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# *Teaching Tip*: Embedding Sustainability in Information Systems Design Education

**Wendy Rowan**
**Stephen McCarthy**
Business Information Systems,
Cork University Business School,
University College Cork,
Cork, T12 K8AF, Ireland.
wendy.rowan@ucc.ie , stephen.mccarthy@ucc.ie

**Selam Mebrahtu**
**Christophe Gauche**
Strategic Design Scenarios,
Rue du Fort 78,
1060 Brussels,
Belgium.
skidanem@gmail.com , christophe@strategicdesignscenarios.net

**Katie O'Reilly**
**Damilola Odili**
Business Information Systems,
Cork University Business School,
University College Cork
Cork, T12 K8AF, Ireland.
1211105718@umail.ucc.ie , manuel_odili@yahoo.com

**ABSTRACT**

Sustainability refers to the achievement of present needs without compromising the ability of future generations to meet their own needs. While prior research has highlighted the potential of Information Systems (IS) to support sustainability objectives - for instance, through supporting eco-efficient work practices and democratising healthcare access - our understanding of how to integrate the United Nation's Sustainable Development Goals (SDGs) as a core aspect of IS teaching and curricula remains nascent. This teaching tip presents a pedagogical design and teaching method for embedding sustainability in systems design education using design thinking and 'active learning' techniques. We provide examples of how students translated the SDGs into design concepts that target real-world sustainability problems with feedback from subject matter experts. Recommendations are then provided for supporting students' experiential journeys when exploring sustainability objectives in the classroom by providing opportunities for variation and experimentation.

**Keywords:** IS Education, Sustainable Development Goals, Design Thinking, Active Learning, Digital Social Innovation.

## 1. INTRODUCTION

There is an increased recognition that Information Systems (IS) can positively contribute toward the 'triple bottom line' of environmental (*Planet*), societal (*People*), and economic (*Profit*) sustainability (Dyllick and Muff, 2016; Kranz et al., 2022; Stahl, 2012; Walsham, 2012). Recent IS research has demonstrated the potential of digitalisation for supporting goals such as sustainable energy transitions (Watson et al., 2022), citizens' engagement in IS policymaking (McCarthy et al., 2020a; 2023), and the elimination of poverty (Ravishankar, 2021). However, despite this growing interest in sustainability, IS learning practices and teaching curricula continue to focus on the effective development and use of IS, with sustainability concerns and the unintended 'spillover' effects of digital technologies often receiving limited consideration (Kranz et al., 2022). This has led to problematic gaps in two core areas of IS education: students' awareness of sustainability issues in IS and their problem-solving skills for addressing sustainability concerns through systems design.

From an awareness standpoint, IS education has yet to fully support students' exploration of the meaning and importance of sustainability issues in IS (Kranz et al., 2022). Promoting an understanding of sustainability challenges can ensure that students adopt a more systemic perspective of IS product service systems (van der Have and Rubalcaba, 2016; Suseno and Abbott, 2021). This enables students to go beyond existing product lifecycle considerations by questioning the potential impacts and unintended consequences of an IS solution (Butler, 2011; Markus and Mentzer, 2014). Sustainability must be understood as central to IS design and development, with firms reaping what they sow in terms of environmental, social, and economic capital. As stated by Dyllick and Hockerts (2002 p. 133) "*A company ceases to exist once no economic capital is left, but in reality, a company will become unsustainable long before*". By educating students on the importance of sustainability across the value chain, business schools can better prepare IS graduates for delivering high-quality, sustainable digital products and services to users in the future (Harris et al., 2011; Nidumolu et al. 2009; Watson et al., 2021).

In parallel, further research is needed to explore sustainability-driven design approaches that promote students' ability to problem-solve using digital technologies (Matthee and Turpin, 2019). Questions remain on what teaching practices are required to empower IS students so that they can be creative, confident, and skilled in resolving sustainability-based challenges during systems design (Harris et al., 2011; Watson et al., 2021). This requires a cognitive shift within IS education to frame sustainability as an opportunity rather than a risk, where practices such as responsible production, corporate social responsibility, financial transparency, and ethics are framed as a strategic imperative in IS (Harris et al., 2011). Students must be educated on how users, management, suppliers, and potentially even citizens can contribute towards the delivery of sustainability objectives throughout the value chain (Hart and Milstein 2003; Pan et al., 2022). This requires new problem-solving approaches in IS education which foster graduate skills for tackling sustainability challenges (such as social responsibility and global citizenship), alongside the traditional demands for digital competency.

The objective of this teaching tip aims to outline how the principles of design thinking and active learning can help embed sustainability in systems design education. The article centres on a 3-day student design workshop involving 17 hours of dialogue where students sought to create concept designs of digital offerings which address a selected sample of the Sustainable Development Goals. We contribute insights into a novel approach to IS design education where the United Nations' Sustainable Development Goals (2022) are a key source of problem statements for IS students when creating digital solution prototypes. We further conceptualise how active learning can support students when exploring these problem statements using techniques such as storyboards, user journeys, personas, and ideation games to create a 'safe space' for tackling key sustainability challenges. Lastly, we contribute recommendations for evaluating students' work with sustainability as a key criterion.

Our paper is structured as follows: Section 2 provides the background to the paper by reviewing the literature on sustainable development goals, design thinking in education, and active learning. Section 3 introduces the background to our case while Section 4 presents findings from the 3-day student design workshop. Building on insights from the participants, Section 5 summarises our teaching tip which emphasizes the value of collaborative learning and the benefits of sustainability education in IS programmes. Section 6 brings the paper to a close with a conclusion.

## 2. BACKGROUND

### 2.1 The Sustainable Development Goals

The United Nations (UN) Sustainable Development Goals (SDGs) framework came into being in 2015 following a series of discussions between world leaders at the UN Conference on Sustainable Development (Corbett and Mellouli, 2017; United Nations, 2022). The ambition of the SDG framework was to address the most urgent problems we face as a society such as those related to climate action, the reduction of inequality, and improved financial prosperity of all (United Nations, 2022).

Incorporating the SDGs into education and research has also been highlighted as a mandatory strategic priority for business schools going forward by accreditation bodies such as the European Quality Improvement System (EQUIS) and the Association to Advance Collegiate Schools of Business (AACSB). The United Nations' Principles for Responsible Management Education further seeks to raise the profile of sustainability in business schools by ensuring that business students have the skills necessary to balance economic and sustainability goals (PRME, 2018).

