDG report and findings, no later than Tuesday, 31 May, 11:00 pm. (link to be announced)
5. As a group you will attend a GUC MUN General Assembly meeting event at GUC. Some members from each group will be randomly selected during the event to present a 10 minutes PowerPoint to the GUC MUN, summarizing the SDG country report and findings on Thursday, 2 June 5:00 – 8:00 pm. (location to be announced).

Required Report Content & Format:

A Cover page with group members names, IDs, and the country represented

Acceptable report page range 4-6 pages including maps, figures, and tables.

A reference section for all material used have to be included

Required Presentation Content & Format:

A Cover page with group members names, IDs, and the country represented

Presentation no to exceed 10 minutes; including maps, figures, and tables.

A reference section for all material used have to be included

Important note:

For resources for the report and presentation check posted: CIG1002 - GIS - UN SDG Country Report.pdf