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Fostering Critical Thinking, AI and Data Literacy, and Global Competence amongst Business Students

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Abstract

This work-in-progress applied research paper reports on how undergraduate business students at an Irish university engaged with the UN Sustainable Development Goals. Through working on an authentic problem-based learning assignment using analytics tools, students improved their data and artificial intelligence (AI) literacy. The assignment also fostered global competence, critical thinking, and digital responsibility, with students reflecting on the challenges of working with complex, polymorphic data of mixed quality, and consequent implications for effective evidence-based policy making.

Keywords: critical thinking, AI literacy, data literacy, global competence, UN Sustainable Development Goals, digital responsibility

1. INTRODUCTION

In the era of big data and abundant misinformation, it is crucially important that graduates should possess strong critical thinking, data literacy and artificial intelligence (AI) literacy skills so that they are suitably equipped to tackle global challenges (Hassani *et al.*, 2021).

This study reports on the experiences of undergraduate students at the University of Galway, Ireland, as they worked on an authentic group-based assignment that required them to actively engage with the UN Sustainable Development Goals (SDGs). In 2023, the University of Galway was designated as a national

SDG Champion by the Irish government's Department of Environment, Climate & Communications, as a consequence of which substantial efforts were made to integrate SDGs into teaching and research activities across all academic disciplines of the university.

The teaching approach on this assignment, which took place within the School of Business & Economics, merged team-based authentic learning with a problem-based learning strategy (Cross & Congreve, 2021; Saur-Amaral *et al.*, 2023). Students used business analytics technologies (MongoDB, Python, Tableau, OpenAI) to grapple with polymorphic data obtained from various sources and

were required to produce a summary report with findings and recommendations.

The objective of the exercise was to cultivate digital responsibility amongst the students, focusing on enhancing their data literacy, AI literacy, and global competence.

2. BACKGROUND AND MOTIVATION

Global competence refers to the ability of individuals to understand, engage with, and navigate the complexities of our interconnected world effectively. It encompasses a range of knowledge, skills, attitudes, and values necessary for individuals to thrive in diverse cultural, social, economic, and political contexts (Li, 2013; Kjellgren & Richter, 2021).

Given the significant contribution of business enterprises to sustainable development, business schools need to assure that their graduates not only acquire professional skills and expertise, but also develop the global competencies necessary to tackle the issues outlined in the UN's SDGs 2030 Agenda.

In order to make informed, evidence-based decisions and recommendations, high quality data about SDG indicators is a vital resource (Jütting & McDonnell, 2017).

The data democratisation movement is about making data about SDGs and other issues of public interest accessible, understandable, and available to all for the greater good of society. It aims to reduce information asymmetry, enhance accountability, and drive innovation by enabling a broader spectrum of people to access, analyse, and utilise data (Lefebvre *et al.*, 2021).

Data democratisation is facilitated by the growing amount of publicly available "open data", which is a vital resource as individuals, organizations and governments work together

towards achieving the UN SDGs (MacFeely, 2017; Jütting & McDonnell, 2017; Hassani *et al.*, 2021).

However, in order to interrogate this ever-swelling ocean of open data, students need to have a certain level of data literacy and now, also, a certain level of AI literacy.

Data literacy refers to the ability to read, understand, interpret, and communicate with data effectively. It involves skills and competencies related to accessing, analysing, evaluating, and making sense of data in various formats, including numerical, textual, graphical, and multimedia data. AI literacy refers to the understanding and competency individuals have in comprehending, engaging with, and utilising AI technologies effectively and responsibly.

Traditionally, business and management students have had quite low levels of data and AI literacy (McClure & Sircar, 2008; Pothier & Condon, 2020; Xu & Babaian, 2021). Despite considerable advances in business intelligence (BI) technologies, the ability of most end-users to use these tools is limited due to issues with data and AI literacy (Watson & Laney, 2020). This study therefore set out to address this deficiency by seeking to develop these vital skills amongst business students.

3. METHODOLOGY

This applied pedagogic research was conducted in a class of Second and Third Year students of the B.Sc. in Business Information Systems at the University of Galway, Ireland in the 2023/'24 academic year. A total of 65 students participated, with 34% female and 66% male students. The class included citizens of Bangladesh, Belgium, Bulgaria, Hungary, Ireland, Malaysia, Nigeria, Pakistan, Poland, Phillipines, Saudi Arabia, USA and Zimbabwe.

