Problem-based learning and the integration of sustainable development goals

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Abstract

Purpose – This study explores how problem-based learning (PBL) programs can address Sustainable Development Goals (SDGs) via the higher education (HE) curriculum, teaching materials and relevant assessments, supporting learning at scale for HE institutions.

Design/methodology/approach – Employing SDGs and their indicators as the coding framework, our two-phase study evaluates the curriculum and teaching materials of seven PBL programs at a leading higher education institution (HEI). The first phase involved a content analysis to assess the degree of sustainability integration in 156 relevant courses. The second phase applied a semi-automated mapping protocol to analyze learning and teaching materials in 120 relevant courses.

Findings – The school aligns with 17 SDGs (100%), covering 94 indicators (55.62%). On average, each program within the school addresses over ten of these goals and incorporates more than 24 associated indicators. However, the study reveals an imbalance in the incorporation of SDGs, with some goals not yet deeply and comprehensively embedded in the curriculum. While there is a substantial focus on sustainability theories, the practical implications of SDGs in emerging countries, particularly through case studies and assessments, require significant enhancement.

Practical implications – Mapping SDGs allows HEIs to identify strengths and gaps in SDG integration, thereby improving the PBL approach to enhance student work readiness in sustainability-focused careers.

Originality/value – Through the lens of transformative learning theory, this study provides evidence of SDG integration into PBL curricula. It highlights a mapping methodology that enables HEIs to evaluate their sustainability readiness in curriculum, teaching materials and relevant assessments.

Keywords Sustainable development goals, Education for sustainable development, Problem-based learning, Curriculum mapping, Work-applied education

Paper type Research paper

1. Introduction

In HE, sustainability policymakers increasingly recognize the pivotal role of HEIs in integrating Sustainable Development Goals (SDGs) into their operations and inculcating sustainable concepts to prepare future labor forces (Osman *et al.*, 2017). Consequently, Education for Sustainable Development (ESD) has emerged as a key theme, aimed at equipping students with the skills and knowledge to address sustainability challenges (United Nations Educational Scientific and Cultural Organization, 2017). This reflects the expectation of education as a driving force in achieving the SDGs (Vaughter *et al.*, 2016). HEIs are called upon to enhance their efforts by fostering collaborations and interactions with both

local and international stakeholders to address sustainable development issues (Nhamo and Mjimba, 2020). The integration of SDGs into curricula is vital for assessing how effectively educational institutions contribute to global sustainability efforts (Curtis *et al.*, 2021; Ruiz-Mallén and Heras, 2020). Integrating ESD within the curriculum transcends mere knowledge transfer; it is about nurturing the ability to critically engage with complex environmental and societal issues (Sterling and Orr, 2001). While HEIs have made significant achievements in creating positive societal impacts (Viegas *et al.*, 2016; Figueiró and Raufflet, 2015), scholars argue that the sector should intensify efforts to update educational content to emphasize issues like environmental sustainability, economics, culture, gender equality and social responsibility (Sá and Serpa, 2020; Ahel and Schirmer, 2022; Nölting *et al.*, 2020; Rodríguez Aboytes and Barth, 2020).

Problem-based learning (PBL) particularly aligns with ESD objectives, transforming students into active problem-solvers confronting real-world sustainability issues (Puntha *et al.*, 2015). It revolutionizes ESD acquisition by immersing students in a student-centered learning journey, where they tackle sustainability-related problems and promote a deeper understanding of these critical issues. In PBL environments, learners engage in research, discussion and solution development for tangible, real-world problems (Savin Baden and Howell, 2004), activating participants in their learning process and internalizing sustainable development principles more effectively. This learning mode ensures that learners are not only theoretically informed about sustainability but also skilled in applying this knowledge in real-life scenarios, a vital preparation for a job market increasingly prioritizing sustainability and social responsibility (Fergusson, 2022). Despite the noted importance of sustainability in PBL design and its contribution to scalable learning, limited research comprehensively addresses this intersection. Therefore, this study aims to explore the integration of sustainability mapping into PBL curricula, learning and teaching materials and to evaluate its suitability as a benchmark for HEIs' strategic planning in problem-based, large-scale learning. The study addresses the research question:

RQ1. How PBL can address Sustainable Development Goals in the higher education curriculum?

By examining the integration of SDGs into the curriculum using PBL, we contribute to the HE literature by providing a methodology that can be scaled up and adapted to diverse higher educational settings and industry needs. This flexibility makes it particularly relevant for learning at scale, as it can be applied in large lecture settings, online courses or smaller, more interactive classes while maintaining educational quality and relevance (Ahmad *et al.*, 2023). In addition, our study also responds to the call for the application of the Principles for Responsible Management Education (PRME) i5 framework to increase the business school education relevance and their leadership abilities in addressing the global interconnected social, economic and ecological challenges via the development of sustainable knowledge, skills and mindsets in the school program curricula (PRME, 2022).

