Green ICT in Business Information Technology Education: A Practice-Based Approach

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***Abstract* — The rapid expansion of digital technologies has intensified the environmental footprint of the information and communication technology sector, while simultaneously positioning digital solutions as key enablers of sustainable development. This tension creates an urgent need to reconsider how future information technology professionals are educated. The purpose of this reflective practice paper is to describe and critically reflect on how Green Information and Communication Technology principles are embedded into Business Information Technology education at a university of applied sciences.**

The paper draws on three course implementations conducted during 2025–2026, involving 152 bachelor-level students. Student perspectives were collected through mandatory discussion-based reflection tasks completed on the institutional online learning platform. The reflections explored students' views on the role of Green ICT in professional practice, the responsibilities of ICT professionals, and the relevance of sustainability for their future careers.

Observations from course implementations indicate that students increasingly recognize the environmental implications of digital solutions and begin to connect sustainability with their emerging professional identity. Integrating sustainability into disciplinary teaching appears to strengthen both technical competence and ethical awareness.

The paper concludes that sustainable education in the digital era does not necessarily require large-scale curriculum reform, but rather a systematic integration of sustainability into everyday teaching practices. These practice-based experiences provide insights for higher education institutions seeking to align digital education with environmental responsibility and long-term societal needs.

***Keywords*— Green ICT, sustainable education, higher education, professional competence, curriculum integration, sustainability awareness**

I. INTRODUCTION

Digital technologies are an essential part of modern societies and professional practice. At the same time, the rapid expansion of digital services, data processing and connected devices has increased the environmental footprint of the information and communication technology (ICT) sector [1]. Energy consumption, material use and electronic waste have become important concerns, raising questions about the sustainability of digital development.

On the other hand, digital technologies are widely recognized as enablers of sustainable development. ICT can support more efficient use of resources, enable new service models and reduce emissions in sectors such as transportation and industry. This creates a tension: digital technologies contribute to environmental challenges while also offering tools to address them. This dual role of ICT has been previously recognized in the literature [2].

Higher education institutions have an important role in preparing graduates who can balance technological innovation with environmental responsibility. Rather than treating sustainability as a separate subject, recent literature increasingly recommends integrating sustainability principles throughout existing ICT and computing curricula [3], [4], [5], [6]. Such an approach allows students to encounter sustainability in authentic professional contexts instead of viewing it as an isolated topic.

Business Information Technology education provides a particularly suitable context for this integration. Future ICT professionals make decisions that influence software design, infrastructure, digital services and technology adoption, all of which have environmental implications. Embedding Green ICT into existing courses therefore helps students connect sustainability with the technical and professional decisions they are likely to encounter in their future careers.

This paper presents a reflective practice approach to integrating Green ICT into Business Information Technology education at Laurea University of Applied Sciences. Rather than reporting the results of a formal educational research study, it describes practical curriculum development carried out across several course implementations and reflects on students' responses to these changes.

The paper is guided by the following questions:

How can Green ICT principles be integrated into existing Business Information Technology courses without introducing separate sustainability courses?

How do students perceive the relevance of Green ICT for their future professional roles?

By sharing practical experiences from curriculum integration, the paper aims to contribute to ongoing discussions on sustainability education in ICT and to provide an example that may be useful for educators seeking realistic and scalable ways to strengthen sustainability competences within existing degree programmes.

II. LITERATURE REVIEW

The growing environmental impact of digital technologies has increased interest in sustainable information and communication technology (ICT) and its role in higher education. Green ICT refers to the design, development and use of digital technologies in ways that reduce environmental impact across their lifecycle, including energy use, material consumption and system longevity [1]. Green ICT is commonly understood from two complementary perspectives. One focuses on reducing the environmental impact of ICT itself through energy-efficient software, hardware and digital infrastructure, while the other highlights the role of ICT in enabling sustainability across society. In the literature, these perspectives are often referred to as *Green of ICT* and *Green by ICT*, respectively [2]. While both perspectives are important, this paper primarily focuses on *Green of ICT* by examining how future ICT professionals can reduce the environmental impact of digital technologies

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through software development, technology choices and responsible ICT practices.

Higher education institutions have a key role in preparing graduates who understand both the opportunities and the environmental responsibilities associated with digital technologies. One of the key challenges identified in the literature is how sustainability should be incorporated into ICT education. Recent studies argue that sustainability should no longer be treated as a separate topic but embedded throughout computing and information systems education [4], [6], [7], [8]. This integration helps students connect sustainability with authentic professional decision-making rather than viewing it as an additional or unrelated subject.

Several approaches have been proposed for integrating sustainability into ICT education. These include dedicated sustainability courses, curriculum-wide competence frameworks and the integration of sustainability topics into existing technical courses [3], [5], [6], [8]. Embedding sustainability into existing courses offers a practical approach because it allows students to encounter Green ICT principles in authentic technical contexts without increasing the number of separate courses in already full curricula.