Education on the SDGs aims to support learning that incorporates both cognitive (e.g., knowledge and learning) and non-cognitive (e.g., social and collaborative) pedagogies (Rieckmann, et al., 2017). Therefore, moving beyond knowledge acquisition to the development of skills in collaboration, negotiation, and problem-solving through innovative methods is seen as an essential requirement for IS educators (Harris, et al., 2011).

| Theme (UN, 2022) | Mission Statements (Authors' wording) |
|---|---|
| SDG 3 Theme #1:<br>*Ensure healthy lives and promote well-being for all at all ages.* | • How can we use digital technology to prevent the spread of communicable diseases?<br>• In what way can we prevent the incidence of non-communicable diseases through digital solutions and/or promote healthy lifestyles for lower socio-economic groups?<br>• With air quality becoming so endangered by pollution, what digital solutions would be most beneficial to society in addressing this problem? |
| SDG 9 Theme #2:<br>*Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.* | • How can digital solutions help provide resources and/or financial support to small companies?<br>• How can digital solutions be used to monitor, control, and/or reduce the CO2 emission of industrial processes and products? |
| SDG 11 Theme #3:<br>*Make cities and human settlements inclusive, safe, resilient, and sustainable.* | • How can digital solutions be used to increase the proportion of the population that has convenient, safe, and affordable access to public transport (e.g., by sex, age, and persons with disabilities)?<br>• How can digital solutions decrease the number of deaths, missing persons, and persons affected by disasters (particularly in vulnerable groups)?<br>• How can digital solutions reduce the proportion of victims of physical or sexual harassment (by sex, age, disability, or location of the incident)? |

**Table 1. Summary of SDG Themes Adopted in the Case.**

### 2.2 Design Thinking in Information Systems

With 169 targets across 17 goals defined in the SDG framework (United Nations, 2022), a process of reduction was required for our case to ensure a manageable selection in our teaching approach. Our case focused on three goals from the United Nations' SDG framework, Goal *3: Good health and well-being*; *Goal 9: Industries, Innovation, and Infrastructure*; and *Goal 11 - Sustainable Cities and Communities*. Within these 3 SDGs, a total of 31 targets have been defined, Goal 3: Good Health and Well-being holding 13 targets; SDG 9: Industries, Innovation, and Infrastructure – 8 targets; and SDG 11 Sustainable Cities and Communities – 10 targets (see Table 1)An essential requirement for responsible management education is to develop a connection between student learning and real-world organisational and societal problems (Matthee and Turpin, 2019; PRME, 2018). Design thinking as a teaching practice can help fulfil this objective through student engagement in two key activities i) exploring the problem space through collaborative dialogue and the development of design frames ii) building and evaluating an artefact that seeks to address the problem and add value (Brown, 2008; Dorst, 2011). It is well documented in the literature that design thinking can have a profound effect on a group's culture, that these cultures can reciprocally influence the use of design thinking tools, and that these design thinking tools can produce both physical artefacts and emotional experiences (Elsbach and Stigliani, 2018). As Brown and Wyatt (2010) suggest design thinking is a process of overlapping spaces rather than orderly steps. The three spaces involve inspiration, ideation, and implementation. Inspiration is the problem, threat, or opportunity to think about workable solutions. Ideation is where one thinks, feels, explores, and tests ideas. Implementation moves from project to practice – trying out solutions and iterating the design thinking spaces as required. Following the work of Dorst (2011), Figure 1 presents the iterative spaces involved in the design thinking process which are further discussed in the paragraphs that follow.

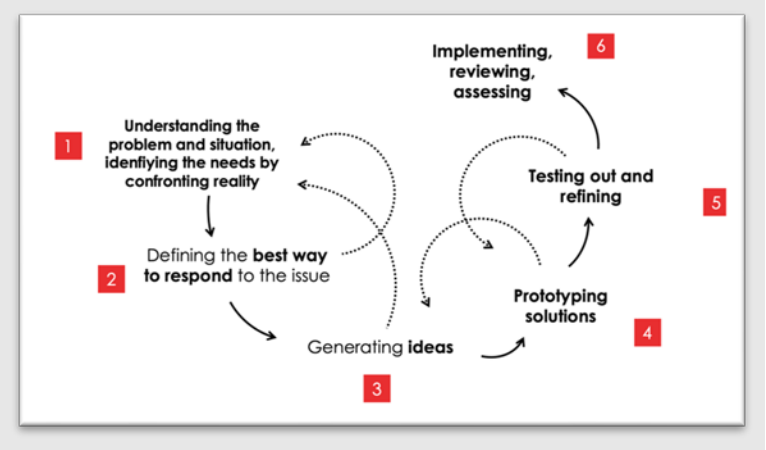



**Figure 1. The design thinking approach (SDS, 2021).**

Firstly, design thinking seeks to generate knowledge that is problem-driven by identifying situational needs and potential responses to issues (Brown, 2008; McCarthy et al. 2022). This approach not only addresses the problem through creative thinking but also evaluates potential sources of the problem in the first instance (Matthee and Turpin, 2019). Designers aim to explore human, social, and environmental considerations (Liedtka, Salzman, and Azer, 2017b). For example, problem trees, storyboards, personas, and scenario building are useful tools and methods that can inform the problem definition (see Table 2).

Secondly, design thinking aims at prototyping ideas that can then be applied as solutions (Dorst, 2011). Building on a problem-inspired approach, key stakeholders are involved throughout the process to review and assess potential solutions. Design thinking employs real-life testing to guide the design of artefacts (paper-based or digital) (Brown, 2008). During iterations of design, small groups of users are invited to test the early prototypes and provide feedback through different methods such as walk-throughs, the observation of users, and open-ended discussions to obtain user feedback (Mootee, 2013).

The final iteration aims to produce a workable prototype for larger pilot testing (Mootee, 2013). Design principles can also be developed aimed at informing the design of IS solutions that respond to sustainability challenges by identifying the routes to transformation (Monson, 2021). While design thinking has a long history as a supporting practice for innovation in organisations, its application to educational settings is more nascent (Scheer, Noweski, and Meinel, 2012; Gallagher and Thordarson, 2018). Students unfamiliar with design thinking, can use the four questions to think about the opportunities/scope/design brief/plan (What is? What if? What wows? What works?), and using the 15-step process helps to build confidence in the most novice of participants (Liedtka, Salzman and Azer, 2017a). Our case investigates how design thinking can potentially help educate students on how to prototype products, services, and systems that address human needs such as unmet requirements, problems, and difficulties of sustainability.

| | **Description** | **References** |
|---|---|---|
| Problem trees | Problem trees involve the mapping of all key challenges, difficulties, pain points, and emotions that a user experiences when exploring a given physical or digital product or service. | (Ho, 2001; Veselý, 2008) |
| Storyboards | A storyboard is a linear sequence of graphic representations of a story, concept, or action, divided into sequential scenes (squares). It is usually used to represent what a solution will look like once it is implemented or played out. | (Maguire, 2001; Sutherland and Maiden, 2010) |
| Personas | Personas are fictitious characters created based on field or desk research to represent the different user profiles that are likely to use a given service, product, or application equivalently. The creation of personas helps with understanding the needs, experiences, behaviours, and goals of users. | (McCarthy et al., 2020b) |
| Scenario building | Scenario building enables and facilitates the process of generating a wide range of ideas on a given topic. The ideation phase in a creative process concentrates on developing narratives on the future. A filtering activity will then be carried out to select promising narratives. This aims to generate disruptive and future-oriented solutions through co-creation. | (De Jouvenel, 2000; Durance and Godet, 2010) |

**Table 2. Description of design tools and methods.**




**Figure 2. Principles of Active Learning in Education.**

### 2.3 Active learning

Active learning is based on the principles of constructivism and experiential learning where teaching activities are learner-centric and involve student engagement in actions such as inquiry, discussions, role-play, simulations, group work, and reflection (Biggs and Tang, 2011; Dewey, 1997; O'Connor, 2022; Steffe and Gale, 1995). In active learning, educators act as facilitators to guide students along a pathway toward the realisation of learning outcomes. This approach contrasts with the 'instructivist' pedagogies of knowledge transfer through lectures in higher education (Biggs and Tang, 2011; O'Connor, 2022).

