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# SUSTAINABILITY IN TRAINING – DESIGNING SOCIOTECHNICAL ECOSYSTEMS

## *Descriptive Case Study*

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## **Abstract**

*There is increased interest in understanding how sociotechnical systems can be conceptualized beyond corporate-customer service relationships. Digital ecosystems support flexible, fluid interaction, enabling participation and engagement. In the context of societal integration, these systems can create inclusiveness and ultimately contribute to a more sustainable society. To obtain these benefits, we argue that sociotechnical systems must be deliberately and responsibly designed and that such an approach needs to be integrated into the training of future designers. This paper draws on the Nordic sociotechnical approach to design and theories on digital ecosystem. Building on a qualitative case study on integration and language learning, involving students as designers, we discuss three existing principles of sustainable digital ecosystems: part-of-ness; systemic wisdom and; information ecology. The paper contributes an extended understanding of the design of sustainable sociotechnical ecosystems and a discussion of the role of students in the design.*

*Keywords: Sociotechnical Ecosystem, Sustainability, Design, Nordic Sociotechnical Approach, Integration, Students in training; Higher Education*

## **1 Introduction**

There is a growing interest in Information Systems (IS) research to understand alternative conceptualizations of sociotechnical systems that challenge the prevailing economic paradigm of corporate-customer service relationships (Lindman et al., 2022; Zuboff, 2015). In this paradigm, corporations have been criticized for neglecting the health and well-being of their consumers and for not adequately protecting the environment (Márton, 2021). While sustainability and digital transformation are key societal directions and pursuits, the design of sustainable digital ecosystems in this context has yet to receive more attention (van Gils & Weigand, 2020). Sustainability comprises environmental, social, and economic dimensions (Bruntland, 1987). These three dimensions are not only vital for our existence but also pose a challenge to achieve. Given their interconnected nature and mutual influence, they often result in ill-structured, complex problems and necessitate difficult trade-offs for individuals, organizations, and society to manage. To succeed, we must understand how the sociotechnical systems we design affect practices and societal developments and be deliberate and responsible when designing these systems (Aanestad et al., 2021; Ahuja et al., 2023). This study focuses on the economic and social dimensions of sustainable development by suggesting a design approach for inclusiveness that challenges existing reductionist economic systems where mainly big platform owners' profit (e.g., Lindman et al., 2022; Zuboff, 2015). Moreover, the study integrates the sustainability

approach by introducing design students in higher education, i.e., designers in training, to a larger societal problem, engaging them in a real-life project, where they design a digital system for language learning in the context of integration.

A stream of literature investigating digital ecosystems uses metaphors from natural ecosystems (Márton, 2021; Star & Ruhleder, 1996). As Márton (2021) highlights, natural ecosystems are well understood in terms of their vulnerability to human abuse, e.g., when we pour poison into the water or pollute the air, we will destroy not only the water where the poison was poured but also the lives of plants, animals, and humans that consume the water and the air for a living, hence the whole ecosystem. However, regarding digital ecosystems, it is not well understood how they are destroyed and how they can be maintained to stay healthy. Nature has been understood in terms of ecosystems. Still, when it comes to digital systems, we are applying another logic that has partly failed to be incorporated into the natural ecosystem until now but has been technology-deterministic and reinforced the Anthropocene, ignoring the health of the planet and people. The dominant economic paradigm makes it challenging to analyze digital systems from a sustainability perspective and criticize how systems are designed and governed.

Using the lens of digital ecosystems can help when designing sustainable digital ecosystems that contribute to the health of people and the planet, not only profit to system owners. According to Márton (2021), ecological thinking emerged as a response to the heterogeneous, complex, unbound, and interconnected systems we increasingly face as digital ecosystems (El Sawy et al., 2010; Star, 1995). Digital ecosystems can be described as product agnostic since their functionality is not predetermined, like physical artifacts, but instead, they are characterized by editability, openness, re-programmability, and interoperability (Constantinides et al., 2018; Eaton et al., 2015; Kallinikos et al., 2013; Yoo et al., 2010). The generativity and self-strengthening mechanisms that exponentially increase the value for individual users when a large installed base of users adopt the same solution contrasts with traditional economic models and can explain, for example, how the value of social media sites such as Facebook and LinkedIn, are increasing in value to each user as more people join (Yoo et al., 2012; Zittrain, 2006). Planning, analyzing, and driving change in such environments implies an overview and analysis of sociotechnical driving forces that generate these systems and the services and resources required to continuously adapt in a digitalized world (Lindman et al., 2022; Márton 2021). In this paper, we discuss and critically reflect on the design of sociotechnical systems for societal integration and language learning, involving students as designers. We pose the following research question: *How to conceptualize sustainable sociotechnical ecosystems and what is the role of student designers in that process?*