2. (Higher) education for sustainable development (ESD)

Education for Sustainable Development (ESD) highlighted that education institutes need to equip learners of all ages with the knowledge, skills, values and attitudes necessary to confront interconnected global challenges (Ahel and Schirmer, 2022). ESD incorporates the triple bottom-line dimensions of sustainability – economy, environment and society – through an integrated approach that enhances decision-making capabilities and quality of life (Nousheen *et al.*, 2020). Specifically, HE for Sustainable Development (HESD) is a specific subset of ESD (Zhang and Wang, 2021). It encompasses seven primary dimensions of sustainability transformation: institutional framework, campus operations, education,

research, outreach and collaboration, on-campus experiences and assessment and reporting (Lozano *et al.*, 2013; Zhang and Wang, 2021). Integrating HESD enables university students to understand and evaluate significant contemporary changes from a sustainability perspective, fostering a reassessment of human-nature interactions and encouraging active contributions toward societal sustainability transformation (Nölting *et al.*, 2020).

The integration of HESD can be achieved by the application of a transformative learning philosophy that empowers students with relevant knowledge and skills in learning experiences, closely aligned with SDG concepts (Cottafava *et al.*, 2019). Transformative learning plays a crucial role in enhancing teaching-learning processes, a fundamental pillar of teaching, learning and capacity development for sustainable development (Hallinger and Chatpinyakoop, 2019). Transformative education initiatives, including project-based and action-oriented activities, create synergies with stakeholders like NGOs or industry partners, enhancing the impact and reach of sustainability efforts (Leal Filho *et al.*, 2008). HEIs that do not promote cultures encouraging transformative learning mindsets or remain static are likely to hinder their progress toward sustainability (Trechsel *et al.*, 2023).

More importantly, the integration of HESD will address the call of PRME for the impactful five frameworks (i5) for Learning in Leadership Education (PRME, 2022). PRME's mission is to promote responsible management education and sustainable development relevance within business schools. Thus, the i5 framework aims to equip future business school leaders with the necessary skills and knowledge to address global social, economic and ecological issues in joyful, socially interactive, active engaging, iterative and meaningful methods. The initiative highlights that solving global complex problems is asymptotic to sustainability missions through the development of pedagogical "playful learning" approaches (PRME, 2022). The integration of HESD, therefore, demonstrates HEIs' sustainability readiness and ability toward the i5 framework.

3. Problem-based learning strategies for work-applied education

Work-applied education is a vital component of HE, aimed at preparing students with essential skills and knowledge to confront and resolve real-world challenges, thereby contributing to addressing societal issues (Margerison and Ravenscroft, 2020). This approach not only facilitates the practical experience and real-world application of learning, providing students an advantage in the job market but also benefits society through the contribution of well-equipped graduates (Baker *et al.*, 2017). Work-applied education fosters collaboration between HE institutions and stakeholders, leading to broader impacts and adapting effectively to contemporary issues.

In facilitating work-applied education, PBL serves as an innovative, student-centered teaching method. PBL focuses on solving real-world problems through teamwork and critical thinking (Osman and Kriek, 2021). PBL employs diverse teaching methods and strategies, enables students to engage in problem-solving, comprehend theoretical concepts and apply knowledge and skills practically (Schultz *et al.*, 2014). This approach nurtures important values, knowledge acquisition and the development of competent individuals. It is recognized as an effective method for promoting active learning, critical thinking, problem-solving skills and collaboration among students (Fergusson, 2019, 2022).

In large educational settings, it offers a scalable teaching method that accommodates large groups without sacrificing educational quality (Klegeris *et al.*, 2013). Contrary to conventional lecture-based approaches, PBL encourages collaboration and peer-to-peer learning, particularly beneficial in extensive classes (Fukuzawa and Boyd, 2016). It fosters quick and effective enhancement of students' knowledge and experiences in sustainability, preparing a larger cohort to competently address sustainability challenges (Routhe *et al.*, 2021). These components have a symbiotic interaction with one another where ESD provides the content, PBL refers to the methodology and transformative learning is the philosophical

underpinning. This trio synergistically fosters not only knowledge acquisition but also a profound shift in perspective essential for sustainable development. To effectively promote sustainable development, PBL and transformative learning require the content that ESD offers. By using knowledge in real-world interconnected social, economic and ecological issues, PBL enhances the learning and teaching process and highlights the significance and applicability of sustainability. Through the facilitation of a profound and meaningful shift in perspective, transformative learning enhances both ESD and PBL by enabling students to develop a comprehensive understanding of sustainability issues and adopt values and behaviors that are consistent with sustainability principles.

4. Problem-based learning through SDG integration into higher education curriculum

To actualize their commitment, HEIs must ensure their curricula integrate SDG concepts, thereby fostering a transformation in students' perspectives toward sustainable development advocacy. This imperative aligns with transformative learning theory, as outlined by Mezirow (2003, 1997), which posits that education – particularly through learning and teaching – plays a crucial role in driving transformative momentum and facilitating personal and societal change to address sustainability issues. Transformative learning involves revising problematic frames of reference to become more inclusive, open, introspective, and emotionally flexible, leading to disruptive change (Mezirow, 2003). The organizational design approach for embedding sustainability in HE varies. It ranges from developing specific sustainability degree programs to establishing standalone schools for sustainability or adopting multi- and trans-disciplinary approaches across faculties. Regardless of the approach used, sustainability should be a comprehensive curricular content element, bridging social and natural sciences and understanding the interconnectedness of social, environmental and economic systems (O'Byrne et al., 2014). Thus, sustainability must be integrated into all study areas and made accessible to all students, not limited to those specializing in sustainability sciences (Karmasin and Voci, 2021). While this study demonstrates the thorough integration of the SDGs within the curriculum and materials, it is important to acknowledge that further research is needed to assess whether this integration automatically leads to transformative learning and work readiness in sustainability.