Active learning is about being creative, engaged, and in control with learners directly interacting with content without the need for monitoring or assessment (Dewey, 1997; Steffe and Gale, 1995). This builds a willingness to experiment, understand, follow curiosity, and hold oneself accountable to personal standards for achievement (Biggs and Tang, 2011). It is less about extrinsic or intrinsic motivation but more about the 'first-person' in the learning process (Heick, 2021). These ideals are not dissimilar to the ideas behind experiential learning as first described by Kolb (1984, pg. 38) "*Learning is the process whereby knowledge is created through the transformation of experience*."

Active learning is also a useful approach for design-based processes which, inherent to its practice, promotes learning by doing and opens space for collaborative creativity in which students can go back and forth, 'ping-ponging' concepts and ideas (Liedtka, Salzman, and Azer, 2017a). In turn, active learning can facilitate the testing of innovative ideas before they are implemented in practice (Leckenby, et al., 2021). As Dewey states, "*have...something to do, not something to learn; and the doing is of such a nature as to demand thinking or the intentional noting of connections; learning naturally results*" (1997, p. 154). Active learning can deliver on this potential by tapping into the principles of developing independent, self-directed, creative thinkers (Dewey, 1997). However, such outcomes can only be achieved in an environment of safe failure, active learning offers these much-needed spaces for play and exploration (Biggs and Tang, 2011).

We next present a background to our case which sought to explore the opportunities for active learning in information systems education to address sustainability problems and design digital solutions that consider both social and technical requirements.

## 3. BACKGROUND TO 'THE STUDENT DESIGN WORKSHOP'

Our teaching tip centres on a 3-day student design workshop titled 'Building Sustainable Digital Solutions through Student Partnerships' which was organised in January 2022 involving voluntary postgraduate students in Information Systems (IS) based in University College Cork, Ireland. Students were invited to engage in a collaborative design thinking process and propose digital solutions for SDGs. The purpose of this intensive workshop was to enable students to become partners in this design process, working in groups with design experts to co-create innovative IS prototypes for use in a sustainability area of their interest. The anticipated outcomes from this activity included the creation of concept designs for IS prototypes that addressed sustainability concerns. Following the workshop, each group was also invited to apply to an entrepreneurship competition in the business school and the university's innovation hub.

| Workshop Days | Running Order |
|---|---|
| Day #1 - Take | • Introduction to Design Thinking.<br>• Presentation of the Design Challenges.<br>• Group Activity: Explore and investigate the challenges.<br>• Keynote: Problem setting presentation.<br>• Group Activity: Reframe design challenges/missions.<br>• Group Activity: Round #1 Ideation.<br>• Alpha Crash Test & Feedback.<br>• Group Activity: Select an idea and further develop it. |
| Day #2 - Build | • Beta Crash Test of Initial Ideas (external Stakeholders).<br>• Reflect, discuss & decide on improving ideas.<br>• Group Activity: Transforming ideas into concepts.<br>• Keynote: How to visualise and narrate ideas.<br>• Group Activity: Work on concept visualisations.<br>• Keynote: Making ideas stand out on the market.<br>• Group Activity: Explore business models of concepts.<br>• Group Activity: Finalise concept posters. |
| Day #3 - Land | • Recap and Warm-up.<br>• Group Activity: Business Resilience self-evaluation.<br>• Reflect and explore how to improve business models and concepts.<br>• Group Activity: Prepare the final concept poster and prototype.<br>• Getting ready for the marketplace pitch.<br>• Pitch to external Stakeholders.<br>• The Marketplace and Investing for promising solutions (external Stakeholders). |

**Table 3. Overview of the running order for the 3-Day Student Design Workshop.**

The target audience for this activity was MSc and PhD students in information systems and computer science including areas such as business analytics, management information systems, and accounting information systems. A total of fifteen volunteer students, four facilitators (2 lecturers and 2 designers), and five subject matter experts attended the three-day workshop.

The three-day event took place in the executive education centre of the business school during the COVID-19 pandemic. The Microsoft Teams and the centre's Audio Visual (AV) system were used to allow subject matter experts to join remotely as required.

Over the 17 hours of activities held during the three-day student design workshop (see Appendix A.), students were able to identify the true needs of the selected SDG problem statements and develop multiple solutions that could be implemented. The schedule (see Table 3) included a mix of activities focused on learning (short training sessions on the design thinking approach) and doing (creating concepts and developing potential solutions/products) which allowed students to collaborate, brainstorm, reflect, and adapt a design approach.

The information sessions were delivered by the educators – the two designers from Strategic Design Scenarios and the two IS lecturers – and were aimed at furnishing students with the necessary details to complete each activity. The activities included a mixture of informal group discussions and feedback sessions between the designers, lecturers, and students (see Appendix B.). Each activity was timed, so that there was clear guidance and a sense of urgency to get tasks completed, before moving on to the next session. The outputs from each group's activity were discussed by the full group before progressing. This iterative process was conducted for each session across the three days.

Data from group activities were captured and mapped onto a shared Miro whiteboard (https://miro.com/), with designers, lecturers, and students having equal access. The Miro board was pre-designed with templated activities mapped and spaces allocated for each group's outputs. Whiteboards offer a creative collaborative space for students to engage in joint work. Using a virtual platform was not only more sustainable than paper but also more durable – being readily accessible for all participants during and after the event. At the end of two days, the findings were reviewed by external subject matter experts (SMEs). The external SMEs took part in two feedback sessions, during day two and day three of the student design workshop. The feedback provided important input during the creative development of projects and guided changes throughout the design cycle. SMEs came from diverse fields including innovation and entrepreneurship, technology transfer, start-up generation, information systems, and participatory design. Their involvement was voluntary.

The following section presents findings from the activities that took place during each day and analyses some of the key student design workshop outcomes.

## 4. OUTLINE OF THE TEACHING APPROACH

### 4.1 Day 1 – "The Take Off"

Day 1 marked the introduction of the event which kicked off with a brief presentation from the facilitation team. The presentation explained the rationale behind the student design workshop to provide innovative solutions for a selected number of SDGs using the design thinking approach incorporating the principles of active learning. Day 1 focused on steps 1 and 2 of the design thinking approach presented in Figure 1, namely understanding the problem/need, and defining the best way to respond.