Recent literature also highlights the growing importance of sustainability competence as part of the professional profile of future ICT specialists [4], [8]. More broadly, higher education institutions are increasingly expected to develop competencies that support both digital and green innovation, extending ICT education beyond purely technical knowledge [9].

Sustainable education is also linked to broader pedagogical approaches. Education for Sustainable Development emphasizes the importance of combining technical knowledge with ethical awareness and systems thinking. According to UNESCO [10], education should support learners in understanding complex global challenges and making responsible decisions.

In the context of ICT, professionals need to understand the environmental implications of digital systems and the broader consequences of technology-related decisions. Hilty and Aebischer [2] argue that ICT plays a dual role in sustainability, making sustainability awareness an essential aspect of professional competence.

Another important theme is shared responsibility. Sustainable ICT is not only a technical issue but also an organizational and societal one. Responsibility is distributed between individuals, organizations and policymakers, which highlights the need for education that reflects this complexity [6], [10].

Lifecycle thinking is also central to sustainable ICT. This includes considering resource use and environmental impacts throughout the lifecycle of digital systems. Calero et al. [11] emphasize that sustainability in software and systems design requires attention to long-term effects, efficiency and maintainability.

Despite increasing attention, there are still gaps in how sustainability is implemented in higher education. Sustainability is often addressed in isolated courses rather than integrated into everyday teaching practices [4]. There is also limited understanding of how students perceive sustainability as part of their professional identity in ICT fields.

This paper contributes to the literature by providing a practice-based perspective on how Green ICT can be embedded into Business Information Technology education. Instead of proposing a new model, it focuses on integrating sustainability into existing teaching practices and understanding how students respond to this approach.

III. Materials and Methods

This reflective practice paper is based on teaching experiences from the Business Information Technology programme at Laurea University of Applied Sciences. Rather than reporting the results of a formal educational research study, the paper describes how Green ICT principles were integrated into existing teaching practices and reflects on recurring themes observed in students' responses during course implementations.

The primary observations presented in this paper are based on three implementations of the same mandatory bachelor-level course conducted during the academic years 2025–2026. Altogether, 152 students participated in these course implementations. The course prepares future ICT professionals by combining software development, digital business and professional ICT competences. Green ICT themes were integrated into the existing course content without introducing separate sustainability modules.

In addition to the main course discussed in this paper, examples of Green ICT integration from two other Business Information Technology courses are presented to illustrate how sustainability themes can be embedded across different subject areas. These examples include Green Coding principles introduced in a Basics of Programming course and discussions on data centres, artificial intelligence and sustainable ICT infrastructure in an ICT Infrastructure course. Student reflections from these courses were not collected or analyzed; they are included solely as examples of curriculum integration.

Student perspectives were gathered through mandatory discussion-based reflection tasks completed on Laurea's online learning platform as part of the normal course activities. Students were asked to reflect on topics such as the role of ICT professionals in promoting sustainability, the environmental impact of digital technologies, the relevance of Green ICT in software development, and the distribution of responsibility between individuals, organizations and policymakers. The purpose of these reflections was to encourage students to connect sustainability concepts with their future professional practice.

The reflections were reviewed to identify recurring themes that illustrated how students understood the role of Green ICT in their education and future careers. The observations are presented at a general level and are supported by a small number of short, anonymized quotations that illustrate representative student perspectives. These quotations are included as examples of recurring themes rather than as research evidence.

The purpose of this paper is not to produce generalizable findings but to provide a reflective account of curriculum development and teaching practice. By describing practical experiences from integrating Green ICT into existing ICT education, the paper aims to offer ideas that may be transferable to similar higher education contexts

A. Ethical Approval and Informed Consent

This paper is based on reflective teaching practice conducted in a higher education context and does not constitute formal research involving human subjects. The

student reflections used in this study were part of regular course activities and were not collected for research purposes. Participation in course activities followed standard educational practices of the institution. To ensure that the use of student reflections remains ethically appropriate, all observations are presented in an aggregated and anonymized form. No personal or sensitive data were processed, and no individual students are identifiable. The focus is on illustrating common perspectives rather than reporting individual responses. Therefore, according to institutional and national guidelines, ethical approval was not required for this study.

IV. Results and Discussion

Integration of Green ICT into Teaching Practice

The integration of Green ICT principles into teaching was implemented as part of existing professional subjects within Business Information Technology education. Rather than introducing new courses or separate content areas, sustainability was embedded into core topics such as software development, systems design and digital services.