A wide range of tools and methods to assess HEIs' sustainability in general have been continuously developed by scholars, in which curriculum design is also a crucial pillar to examine. Literature has identified a wide range of sustainability assessment tools for HE curriculum that vary across contexts, with each framework emphasizing its own set of agendas toward sustainability (Berzosa et al., 2017; Fischer et al., 2015; Weiss and Barth, 2019; Trad, 2019). One of the widely implemented frameworks is mapping curricula against the 17 SDGs. Case studies, such as those by Chaleta et al. (2021) at the University of Évora and Lu et al. (2023) in China have employed different methods for this purpose. However, there is a gap in comprehensive documentation representing curricula holistically, such as including learning and teaching materials. A comparative review of 16 sustainability assessment tools by Yarime and Tanaka (2012) emphasized the need to focus on course content and materials in assessing sustainability integration, rather than solely focusing on the macro curriculum. Moreover, most studies focus on the so-called "Western" world, leaving a gap in research from developing countries (Weiss and Barth, 2019).

PBL in particular is increasingly recognized as a transformative method for integrating SDGs into HE curricula. In PBL settings, students work on projects reflecting the complexity of real-life sustainability issues, such as developing sustainable business models or designing solutions aligned with SDG principles (Díaz-Iso et al., 2019). This approach is vital for

embedding SDGs in HE curricula, equipping students with the competencies needed to address global sustainability challenges and paving the way for a more sustainable future in HE. Our study's design and analysis were explicitly informed by transformative learning theory. In examining the SDG integration within curricula, we looked for educational elements that promote the kind of critical reflection and perspective transformation central to transformative learning. The presence of all 17 SDGs in course content is interpreted not merely as covering a range of topics but as facilitating opportunities for transformative educational experiences, where students engage deeply with complex sustainability challenges, challenging and changing their perspectives in line with transformative learning principles.

5. Methodology

5.1 Case study selection: School of Communication & Design, RMIT University Vietnam

We selected the School of Communication & Design at the Royal Melbourne Institute of Technology (RMIT) Vietnam to investigate the integration of SDGs in the PBL curriculum. This selection was based on two key criteria: (1) the rise of the Vietnamese international HE landscape and (2) the school's application of practical creative PBL contributing to transformative HESD. RMIT University is ranked 7th in the Impact Ranking 2023 by Times Higher Education based on SDG integration (Times Higher Education, 2023). Its strategic collaboration with various organizations and industries addresses sustainable development challenges (RMIT Univeristy, 2022), alongside a work-integrated, problem-based pedagogical approach toward the curriculum across its programs (RMIT Univeristy, 2023). This offers students practical experience in applying the SDGs, enhancing their problem-solving and critical thinking skills. These methods, including PBL, have proven to be more effective than traditional teaching approaches in advancing sustainability knowledge and skills (Yuan *et al.*, 2021).
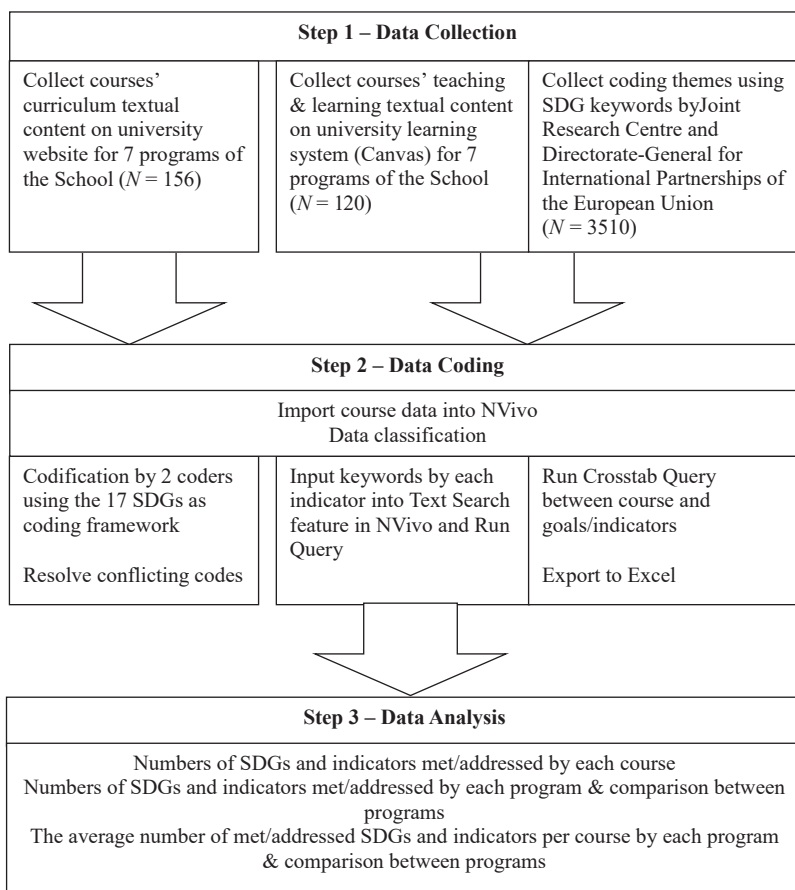
5.2 Data collection and analysis