To begin, the students were invited to complete a Team Player Survey (see Figure 3), using shapes and colours to identify the characteristics of each student which would inform group allocation. The results categorised students as executors, collaborators, communicators, and challengers (Parker, 1990). Reflecting on the value of this activity early in the process, one student remarked: "*After filling in the survey, I realized I was an executor and collaborator. After participating in this task, I was teamed up in Group 1 with a challenger. This served the purpose of creating a more balanced team.*"




**Figure 3. Quiz to identify the characteristics of each student for group formation.**

Students were allocated to four distinct groups, based on their selected SDG. This included Goal 3: Good health and well-being; Goal 9: Industries, Innovation, and Infrastructure; and Goal 11 - Sustainable Cities and Communities. After forming the groups, the first task was for students to discuss and select an SDG problem from the eight mission statements that represented the three distinct themes (according to SDGs 3, 9, and 11). Table 4 presents the four SDG mission statements chosen by the groups that guided their exploration of sustainability issues in IS.

| Group | SDG Mission Statement |
|---|---|
| Group 1 | "**How can digital solutions reduce the proportion of victims of physical/ sexual harassment (e.g., by sex, age, disability status, and place of occurrence)?**" which falls under target 11.7 of the 'Sustainable Cities and Communities' sustainable development goal. |
| Group 2 | **"In what way can we prevent the incidence of non-communicable disease through digital solutions and promote healthy lifestyles for lower socio-economic groups?"** which falls under target 3.4 of the "Good Health and Well-being" sustainable development goal. |
| Group 3 | "**How can digital solutions help provide resources and/or financial support to small companies**" which falls under target 9.3 of the "Industry, Innovation, and Infrastructure" sustainable development goal. |
| Group 4 | "**How can we use digital technology to prevent the spread of communicable diseases**" which falls under target 3.3. of the "Good Health and Well-being" sustainable development goal. |

**Table 4. SDG Mission Statements for the 3-Day Student Design Workshop.**

The students were then asked to undertake desk research to build an understanding of their selected mission statement. Problems were identified from the research and then analysed using a problem tree analysis method

(Chevalier and Buckles, 2019). Using this analysis tool, student groups assessed a range of complex sustainability issues in their domain of choice and engaged in brainstorming to present a quick overview of the spillover consequences of these issues for users (see Figure 4).

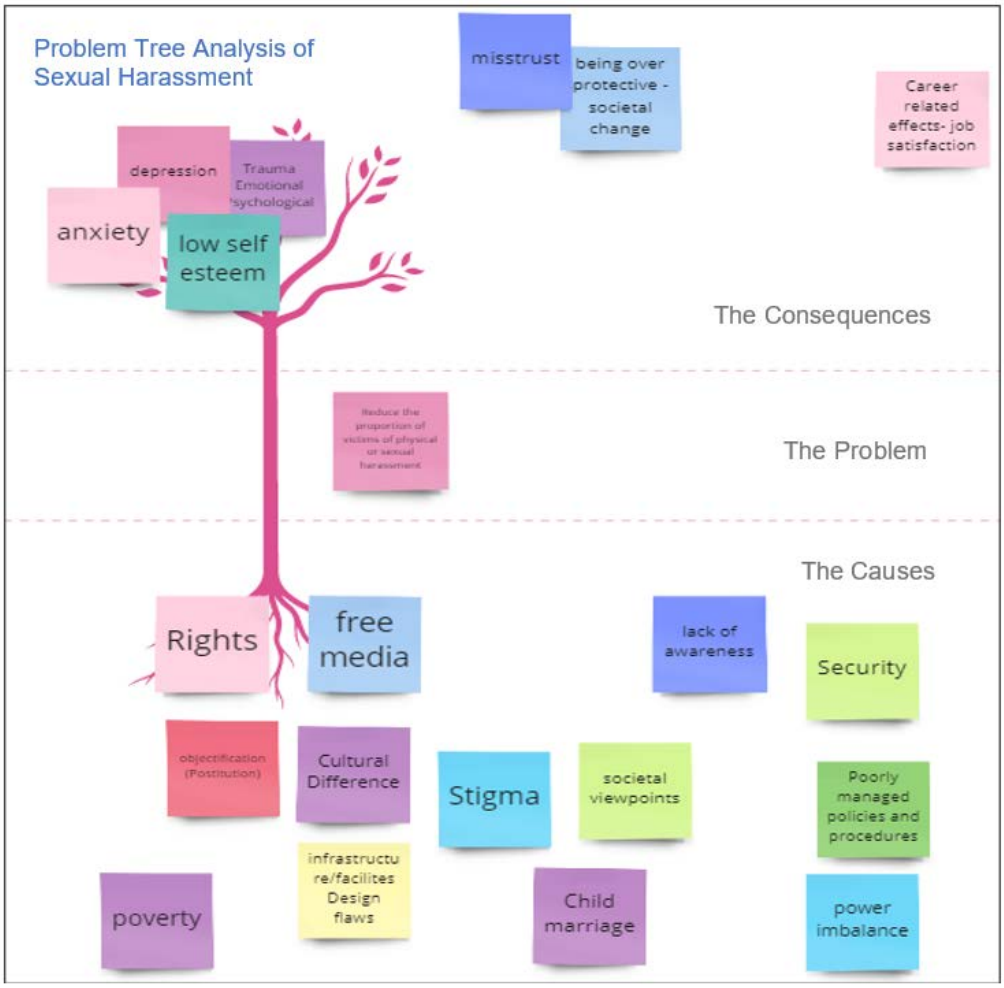



**Figure 4. Group 1's Completed Problem Tree Analysis for Sexual Harassment (SDG 11)**

Students were asked to frame the SDGs as system design challenges building on their existing research and problem analysis. For instance, group 1 narrowed their focus to two design challenges that they would investigate further:

i. How can digital solutions help report sexual harassment incidents globally and in connection with the social laws of the land?
ii. How can we reduce the effects of stigmatization faced because of sexual harassment using digital solutions?

Reflecting on this process, one student observed: "*The best part was that the focus was not only on the design but on the process of ideation and converting it into a concept. It was so amazing to see how all the teams, which initially were confused with so many ideas, reached a point where they visualised their best ideas into concepts along with their business model and its prototype. It was an amazing learning and team-building experience.*"

The next task involved brainstorming digital solution concepts that can tackle the SDG challenge using the "*Scenario Stretching*" card game, developed by Strategic Design Scenarios. This activity aimed to generate disruptive, surprising, and out-of-the-box ideas, scenarios, and IS solutions (see Figure 5). The iterative process broke down several sustainable digital solution concepts, leaving a subset that required further elaboration. The following three ideas were produced during the second iteration by student group 2 which focused on an app for nutrition management among lower socio-economic groups:

i. Create an app targeted towards lower socio-economic groups, which will help them track all foods consumed daily and suggest vitamin-rich, cheap options.
ii. Users belonging to this group are made aware of the nutritional value of food by providing micro-nutrient splits, tracking calories, conducting awareness campaigns, etc.
iii. Lower socio-economic groups will be provided with access to a chatbot health expert before reaching out to a doctor for an in-person appointment. They can then reach out to the expert via chat/telephone/ video call to instantly connect for their queries or concerns.