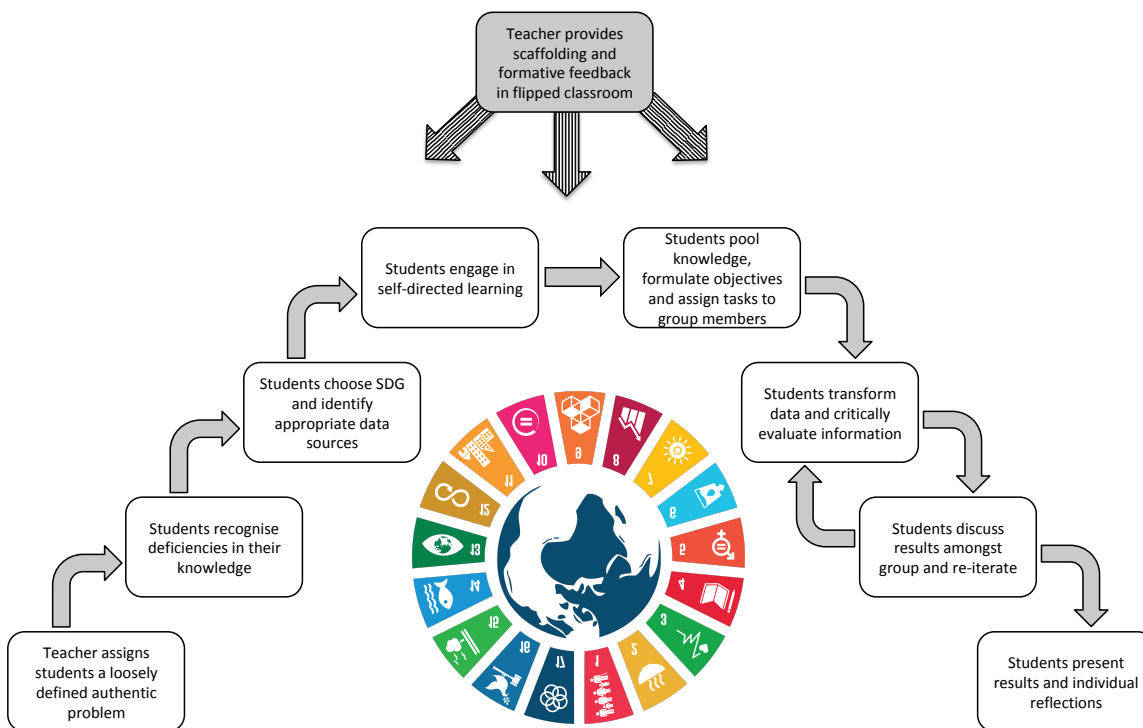


Figure 1. Authentic problem-based learning with flipped classroom approach

They worked with polymorphic open data collected from a variety of sources including the UN SDG Indicators Database, World Bank Data Catalog, UN Women Data Portal and EU Eurostat SDGs Database. Students worked collaboratively in teams of 4 or 5 members to select SDGs, identify relevant indicators, obtain data, and create a MongoDB database. They used Python for data cleansing and transformation. Using a systematic prompting methodology developed by the course teacher (which, amongst other inputs, used JSON metadata schemas), students employed OpenAI technologies to generate code derived from natural language query specifications. They imported the query output into Tableau and created interactive visualizations. Finally, they prepared a comprehensive report to document findings and reflect on the well-known challenges of working with SDG data (Jutting & McDonnell, 2017; MacFeely, 2017).

The course adopted a flipped learning approach with students assigned e-learning materials to cover in advance of each week’s class, which was mostly used by the teacher to provide ongoing formative feedback and advice to students on their assignments as they progressed. The students had no prior knowledge of the technologies they were using, but with the help of the systematic AI prompting methodology developed by the teacher, they quickly learned how to manipulate and interrogate the data.

After submitting the assignment, students were asked to participate in a survey which gathered qualitative data about their impressions, as well as quantitative data using questionnaire items adapted from previous instruments (Honey, 2005; OECD, 2018; Wang *et al.*, 2023; Ng *et al.*, 2024, Wolff *et al.*, 2016; Pothie & Condon, 2020).

4. PRELIMINARY RESULTS

Data analysis is still in progress but preliminary results indicate that the exercise was effective in achieving its intended learning outcomes.