The study explored the SDG integration examination through a qualitative research design. Qualitative approaches such as content analysis provide a versatile way to process most data types by organizations while conforming to any choice of sustainability framework (Erin *et al.*, 2022). The data collection procedure and data usage have been reviewed and approved by both the University's Ethics Committee and the management of the School. Accordingly, consent was obtained from the key staff of all seven programs under study, including Professional Communication, Design Studies, Digital Media, Fashion Enterprise, Languages, Digital Film and Video and Games Design. Limited to the collection of curriculum and learning–teaching materials only, the personal information of the teaching faculty and program managers was not collected, therefore protecting the privacy and confidentiality of the school's personnel.

In the first phase, sustainability integration in these programs' curricula was investigated through content analysis of relevant courses in seven programs. This method, adapted from previous studies (Chaleta *et al.*, 2021; Lu *et al.*, 2023), is recognized for its objectivity in assessing HEI sustainability performance against comprehensive benchmarks like SDGs. Two trained individual coders were involved in the data collection and coding process to reduce subjective, individual bias and misinterpretation (Burla *et al.* (2008). Data for 156 course contents were collected independently, including course overviews, learning outcomes, teaching schedules and assessment details from the school's website for the first semester of 2023. This information was imported into NVivo for coding, using the 17 SDGs and their indicators from the Statistics Division of the Department of Economic and

Social Affairs - United Nations (2017) as themes. The coding process involved identifying course contents that addressed Sustainable Development indicators and then, grouping these into corresponding goals. After the first round of coding, the inter-coder reliability was above 0.8 and met a sufficient level of reliability (Nunnally, 1978). For conflicting codes, the two coders and the research team resolved together to reach a final decision. After the coding procedure, each course was checked for the indicators and goals it met and then imported as a dichotomous variable (1 = presence and 0 = absence) to Excel. Descriptive analysis of the mapping data was then conducted using Excel, as demonstrated in Figure 1.

The second phase, focusing on learning and teaching material mapping, sought to reinforce the curriculum state of sustainability integration from the student's perspective. This phase adopted the semi-automated mapping protocol of Horne *et al.* (2020). This approach was chosen to ensure that the systematic coding results are bias-free from the human coders perception. Moreover, considering the significant volume of learning and teaching materials – the semi-automated coding procedure allowed us to map a larger size of content efficiently with limited resources. The data collection procedure involved gathering

Step 1 – Data Collection

| Collect courses' curriculum textual content on university website for 7 programs of the School ($N = 156$) | Collect courses' teaching & learning textual content on university learning system (Canvas) for 7 programs of the School ($N = 120$) | Collect coding themes using SDG keywords byJoint Research Centre and Directorate-General for International Partnerships of the European Union ($N = 3510$) |

Step 2 – Data Coding

Import course data into NVivo
Data classification

| Codification by 2 coders using the 17 SDGs as coding framework Resolve conflicting codes | Input keywords by each indicator into Text Search feature in NVivo and Run Query | Run Crosstab Query between course and goals/indicators Export to Excel |

Step 3 – Data Analysis

Numbers of SDGs and indicators met/addressed by each course
Numbers of SDGs and indicators met/addressed by each program & comparison between programs
The average number of met/addressed SDGs and indicators per course by each program & comparison between programs

Source(s): Property of the authors

Figure 1.
Curriculum and
material mapping
method process using
content analysis

the learning and teaching materials of 120 available courses through the university's canvas learning system. The sample size of courses is smaller than that used for curriculum mapping. This discrepancy was due to the availability of learning and teaching materials for future offering programs (e.g. Games), insufficient text-based materials or courses not offered in English. In the coding procedure, we utilized the text query search function in NVivo to automate the process, employing the SDG keyword set provided by the Joint Research Centre and Directorate-General for International Partnerships of the European Union (Borchardt et al., 2023). These SDG keywords mentioned in the learning and teaching materials were coded into the corresponding indicators. After coding the course content into indicators, the codes for each indicator were grouped into the corresponding goals, mirroring the approach used in the first phase (see Figure 1).

6. Findings

The analysis revealed that the school's curriculum aligns with 14 out of 17 SDGs, incorporating a total of 60 indicators. As shown in Figure 2, each program meets 8–12 goals and 18–32 indicators. On average, each program addressed about 10 goals (M = 10.42, SD = 1.18) and 25 indicators (M = 24.86, SD = 4.67). Each course, on average, addresses four goals (M = 4.20, SD = 1.50) and seven indicators (M = 7.44, SD = 3.07). The Games program leads with 12 SDGs achieved, while Professional Communication lags with only eight SDGs and 22 indicators met. In contrast, the Fashion Enterprise program demonstrates the highest sustainability integration, meeting 11 SDGs and 29 indicators. At the course level, Fashion Enterprise also leads with an average of 4.69 goals per course, as depicted in Figure 3. Professional Communication courses, albeit a low number of indicators met, meet on average more than four goals per course.