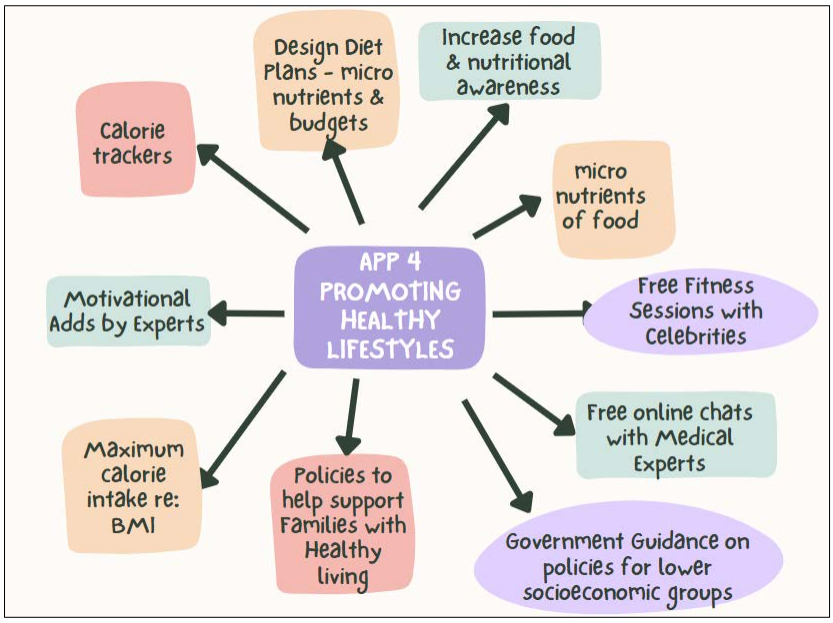



**Figure 5. Group 2's Completed Brainstorming for Promoting Healthy Lifestyles (SDG3).**

After an hour of brainstorming (see Figure 6 example mission statement cards), students shared their ideas at a round table to obtain feedback from the facilitators. Through much deliberation and review of the feedback, the groups decided to further distil their ideas into two concepts which marked the fifth and final task of that day. The final digital solution concepts of Group 3 were as follows (SDG9):

- "*We are going to propose a system where we will register all the country farmers and get the details about the land (owned/ borrowed), what kind of products they are going to cultivate on the land, and their level of expertise. The system can keep track of production and control hoarding. Using this system, a new farmer will be able to easily assess the land to cultivate and the government will be able to keep a check on the landlords and farmers. In case of loss, it will be easy to estimate the loss of cases. Furthermore, this system will be able to keep track of new products and fertilizers that people have used by measuring production. This will help to control the input and output.*"

As stated by another student: "*The workshop developed the art of brainstorming for all groups and made it fun by picking random cards that helped us form our design challenges. Personally, this workshop helped develop my critical thinking skills, collaboration, and analysis abilities. At the end of two days, two ideas were developed and implemented using strategic management templates. Over the three-day workshop, I went from knowing nothing about product design and digital solutions to developing sustainable ideas using digital solutions that can be used and utilised by society.*"




**Figure 6. Example mission statement cards for the SDG workshop.**

### 4.2 Day 2 – "Build"

On the second day, students were invited to develop their selected ideas further. This focused on steps 3 and 4 of the design thinking approach (see Figure 1) which included generating ideas and prototyping solutions. The day kicked off with a round table discussion between peers and designers on how to develop their ideas further. Students received feedback from the facilitators and their peers which were integrated into their evolving concept designs. The second task of the day was for each group to pitch their ideas briefly to three subject matter experts and external collaborators of the event. This included the director of a university-based innovation hub, an adjunct professor in design thinking and innovation, and a lecturer in technology innovation and entrepreneurship.

The group was then tasked with developing selected solutions that drew on feedback from external collaborators. This led to the following developments in Group 1's idea:

i. ***Design a trained system for sexual/physical assault using Machine Learning (ML) or/and Artificial Intelligence (AI).*** The key objective of this system was to develop/create more awareness around physical/sexual abuse in early teenagers and adults, for both abusers and abusees. Day 1 research revealed that a lot of people are ignorant of these acts – whether they are being assaulted or carrying out acts of assault. This system will include questions that are relevant to sexual/physical assault. At the end of every session, users of this system will be informed of their current level of awareness on the subject matter and solutions on how they can prevent physical/sexual assault. Furthermore, this system can also offer support where necessary by linking to social care workers where available.

ii. ***Design a game for kids to enlighten them on boundaries and consent***. The game is aimed at children aged 10-16. The user first builds a profile by providing their age and name and then they choose a scenario – be it home, education, play, sports activities, or public settings. The marketing approach and plans for this app would be to target elementary schools to start conversations early and to provide an informative but fun platform for children to learn from.

Students were then asked to develop a storyboard showing how IS would solve the SDG challenge, describing in four steps (or more) how the digital solutions would be used or how they should be accessed (for an example see Figure 7). The activity aimed to help students develop a fit between their products (digital solutions) and the use context. After this, one of the designers from Strategic Design Scenarios presented an introductory lecture on how to visualize concepts effectively to enhance better communication with the audience to generate reactions and feedback. Students were then invited to develop concept posters using stock images to propel their ideas on storyboards using simple online images (black and white or coloured).