This integration focused on practical and professionally relevant themes, including lifecycle thinking, energy-efficient design, system longevity and responsible digital decision-making. These topics were addressed through assignments that reflected real-world contexts, allowing students to connect sustainability considerations with their future professional roles. This was particularly evident in tasks related to programming and ICT infrastructure, where students were able to connect sustainability directly to technical decisions such as coding practices, system design choices and the environmental impact of digital services.

The same approach was also applied in other courses within the programme. In the Basics of Programming course, students were introduced to Green Coding through Microsoft self-learning materials that illustrated how programming choices, algorithm efficiency and resource use influence energy consumption. In the ICT Infrastructure course, sustainability discussions focused on topics such as data centres, cloud services, artificial intelligence and their environmental impacts. Although student reflections from these courses were not analysed, these examples demonstrate how Green ICT can be progressively embedded across different areas of an ICT curriculum.

This approach aligns with previous research suggesting that sustainability is most effective when embedded within existing technical education rather than taught as an isolated topic [5], [7], [8]. Integrating sustainability into existing teaching can support more meaningful learning by linking abstract concepts to practical applications.

Student Awareness and Understanding of Sustainability

Student reflections suggested that the integration of Green ICT into existing course activities contributed to increased awareness of the environmental impacts of digital technologies. Analysis of the reflections revealed three recurring themes: increased awareness of the environmental consequences of ICT, recognition of sustainability as a professional competence, and an understanding of sustainability as a shared responsibility extending beyond individual actions.

Many students recognized that ICT is not environmentally neutral and began to consider issues such as energy consumption, device lifecycle, electronic waste and the long-term consequences of technology-related decisions. Several students commented that sustainability should be addressed more explicitly within ICT education and regarded Green ICT as an important part of professional preparation. As one student stated:

"Green ICT should be an essential part of every IT professional's education."

Students also emphasized the importance of understanding the broader impacts of digital technologies during their studies. As one student reflected:

"It is important to understand already during studies how future IT work affects the surrounding world."

These reflections suggest that students increasingly viewed sustainability as something directly connected to ICT practice rather than as a separate environmental issue. Topics discussed during the course, including software efficiency, energy consumption, electronic waste and lifecycle thinking, appeared to help students connect sustainability considerations with everyday technical decisions. Similar observations have been reported in previous studies [3], [4], which suggest that sustainability education can broaden students' understanding of the societal role of technology and strengthen awareness of the wider consequences of digital development.

A second recurring theme was the connection between sustainability and professional competence. Students increasingly associated sustainability with their future roles in software development, digital services and other ICT professions. Rather than viewing sustainability solely as an ethical concern, many regarded it as a practical competence that would influence professional decision-making throughout their careers. This observation supports previous research [4], [8] suggesting that sustainability competence is becoming an integral part of the professional profile of ICT specialists.

Some students also viewed sustainability competence as increasingly relevant for employability. One student described Green ICT competence as "*a valuable competitive advantage for new IT graduates"* and linked sustainability knowledge to changing expectations in the labour market. This suggests that students perceived sustainability not only as a responsibility but also as a professionally relevant capability that may support future career development.

Overall, the reflections indicate that relatively small curriculum interventions can encourage students to think more critically about the environmental implications of digital technologies and their own role in shaping sustainable ICT practices. These observations are broadly consistent with recent literature on curriculum integration in computing and ICT education [4], [6], [8].

While these observations do not constitute generalizable evidence, they illustrate how integrating sustainability into existing ICT courses can support both awareness and professional identity development.

Perceptions of Responsibility and Professional Role

A recurring theme in student reflections was the idea of shared responsibility. One student summarised this shared perspective by writing:

"Concrete changes will not happen without the small actions of many individuals."

Students often emphasized that responsibility for sustainable ICT does not lie solely with individual professionals but is distributed across organizations, policymakers and society. This perspective reflects existing research emphasizing that sustainability challenges require action at individual, organizational and societal levels, highlighting the importance of education that supports systemic thinking and shared responsibility [6], [10]. Understanding sustainability as a shared responsibility may help students develop a more realistic and context-aware view of their future roles as IT professionals.

At the same time, some students expressed uncertainty about their ability to influence sustainability in practice. This highlights the importance of education in providing not only awareness but also concrete tools and perspectives for action.

Perceived Challenges in Integrating Sustainability

While students generally viewed Green ICT as important, some also perceived sustainability considerations as potentially conflicting with efficiency, cost or established work practices. Rather than questioning the importance of sustainability itself, these students highlighted practical challenges related to its implementation. One student noted that sustainability-related requirements may be experienced as an additional burden and can sometimes be perceived as slowing down work processes.

"Green ICT may sometimes slow down work processes and create additional requirements compared to previous ways of working."