Nearly all courses across the school managed to meet Goal 4 – Quality Education and Goal 8 – Decent Work and Economic Growth. Indicators 4.4 (enhancing skills for employment and entrepreneurship) and 8.5 (achieving productive employment and equal pay) are most frequently addressed, as shown in Figure 4. However, there is room for deeper integration of SDGs in many programs and courses, with Goals 1 (No Poverty), 6 (Clean Water and Sanitation) and 14 (Life Below Water), being underrepresented.

The learning and teaching materials mapping revealed a more diverse picture. Each program addresses about 14 SDGs (M = 13.86, SD = 2.36) and 39 indicators (M = 39.43,

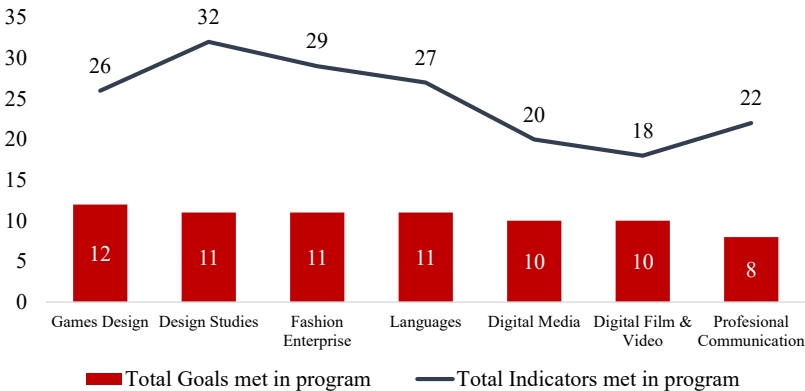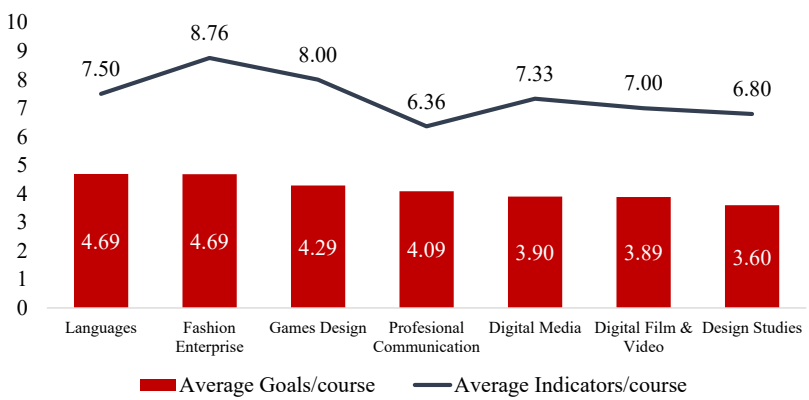**Figure 2.**
Total goals and indicators in programs' curriculum of the School of Communication & Design (RMIT Vietnam)
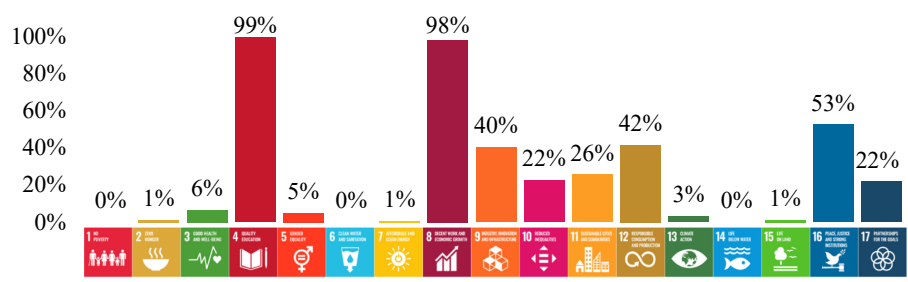
Source(s): Property of the authors

SD = 17.66), with management majors like Fashion Enterprise and Professional Communication leading in the number of SDGs and indicators addressed. Fashion Enterprise covers all 17 SDGs in its materials, while Professional Communication has the highest number of indicators ($N = 66$) as indicated in Figure 5.
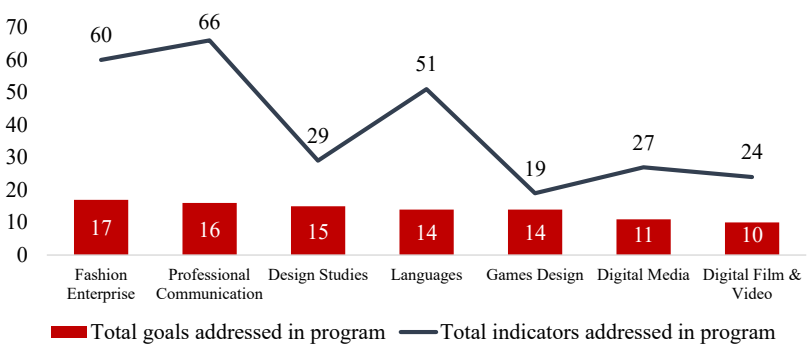