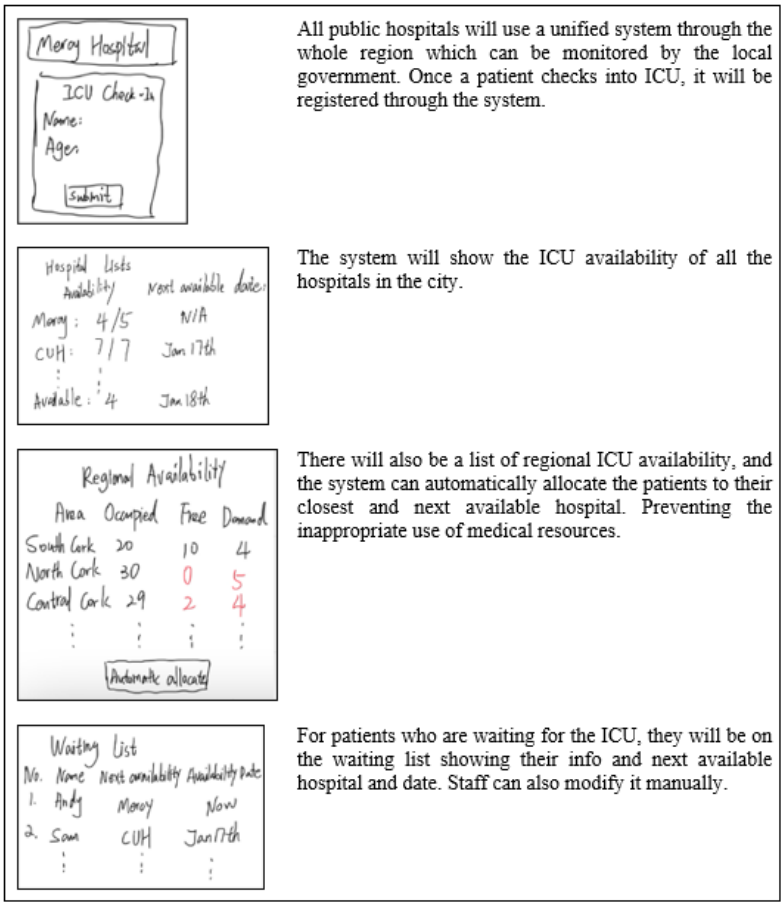



**Figure 7. Group 4's Completed Storyboard for a Platform to Manage Medical Resources (SDG3).**

The next step in the activity schedule was to develop a value proposition and business model for these solutions (Osterwalder, Pigneur, and Tucci, 2005). The facilitators explained concepts within the Business Model Canvas and discussed the importance of economic viability to ensure a business concept would succeed in the marketplace (Osterwalder, Pigneur, and Tucci, 2005). Discussions within groups guided their completion of the Business Model Canvas and Value Proposition Canvas templates. Discussions revolved around some of the following questions for problem-solving:

i. What does your customer want? What does your customer get from your product or service?
ii. What is unique about your product or service?
iii. In terms of sustainability, how do you make sure your product is economically viable?

An especially important goal of the concept designs was their resilience in the real world. The designers reviewed teams' solutions to see how resilient they would be by presenting a fictional scenario to test team response e.g., Criminals have "hacked" the app, what are you going to do? This highlighted the importance of security as a requirement for design concepts and the value of problem-solving for unexpected events.

### 4.3 Day 3 – "Land"

Day 3 directed attention toward steps 5 and 6 of the design thinking approach (see Figure 1), namely testing out reviewing and refining the ideas, and assessing for sustainability concerns. This sought to address the problems of both student awareness and problem-solving in tandem to embed sustainability in IS education. The day began with a round-table discussion and a progress report on the solutions designed thus far. After these, the design team began a discussion on the essence of good visuals in designing digital solutions and product development. The principle was to build 'reactors' (cf. Brussels Environment, 2016) that mimic the principles of commercial ads to present ideas in a compelling and easily understandable way to provoke reactions. This creative task forced students to encapsulate their concept in one image, one logo, one name, and a catchline.

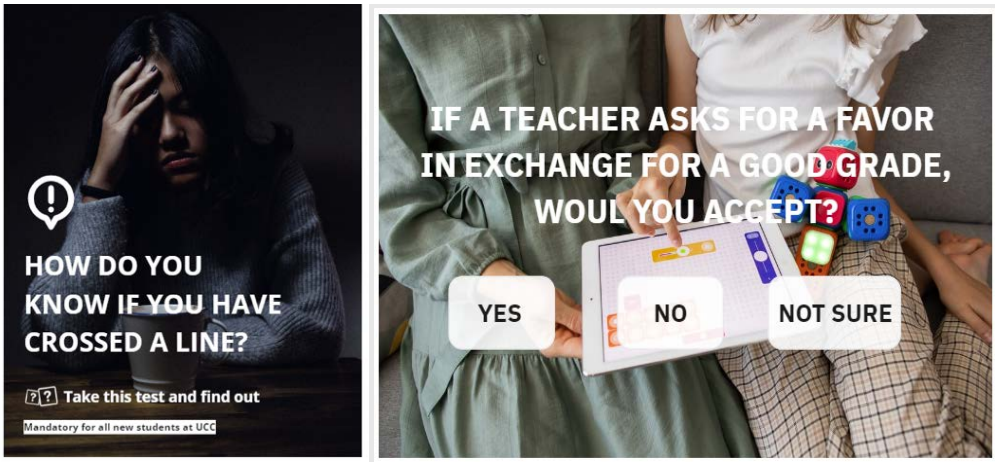



**Figure 8. Reactor for Group 1's Design Solution (SDG11).**

Each group started working on visuals using high-resolution images that would help sell their respective solutions with minimal effort. This was done by rigorously selecting the right pictures taken from web image libraries, like Unsplash.com (see Figure 8), or by taking a picture right on the spot with students themselves (see Figure 9). Additionally, the students included a statement in these images which also aligned with their developed Value Proposition Canvas.




**Figure 9. Reactor for Group 4's Design Solution (SDG3)**

After finalising these visuals, each group got set for their final pitch with the external collaborators, including the innovation specialist of a national health innovation hub. Students pitched their final ideas having taken feedback from the previous day.

The experts commented on which group's design solution they thought was the best and most feasible – from the user perspective, and the business case viewpoint. This was based on an assessment of which idea was most realistic and could be implemented in a specific context.

## 5. LESSONS LEARNED AND RECOMMENDATIONS FOR IS CURRICULA

In terms of contributions, our teaching tip demonstrates a novel approach to design thinking in IS education where the United Nations (UN, 2022) Sustainable Development Goals are a key source of problem statements for IS students when designing digital solutions. The course outline of this 3-day student design workshop can provide IS educators with a way to bridge between theoretical to practical realities of sustainability (cf. Kranz et al., 2022) in the classroom using design thinking and active learning to guide the concept design of sustainable digital solutions. Our teaching tip addresses two issues in IS education.

Firstly, the student design workshop helped raise students' awareness of real-life sustainability problems as identified within the UN sustainable development goals (SDGs) framework. Understanding sustainability issues in IS starts with curriculum design at the outset (Penzenstadler et al., 2014). From a practical viewpoint, IS education must instil in students the importance of sustainability for the design and development of digital solutions and teach them about new management implications of sustainability.

Secondly, our teaching tip shows how educators can foster students' problem-solving skills for addressing sustainability concerns through systems design. This requires both independent thought and group work to

harness the potential of each student when producing IS design prototypes for sustainability. Throughout this experience, students were supported in their learning by experts in design thinking and utilised active learning methods such as idea initiation, concept testing, as well as iterative design cycles to create concept prototypes. This centred around group activities such as describing a concept, storyboarding/journey mapping, modelling/wireframing, and business model generation for sustainability. Group activities were guided by the facilitation of small working groups, feedback, and review sessions for informing the next steps for development in the iterative process cycle. For instance, at the heart of our SDG learning experience was, the collection of early stakeholder feedback before going too far in the systems development process. Active learning also allowed students from different personal and educational backgrounds to gain teamwork skills, creative thinking skills, and evaluation skills in a 'safe' environment that supported exploration and experimentation. This also supports the ideology within the SDG framework of inclusive and equitable education for all, in sustainable environments (UN, 2022).