The majority of the students chose to base their project either upon SDG3 (Good Health and Wellbeing) or SDG8 (Decent Work and Economic Growth), but in total the projects addressed 10 of the 17 goals.

As regards global competence, 63% of students had no or very little knowledge about their chosen SDG prior to this assignment. However, 91% professed to know quite a lot or be highly informed afterwards. Furthermore, 81% of students agreed or strongly agreed that the assignment helped them develop the ability to work towards addressing business, policy and societal problems within a global context, 94% agreed or strongly agreed that the assignment increased their knowledge and awareness of sustainability, and 78% felt that the assignment educated them to make more ethical, socially responsible decisions in a business context.

As regards data literacy and AI literacy, 96% of students agreed or strongly agreed that the assignment helped them develop the competence to process and visualize complex data using advanced database technologies; 94% agreed or strongly agreed that it developed their ability to analyse, organise, synthesise and interpret data; 93% felt that the assignment helped them learn how to use AI technologies to improve their work efficiency; and 94% were of the view that the assignment helped them learn how to use AI to achieve common good and serve others

Preliminary analysis of the qualitative data revealed a number of themes. Across all groups, students encountered challenges related to data quality, technical issues, and the

learning curve for using software. However, these challenges contributed significantly to their learning experience and skill development, particularly in critical thinking and problem-solving. Some indicative remarks are:

- *"We found that a lot of our learning came from trial-and-error. While this method can be frustrating, ultimately, it made us grow and develop skills such as critical thinking and innovative problem-solving."*
- *"The challenges we encountered, especially with data sourcing and consistency, tested our problem-solving skills. It compelled us to think critically and adapt our strategies, emphasizing the importance of flexibility in data analysis."*

Several students commented on data quality issues and the necessity of good data to further the UN SDG Agenda. For example:

- *"While working on our MongoDB assignment, we were overwhelmed with the amount of data there is available, but most of it had not been transformed and was not in an easily digestible format."*
- *"We faced difficulties with the availability of data that was correct, relevant, and dependable. We now know that any data analysis project's capacity to succeed depends on the level of accuracy and suitability of the available data."*
- *"Some of the databases we wanted to work on were almost empty. For instance, some databases had observations for only specific years for some regions."*
- *"We found numerous countries where there was no or limited data available ... These gaps in the datasets mean that the insights derived from our analysis of the data may not be entirely accurate."*

The realisation of the transformative power of data visualizations to raise public awareness of UN SDGs and influence policy-making also came through very strongly in students' comments:

- *"By transforming these datasets, it will open the eyes of the public ... data needs to be visualised so everyone has an immediate understanding."*
- *"Data-driven decision making is highly important in sustainable policymaking."*
- *"Simply collecting more data isn't enough; it's how we transform, analyse, and utilize that data that truly makes a difference in advancing sustainable development goals."*
- *"Data that has been transformed and analysed has purpose and can influence local policies."*
- *"Using software like Tableau can put this information into visual forms and allow the data to come alive."*

Overall, this exercise was very well received by teachers and students alike. 91% of students agreed or strongly agreed that it was a valuable learning experience for them. A similar proportion felt that it brought authenticity to their learning and helped develop critical thinking skills.

5. SUMMARY AND CONCLUSIONS

This study examined the experiences of undergraduate business students at the University of Galway as they engaged in a group-based assignment focused on the UN Sustainable Development Goals (SDGs). The assignment integrated team-based authentic learning with problem-based learning, using tools like MongoDB, Python, Tableau, and OpenAI to analyze open data related to SDG indicators. The objective was to develop students' competencies in

data analysis and AI while encouraging responsible global citizenship.

The preliminary findings underscore the importance of integrating data and AI literacy into business education to equip students with the skills needed to navigate complex global challenges. By engaging with SDGs and using advanced data analytics tools, students not only developed technical proficiency but also gained a deeper understanding of sustainability and the impact of data-driven decision-making.

The positive student feedback highlights the assignment's effectiveness in fostering critical thinking, digital responsibility, and global competence. These findings suggest that such authentic learning experiences can play a vital role in preparing future leaders to contribute meaningfully to the UN's 2030 Agenda for Sustainable Development.

The next steps with this work shall be to conclude analysis of the rich qualitative data gathered from students and use the detailed findings to replicate the approach again with some refinements, perhaps in a comparative cross-national study.

For readers interested in adapting this exercise to the specific needs of their own course, the assignment specification is readily available upon request by emailing the author.

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