Figure 3.
Average goals and indicators per course by programs' curriculum of the School of Communication & Design (RMIT Vietnam)

Source(s): Property of the authors

Figure 4.
Percentage of courses' curricula in the School of Communication & Design (RMIT Vietnam) mapped by SDGs

Source(s): Property of the authors

Figure 5.
Total goals and indicators in programs' materials of the School of Communication & Design (RMIT Vietnam)
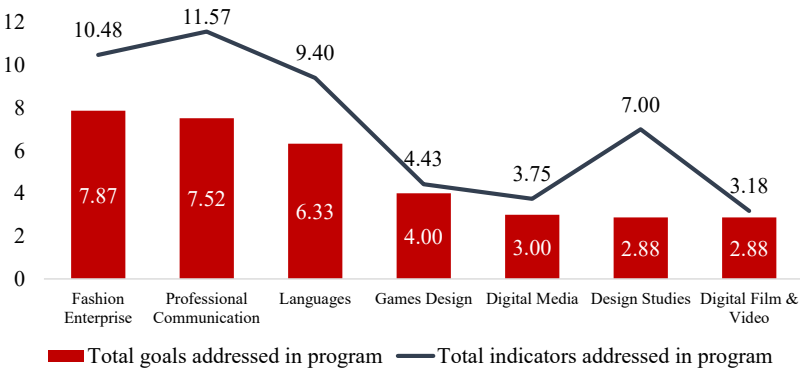
Source(s): Property of the authors

Overall, each course in the school addresses around 5 goals (M = 5.09, SD = 3.59) and nearly eight indicators (M = 7.62, SD = 7.14) in its materials. Management majors are again at the forefront, addressing more than seven goals and ten indicators per course on average, as seen in Figure 6. Art and design programs show lower sustainability integration, ranging from 2.88 to 6.33 goals and 3.18 to 9.40 indicators per course.

The material mapping results, illustrated in Figure 7, show that Goal 4 – Quality Education remains a primary focus, along with issues related to inequalities (Goal 10), sustainable cities (Goal 11) and peace and justice (Goal 16). Each program displays distinct priorities in both curriculum and materials, with management programs emphasizing specific SDGs like goal 16 in Professional Communication and Goals 9 and 12 in Fashion Enterprise. Most programs tend to focus on specific SDGs rather than equally addressing all of them, resulting in lower integration levels for Goals 1, 2, 5, 6, 14 and 15, as reflected in Table 1.
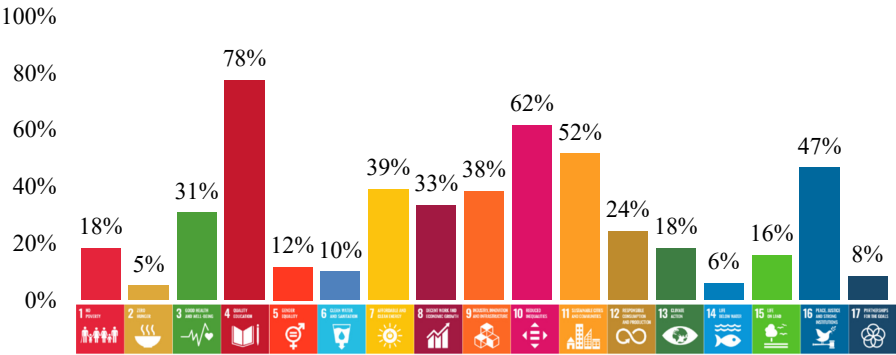
7. Discussions and conclusion

The necessity for sustainability practices is undeniable in today's world, with businesses expecting HEIs to equip students with the fundamental skills and knowledge to address

Figure 6.
Average goals and indicators per course by programs' materials of the School of Communication & Design (RMIT Vietnam)

Source(s): Property of the authors

Figure 7.
Percentage of courses' materials in the School of Communication & Design (RMIT Vietnam) mapped by SDGs