Research has shown that by engaging in sustainable IS initiatives organisations are more innovative, improving their knowledge acquisition and assimilation. The adoption of more sustainable IS innovation is positively associated with improved organisational performance including profitability and market value (Nishant, Thompson, and Goh, 2013) - attributes worth instilling within graduates entering the IS workforce. All participants were offered the opportunity to engage with the university's innovation hub main contact. Following this, group 2 went on to win the "Best Pitch Prize" at a start-up event which eventually developed into the idea of machine learning (ML) to automate diabetic retinal screening and BMI tracking among pregnant women.

As previously stated, design thinking not only guides the creation of artefacts but also emotional experiences. In the next section, students' reflections on the learning experience are offered. The reflections are organised as recommendations according to the principles of active learning in education (figure 2), including 1) problem-based learning, 2) tools for exploring, creating, and building, 3) space for collaboration, 4) experimentation and variation, 5) students as active learners, and 6) Educator as facilitators.

### 5.1 Problem-based Learning and Tools for Exploring, Creating, and Building

The United Nations' SDGs personally resonated with several students in the workshop. For instance, one student from Nigeria saw the workshop as an opportunity to explore positive change using technology to design adequate solutions to tackle some of the SDG goals. As the most populous black nation in the world with over 83 million people living below $2 per day in extreme poverty (United Nations, 2022), technology was investigated as a solution to end poverty, protect planet Earth, and ensure peace and prosperity.

The workshop pushed students to think out of the box and to create, design, and develop digital solutions that could tackle some of the problems currently faced in society, focusing on the SDG targets. However, it was also important to frame this broad goal in terms of five key recommendations for problem-based learning in systems design education:

i. Do thorough research before you think of developing a product or service that will tackle a particular sustainability challenge.

ii. Have a target market. By doing this, students are concentrating on developing their artefacts for a section of the economy rather than for everybody, which can sometimes be unrealistic.

iii. Not all products or services will work everywhere. Again, students need to go back to their market research. For instance, some government laws and policies in a different country might not work for your kind of business model.

iv. Develop a flexible business model that can easily adapt to change where necessary. By drawing up a Business Model Canvas and Value Proposition Canvas, students can develop a clear view of their value proposition, operations, customers, and finances.

v. Design good and simple visualizations that sell your products at a glance to your target audience. In developing prototypes, as designers and thinkers, students need to make sure our solutions are tangible and put solutions in contact with reality.

### 5.2 Space for Collaboration, Experimentation, and Variation

The workshop offered students an opportunity to further their knowledge of the SDGs while sharing ideas with peers. They also gained an opportunity to improve their teamwork skills whilst working on the sustainability topic of their choice. The team player test undertaken on the first morning guided the formation of groups as each student was assigned different labels such as a "leader" or "mediator" based on answers to the test. The value of this exercise was later reflected on by one student who noted: "*It was interesting to see how we fulfilled these roles (sometimes) without even meaning to do so*."

Some students found it challenging to select a final idea to focus on as all the ideas seemed to show potential and were interesting to discuss. However, based on helpful discussions and feedback within the group, students were able to eventually reach a decision.

On the final day, students were presented with the opportunity to present their ideas as a group to external stakeholders for feedback (for an example see Figure 10). The stakeholders were able to offer valuable insight into their ideas and how they could be strengthened. One area that was highlighted for Group 1 was that their idea was too broad and tried to encompass too much. The overcomplication of core ideas led the group to lose sight of the key sustainability aims of the application. This taught students to revisit the question they were trying to answer and ensure they did not forget about what the core idea was by overcomplicating them.




**Figure 10. SDG9 'Reactor' made by Group 3 (a fake ad of the concept as if finalised).**

### 5.3 Students as Active Learners / Educators as Facilitators

The workshop also taught students to turn small actions into big impacts and maximize sustainability within the constraints of given technology resources. For instance, group 2 aimed to improve the sustainability of food production through analytics. As noted by one of the students: "*I am not a doctor; I cannot save lives by curing disease. But with the knowledge and experience we gained from the event, I believed I could help to optimize the distribution of food through technology, turning potential food waste and surplus into nutritional value for socioeconomically disadvantaged people, thus preventing the development of non-communicable diseases*."

Students received feedback from SMEs suggesting that they scale back the number of functions and learned how to ensure their Business Model Canvas was in balance, shifting attention towards financial viability and partnerships. Students learned the difficulty of trying to serve too many people without sustaining the business and ensuring time for the business to grow.

The facilitators adopted a 'stepped-back' approach to provide space for student innovation. Sessions that worked well, were the ones that provided clear instruction on what was being asked of the student groups and provided enough time for group work. Less successful was the session at the end of day 2, when a resilience challenge was set - "You have been Hacked!" This was less successful, for two reasons. Firstly, the challenge was set late in the day when students were starting to become tired. The scheduled closing of day 2 also meant that students had limited time to complete the assigned task. Secondly, toolkit instructions on how to deal with the "You have been hacked!" challenge needed further 'fleshing out' and some students were unclear about the task's objective. These are useful insights when preparing future workshops, it is often through trial and error that facilitators can learn through post-delivery reflection on how to improve sessions.

## 6. CONCLUSION

In this paper, we investigated how design thinking and active learning can empower students to explore the role of IS as a change agent for sustainability problems within organisations or society. Done well, an active learning environment can meet these needs by fostering a culture of collaboration. This can enable IS students to work together and design solutions that meet different sustainability challenges. Our teaching tip includes recommendations for translating the SDGs in an IS education setting such as:

- IS educators should utilise the power of active learning when teaching the importance of sustainability in systems design.
- Sustainability ideas come in many forms. IS educators should aim to test the boundaries of students' thinking through the evaluation of concept prototypes.
- IS educators can create active learning environments that enable students to work collaboratively in the development of concept designs for the greater good.
- Allocating a dedicated block of time is extremely useful for focusing attention when using active learning approaches.

One limitation of our article is that the findings centre on the initial stages of concept design for the later development of digital solutions for sustainability. Future work can engage in longitudinal analysis of learning outcomes across other subject areas such as coding, testing, and potentially even implementation of the original concept designs. We also suggest future research can seek to investigate how learning content must reflect educational and cultural appropriateness to meet a diverse

set of curriculum needs. It would be advantageous to test the strengths and weaknesses of block teaching and learning (evidenced here as a dedicated period) against the traditional semester-long formats. Going forward we suggest the need for research on the use of design thinking and active learning in other contexts, such as North and South America, Australia, Asia, Africa, and other parts of Europe to understand its effectiveness and the need for adaptation. The techniques may also be generalizable beyond the topic of sustainability to graduate classes.