This observation suggests that sustainability is not always viewed as a straightforward addition to professional practice. Instead, students recognized that environmental considerations may involve trade-offs between efficiency, cost, usability and sustainability objectives. Similar tensions have been discussed in previous research on sustainable ICT and software engineering, where environmental goals must often be balanced against other organizational and technical priorities [2], [11].

Implications for Teaching Practice

Based on the teaching experiences described in this paper, sustainability can be integrated into Business Information Technology education without major curriculum reform. In practice, this was less demanding than initially anticipated. Embedding sustainability into existing teaching practices allows students to engage with the topic in a natural and context-relevant way.

The preference expressed by many students for integrating sustainability into existing studies, rather than introducing separate courses, further supports this approach. This aligns with the literature emphasizing curriculum integration as a key strategy for sustainability education [6], [8].

At the same time, the results highlight the importance of making sustainability visible and explicit within teaching. Simply including sustainability implicitly may not be sufficient; students benefit from guided reflection and discussion that connect sustainability to their professional identity.

Discussion

The observations presented in this paper suggest that sustainability in ICT education is most meaningful when approached as an integral part of professional competence rather than as an additional topic. A practice-based approach allows sustainability to be connected to real-world contexts, which appears to support both understanding and engagement. The value of this approach lies in its simplicity and applicability in everyday teaching contexts.

The experiences also highlight the importance of integrating sustainability into existing teaching practices. Rather than relying on separate courses or isolated content, embedding sustainability into core subjects enables students to encounter these themes as part of their professional development. This approach aligns with previous research emphasizing curriculum integration as an effective strategy for sustainability education [5], [6], [8].

However, the teaching experiences also highlighted that awareness alone is not sufficient. While students recognized the importance of sustainability, some also perceived challenges related to its practical implementation. This indicates that teaching should not only introduce sustainability concepts but also provide concrete examples and tools for applying them in real-world situations. Similar observations have been reported in recent curriculum development initiatives, where Green Computing and sustainable software development modules increased students' awareness of sustainability issues while also highlighting the need for practical examples and implementation-oriented learning activities [12].

In a broader perspective, the integration of sustainability into digital education reflects a shift in how professional competence is understood in the ICT field. In a context where digitalization and artificial intelligence are rapidly expanding, technical expertise alone is no longer sufficient. ICT professionals are increasingly expected to consider the wider environmental and societal implications of their work. This highlights the need for education that supports not only knowledge acquisition but also the development of responsible and reflective practitioners. Embedding sustainability into everyday teaching practices can be seen as one way to respond to this change without overloading curricula or creating additional structural complexity.

Furthermore, the experiences suggest that relatively small pedagogical interventions can have a meaningful impact on how students perceive sustainability. By linking sustainability to concrete tasks and professional contexts, students are more likely to see it as relevant and applicable rather than abstract or external to their field. This supports the idea that sustainability education in ICT should be continuous and integrated, rather than delivered through isolated or optional components. In this sense, the approach described in this paper can be viewed as a practical step towards aligning digital education with the broader goals of sustainable development.

V. CONCLUSION

This reflective practice paper has described how Green ICT principles were integrated into Business Information Technology education through existing courses at Laurea University of Applied Sciences. Rather than introducing separate sustainability modules, Green ICT themes were embedded into authentic ICT learning activities related to

software development, digital services and ICT infrastructure.

The experiences from three course implementations suggest that sustainability can be integrated into existing ICT education without major curriculum reform. Student reflections indicated increased awareness of the environmental impacts of digital technologies, a stronger recognition of sustainability as part of professional competence, and an understanding of sustainability as a shared responsibility. The observations also suggest that connecting sustainability to authentic technical tasks and professional contexts helps students perceive it as relevant to their future careers.

The contribution of this paper is practical rather than theoretical. By presenting a practice-based example of curriculum integration, the paper illustrates how sustainability can be embedded into existing ICT teaching in ways that are feasible, scalable and closely connected to professional practice.

The limitations of this paper should be acknowledged. The observations are based on three implementations of a single course within one higher education institution and are supported by student reflection tasks completed as part of normal course activities. Consequently, this reflective practice paper aims to illustrate recurring themes and practical experiences rather than provide generalizable evidence.

Future work could explore how sustainability competence develops over longer periods of study and examine whether Green ICT education influences professional practice after graduation. Comparative studies across institutions and ICT programmes could also provide a broader understanding of effective approaches to integrating sustainability into digital professional education.

Conflict of Interest

The authors declare no conflict of interest. This work is based on reflective teaching practices conducted within a higher education context and was not funded by any external organization. The study does not involve any commercial or financial relationships that could be perceived as influencing the content or conclusions of the paper.

Author Contributions

The author conducted the teaching activities, analyzed the material, and wrote the manuscript. The author has read and approved the final version of the paper.

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