Source(s): Property of the authors

SDG	Professional communication Curriculum Course (N = 22)	%	Material Course (N = 21)	%	Design studies Curriculum Course (N = 25)	%	Material Course (N = 24)	%	Digital media Curriculum Course (N = 21)	%	Material Course (N = 14)	%	Fashion enterprise Curriculum Course (N = 29)	%	Material Course (N = 23)	%	Games design Curriculum Course (N = 17)	%	Material Course (N = 7)	%	Languages Curriculum Course (N = 26)	%	Material Course (N = 15)	%	Digital film and video Curriculum Course (N = 18)	%	Material Course (N = 17)	%
1	0	0	7	33	0	0	2	8	0	0	0	0	0	0	3	13	0	0	1	14	0	0	8	53	0	0	2	12
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	22	2	12	1	14	1	4	0	0	0	0	0	0
3	0	0	13	62	0	0	2	8	2	10	3	21	2	7	9	39	3	18	2	29	1	4	8	53	2	11	0	0
4	22	100	21	100	25	100	16	67	21	100	10	71	29	100	19	83	17	100	6	86	26	100	15	100	18	100	9	53
5	0	0	4	19	1	4	1	4	0	0	1	7	1	3	4	17	2	12	0	0	2	8	4	27	2	11	0	0
6	0	0	3	14	0	0	2	8	0	0	1	7	0	0	6	26	0	0	0	0	0	0	0	0	0	0	1	6
7	0	0	12	57	1	4	7	29	0	0	4	29	0	0	13	57	0	0	1	14	0	0	5	33	0	0	5	29
8	21	95	11	52	25	100	2	8	21	100	2	14	29	100	13	57	17	100	1	14	25	96	7	47	18	100	5	29
9	6	27	15	71	17	68	4	17	5	24	4	29	21	72	11	48	0	0	1	14	4	15	5	33	10	56	7	41
10	5	23	19	90	2	8	10	42	2	10	6	43	6	7	21	91	1	6	3	43	21	81	10	67	3	17	6	35
11	5	23	19	90	7	28	11	46	4	19	8	57	6	21	22	96	8	47	4	57	6	23	12	80	5	28	7	41
12	4	18	8	38	6	24	4	17	16	76	0	0	21	72	16	70	12	71	1	14	1	4	0	0	5	28	1	6
13	0	0	4	19	1	4	2	8	0	0	1	7	1	3	10	43	2	12	1	14	1	4	4	27	0	0	0	0
14	0	0	2	10	0	0	0	0	0	0	1	7	0	0	2	9	0	0	1	14	0	0	1	7	0	0	0	0
15	0	0	4	19	0	0	1	4	1	5	0	0	0	0	8	35	1	6	2	29	0	0	4	27	0	0	0	0
16	17	77	15	71	2	8	4	17	6	29	6	43	20	69	13	57	6	35	3	43	26	100	10	67	5	28	6	35
17	10	45	1	5	3	12	1	4	4	19	0	0	4	14	6	26	2	12	0	0	9	35	2	13	2	11	0	0

Source(s): Property of the authors

Table 1.
Number and
percentage of goals
addressed by
programs in the School
of Communication &
Design (RMIT
Vietnam)

sustainable challenges. Despite guidelines from the United Nations for implementing SDGs, there is a lack of evidence regarding their integration into HEI curricula. Our study, grounded in transformative learning theory, contributes to the theoretical understanding of sustainability in HE by analyzing the integration of sustainability concepts in HEIs' problem-based curriculum. Drawing from Sandri (2020) and Lozano *et al*. (2017), our study distinguishes between learning "about" sustainability and learning "for" sustainability. First, the findings show that HEIs' curricula have a prevalent focus on two most important SDGs: Goal 4 (Quality Education) to equip learners with relevant skills, including technical and vocational skills for the sustainable future (Indicator 4.4) and Goal 8 (Decent Work and Economic Growth) to ensure economic productivity through diversification, technological upgrading and innovation (Indicator 8.2 and 8.5) (Statistics Division of the Department of Economic and Social Affairs - United Nations, 2017). Thus, PBL is an effective approach to introducing sustainable concepts to all learners, as the concept can be thoroughly integrated into all curricula, teaching materials and assessments, promoting transformative education. They play a critical role in raising awareness for learners about global and local sustainable challenges in the field.

While our findings indicate a focus on SDG-related content, especially Goals 4 and 8, the emphasis is on practical application and critical engagement of these learning – key aspects of transformative learning. By approaching SDGs' theoretical knowledge and practical skills using problem-solving assessments, case studies and work-stimulated scenarios regarding specific SDGs, students are exposed to a transformative learning environment compared with traditional lectures and exams. For example, Studio V is an initiative by the School to have Communication and Design students solve sustainability problems such as disaster risk management (Goal 11), children's education (Goal 4), support for people with disabilities (Goal 10), anti-littering behavioral change (Goal 14 and 15) and more as a part of assessment provided by real industry partners and not-for-profit organizations (RMIT University, 2021). This results in a better quality of students' practical learning experiences and supports their future employment. At the same time, growing up in the HEI environment with SGDs' problem-solving mindset, skillset and real-case studies can give students a stronger performance in the practical context of the corresponding industry and become more productive problem-solvers of SDGs at a young age.

With evidence of the established linkage among ESD, PBL and SDGs, the research findings reinforce the need to include sustainability as a crucial pillar in HEIs' curriculum refinements and relevant learning material designs for HE students' practical learning at scale effectively. The integration of sustainability will not be just an option as a competitive edge, but a compulsory element in HE pedagogy. Thus, HEIs are in urgent need to comprehensively integrate sustainability into PBL, with a starting point to examine and acknowledge how far the institutions have gone through mapping and how further they can reach in the strategic curriculum design. PBL, as a pedagogical approach, not only engages students with sustainability content but also actively involves them in the process of understanding and addressing sustainability challenges via up-to-date case studies and practical projects. This active engagement is essential for developing competencies such as critical thinking, problem-solving and ethical decision-making, which are integral to sustainability (e.g. see references from Wiek *et al*. (2011) and Brundiers and Wiek (2017)). Additionally, there are three implications that the HEIs should take into consideration when integrating SDGs in the PBL curricula.