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## AUTHOR BIOGRAPHIES



**Wendy Rowan** is a lecturer of business information systems at Cork University Business School, University College Cork, Ireland. Wendy teaches across a range of courses in UCC from Professional Skills; Principles of Design Thinking; to Health Information Systems. Her research is focused on citizen engagement, having worked on EU H2020 and UK Wellcome projects in the past. She has published in peer-reviewed journals such as Internet Research, Information Technology and People, International Journal of Economics and Management Engineering, Procedia Computer Science, and Communications of the Association for Information Systems (CAIS).



**Stephen McCarthy** is a lecturer and researcher in information systems at Cork University Business School, University College Cork, Ireland. Stephen's research focuses on three areas: (i) shared understanding and control in systems development, (ii) the design of human-centred IT, and (iii) the 'dark sides' of technology use (e.g., smartphone addiction). He has published articles in leading peer-reviewed journals such as Information Systems Journal, Internet Research, Information Technology & People, Computers in Human Behavior, International Journal of Project Management, Journal of Cleaner Production, and Communications of the Association for Information Systems (CAIS).



**Selam Mebrahtu,** at the time of this workshop, was a Design Project Manager at Strategic Design Scenarios, Brussels, Belgium. As a Design Project Manager, Selam managed European research projects funded by Horizon2020 & Erasmus+ and offered design consultancy services to local administrations across Europe. At SDS, work focused on reshaping policymaking using design-centered approaches, leading to improvements in public services and more effective policies that better served citizens. Since 2023 Selam has been working as a Senior Project Lead of Strategy for Made Design and Innovation, Antwerp, Belgium. Selam has been applying her skills in service and strategic design, agile project management, and teamwork to address complex challenges.



**Christophe Gauche** is a Senior Designer and Researcher at Strategic Design Scenarios, Brussels, Belgium. Christophe focuses on sustainable and social innovation, collaborative and participative scenario building, participatory foresight (prospective scenarios of future sustainable ways of living), and service design. He has worked on various projects of public policy design and public innovation with regional authorities and ministries, as well as action-research projects at the EU level (H2020). Lately, he has been collaborating with the French Ministry of Justice on the care of youth under the French Ministry of Sustainability on designing tools that allow citizens and local elected officials to co-create future visions for local sustainable development programmes. Christophe facilitates courses at INET (Strasbourg, France) and teaches “Public Design and Innovation” at Sciences Po (Lille).



**Katie O’Reilly** is a PhD Candidate in information systems at Cork University Business School, University College Cork, Ireland. Katie is focusing on unconscious bias during the development of digital technologies. Exploring how we can mitigate the effects of unconscious bias on these technologies for the users. As an undergraduate student, diversity and equality were subject areas that Katie was hugely interested in, and the opportunity to explore them from a technological perspective as a postgraduate student has enabled Katie to further extend her knowledge in this area.



**Damilola Odili** boasts an illustrious academic background, having secured an MSc in Information Systems for Business Performance from University College Cork, where he was among the top 15% and contributed to the development of a Business Intelligence solution for a US cloud computing and virtualization technology company. Earlier, he earned a BSc from the University of Lagos in Surveying and Geoinformatics. His professional journey reflects a keen acumen as a Business Analyst. He has consistently streamlined business operations, fostered digital transformations, and spearheaded innovations. With roles spanning from remote teams in Nigeria to on-site roles in Ireland, Damilola's expertise lies in optimizing business performance and enhancing customer experiences.

## APPENDICES

**Appendix A. Schedule of the Student Design Workshop.**

| Day | Information Sessions and Activities |
|---|---|
| 1. Take off. | Information Sessions:<br>Welcome, Introduction and Icebreaker \| SDG Mission Statements \| Problem Setting.<br>Activities:<br>i. Discussion on SDG Mission statements.<br>ii. Benchmarking - further exploration of selected statement/s.<br>iii. Reframing using a Problem Tree Analysis.<br>iv. Ideation and mission selection.<br>v. Crash Testing with Peers.<br>vi. Concept Development. |
| 2. Build. | Information Sessions:<br>Value Proposition Canvas (VPC) \| Business Model and Mission Model Canvas (BMC/MMC) \| Visualisation to Communicate Ideas \| Concepts for the Market.<br>Activities:<br>i. Crash Testing with external stakeholders.<br>ii. Concept development, storyboarding, and completing the VPC.<br>iii. Visualising concepts through 12 images.<br>iv. Completing the Business Model Canvas (BMC) or Mission Model Canvas (MMC).<br>v. Creating Concept Posters.<br>vi. Hacked – ethical business solutions. |
| 3. Land. | Information Sessions:<br>Business Resilience \| Visualisation of Ideas \| Preparing the Pitch.<br>Activities:<br>i. Business Resilience Self-Evaluation.<br>ii. Finalising Concept Poster and Prototype.<br>iii. Preparing for the Group Pitch.<br>iv. Final Testing with external stakeholders.<br>v. Q & A Session. |

**Appendix B. Facilitation Guideline.**

**Day 1**

- Welcome – Icebreaker
- Group Activity 1 "Discuss mission statements that will be distributed" Select 1 mission per group. 8 cards of mission statements will be distributed to each group so they can discover with their group. They will then select 1 to explore further. Discuss the mission statements and preselect one mission out of the 5 you have received and tell us why you have selected it - 1 minute per group in plenary.
- Group Activity 2 "Benchmarking" Subgroups get on their computers and start looking at what already exists on the topic + they start getting familiar with the related issues + Look at what already exists + take some notes of things you have found inspiring.
- Group Activity 3 "Reframe" Activity with the problem tree analysis + Select which aspect you want to act on + reframe.
- Group Activity 4 "Ideation round #1" Activity with the problem tree analysis + Select which aspect you want to act on + reframe.
- Group Activity 5 "Alpha crash test" Everyone receives coupons/cubes 'I love that idea' sticker (3) why is it a promising idea? 'Interesting idea' (5).

**Day 2**

- Warm-up + finalizing.
- Beta crash test - External stakeholders will be present.
- Group Activity 1 "Explore how the concept works on a storyboard and share the value proposition." Complete the storyboard to explain how it works step by step.
- Group Activity 2 "Visualization of the concepts." Prepare a dozen image templates to use directly to help the visualization process.
- Group Activity 3 "Complete the business model canvas for your digital solutions." Make sure your idea stands a chance on the market. What if your digital solution is not for profit? Think about what form the solution would take if the main objective were not to generate profit.
- Group Activity "Finalize concept poster." Disruptive elements: is the business responsible and ethical?

**Day 3**

- Group Activity 1 "Business resilience self-evaluation." How responsible, inclusive, and ethical is your solution? Take a proactive

approach to ensure that you do not have any shortcomings that you may have overlooked.

- Group Activity 2 “Reflect on how to improve the solution in terms of resilience.”
- Group Activity 3 “Finalize concept poster and prototype.”
- Group Activity 4 “Getting ready for pitch and marketplace” Project prototypes and development plans will be used in promoting the university innovation hub and other comparable outlets for further progression and funding.