7.1 Tailoring SDG integration to program-specifics
Through comprehensive mapping of both curriculum and learning–teaching materials, HEIs can identify the state of sustainability integration into the program design promptly. A wide

view of the state can spark conversation and in-depth discussion on the current approach of the program or major in sustainability for both HE management and teaching faculty. While the findings indicate a prevalent focus on Goals 4 (Quality Education) and 8 (Decent Work and Economic Growth) across courses, reflecting the emphasis on work readiness in all PBL curricula, some SDGs, such as Goals 1 (No Poverty), 6 (Clean Water and Sanitation) and 14 (Life Below Water), are less represented across programs. These interpretations are because the courses/programs and their versatility tend to address certain sustainable problems more than others. For instance, a low level of SDG 6 and SDG 14 integration does not require immediate action to improve programs like design-related programs or Languages. The study by Browne (2023) on bachelor's level design programs reflected that SDG 11 (Sustainable Cities and Communities) should be focused on the most, followed by Goal 9 (Industry, Innovation and Infrastructure) as the programs can resonate with and be more subject-appropriate. Similarly, Language programs in the study by Chaleta *et al.* (2021) focus more on Goal 4 (Quality Education) and Goal 5 (Gender equality) owing to the nature of the curriculum units. However, it is a crucial problem that needs to be addressed in the Fashion Enterprise program since fashion is among the top industries harming the marine environment (Abu Bedor *et al.*, 2021). Related problems to these SDGs can become the main elements that revolve the curriculum design around, which students can learn through the problem-solving approach. Thus, identifying the right SDGs and indicators for each program is crucial, as there is no "one size fits all" solutions. By mapping and understanding the nature of the course, the industry can provide insights into which SDGs are more focused on, which are less, and what are the most suitable directions to improve in curriculum and material design. HEIs need to differentiate between "must-have" and "nice-to-have" SDGs, allowing educators to develop relevant teaching materials that reflect the specific requirements of each program.

7.2 Enriching the case studies in the local context
The findings highlight that the most respected SDG examples in course content are from different countries around the world. While they are good at demonstrating how SDGs can be addressed via some practical well-known global case studies, they may not reflect the outstanding sustainable issues that Vietnam currently deals with or cares for future generations. In the Fashion Enterprise program, for instance, most courses highlight acknowledged leaders in global sustainability initiatives as case studies, such as well-known brands like Patagonia, or demonstrate problematic approaches to sustainability such as H&M due to the availability of reliable published data. In addition, while some SDGs exist in the curriculum of almost every course, they are not the only goal needed by Vietnamese people. Instead, some missing goals (Goal 1 – No Poverty, Goal 6 – Clean Water and Sanitation and Goal 14 – Life Below Water) are critical in the Vietnam context. Whilst critical reflection is encouraged in all courses to enable students with work readiness in globally connected industries, the Fashion Enterprise curriculum engages where possible with national enterprises to offer PBL in a localized context, integrating Vietnamese case studies of brands practicing sustainable fashions. This leads to an important note that HEI program managers should localize the course materials with suitable sustainable issues, clear examples and case studies in the local context. This will help students engage with current social and environmental issues relevant to local businesses and stakeholders.

7.3 Balancing theoretical understanding and practical execution
It is also noteworthy that sustainable development is a grand vision that was developed on an international scale (Statistics Division of the Department of Economic and Social Affairs - United Nations, 2017). Therefore, when working with the concept and its related goals, it is

easy to fall into the abstract approach, leading to a misfit in learning and solving sustainable issues among learners. Especially for management education, a localized and practical approach to sustainability problems using case studies, assessments and innovative curriculum will be the future of work-applied education at scale rather than a purely theoretical approach. Nevertheless, based on the result findings, most curricula have yet to reach that level of problem-based sustainability integration. While the sustainability concept exists in the curriculum of almost every course, some gaps in sustainability knowledge delivery should be addressed. Most course materials demonstrated a successful approach to the "what" around sustainability and the SDGs, but there is still a lack of emphasis on practical application and implementation strategies. The balanced content can enable students to both learn and apply their sustainable development abilities, which in turn, increases their work readiness on sustainable issues in the marketplace.

8. Limitations and future research
The study faces some limitations. Firstly, while the curriculum mapping procedure covers all the courses provided by the School of Communication and Design, the material mapping procedure did not cover all the courses in the curriculum for two reasons: courses that did not have any students yet because the programs were newly taught (such as the Game Design program) or the materials were not available in English (such as courses from the Japanese minor in the Languages program). Secondly, the methods work mainly with textual content; thus, they cannot cover real experiences of some practical modules such as field trips, industry guest speeches or experiments unless they have textual content archived. Lastly, the study has yet to identify which set of SDGs the research findings compare against for each type of program to evaluate the effectiveness of the current practices.

Future research can explore SDG integration into the curriculum from a wider and more diverse context, such as cross-disciplinary, cross-national or cross-institutional comparison and in-depth analysis longitudinally. SDG benchmarks for different disciplines and industries the HEIs relate to can be helpful to navigate curriculum design rather than a full approach to less relevant SDGs. Moreover, research can also explore from the academic faculty and management viewpoints their advantages and disadvantages in incorporating and designing sustainable PBL for large numbers of students. Intervention experiments are also a feasible direction to identify the effectiveness of sustainability PBL at scale on students.

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