The remaining part of the paper is structured as follows: Section 2 presents our related research and theoretical concepts on design and digital ecosystem. Section 3 describes the project background and methodology, data collection, and analysis. Section 4 outlines the findings, which are then discussed in relation to the three principles of digital ecosystem in Section 5. Finally, Section 6 presents our conclusion and the implications of the study.

## 2 Theoretical framework

This section explores the related research and theoretical concepts that have guided the paper. We draw from the literature on sociotechnical approaches, the Nordic school of thought, and digital ecosystems theory to build a base for analyzing how to design sustainable sociotechnical ecosystems.

### 2.1 A sociotechnical design approach

In the Nordic countries, early systems development in the 60s and 70s was affected almost equally by social, political, technological, and economic factors (e.g., Wynn & Vallo Hult, 2019). This ‘Scandinavian School’ within the field of Information Systems (IS) emerged from the Nordic countries of Denmark, Finland, Norway, and Sweden as a research tradition focusing on relations between humans, technology, organization, and work. It was affected by strong labor unions based on a belief that involving users will improve system development for workplace democracy (Bansler, 1989). It

emphasizes a critical and reflective approach to studying digital systems and technology. It is characterized by focusing on the human aspects, including social and organizational issues, the importance of involving stakeholders in the design and development of information systems, and how ethnographic and participatory research can inform the design of systems and artifacts (Blomberg & Karasti, 2013; Lee & Schmidt, 2018; Wynn & Vallo Hult, 2019).

The Nordic approach to IS aligns well with the view of design as “intentional change in an unpredictable world” (Nelson & Stolterman, 2012, p. 12), an approach to design that emphasizes the need for designers to be proactive and adaptive to embrace uncertainty and ambiguity, and to engage with the broader context in which their designs will be situated. This approach seeks to create intentional change through design interventions, recognizing that the world is constantly changing and that designs must be able to adapt to changing circumstances and unexpected events. It further acknowledges that the problems we face today are often interconnected and systemic and that addressing these problems, thus, requires a holistic and collaborative approach. Finally, the importance of user-centered and participatory design approaches is emphasized, which involve engaging with stakeholders and end-users in the design process to ensure that their needs and perspectives are considered: “Design is the ability to imagine that-which-does-not-yet-exist, to make it appear in concrete forms a new, purposeful addition to the real world” (ibid, p. 12).

A sociotechnical perspective recognizes that an organization consists of interconnected social and technical factors and that adequate consideration should be given to technology as well as informal and formal interactions between people and tasks. This requires viewing technology as situated and mutually adaptive within its context, considering how people, practices, social context, and digital artifacts interact (Mumford, 2006; Sarker et al., 2019). By adopting this perspective, we can gain a more comprehensive understanding of the factors that contribute to successful outcomes and identify areas where improvement can be made to enhance the effectiveness of technology and human interactions. Although the sociotechnical perspective has been around for a long time, it is often backgrounded in current research and practice. Consequently, bad design of information systems problems, such as modern IT systems poorly adjusted to the external or internal environment (e.g., market, organizational culture) of organizations in which they are (to be) deployed. A review of sociotechnical perspectives in contemporary IS research suggests that reintroducing the dual focus of humanistic and instrumental goals is considered “especially important in understanding and harnessing emerging and potentially disruptive technologies in various contexts” (Sarker et al., 2019, p. 40).

Prior research highlights the importance of sociotechnical perspectives to unpack the interplay between the technical and social aspects of app design and development when designing for specific purposes or practices (Islind & Norström, 2020; Vallo Hult et al., 2022). Through co-designing content, the digital environment can facilitate knowledge sharing and engagement in community building for sustainability and trustful information sharing through networking and collaboration over time (Vallo Hult et al., 2020). Sustainability in the process can, for example, involve adopting critical design (Islind & Vallo Hult, 2022) and an ethical approach to design, thus avoiding building bias into the service designed. A critical and ethical design approach can be worked with in different ways, for example, through identifying as many different perspectives as possible by doing interviews, workshops, and tests with a heterogeneous user group and working with wicked problems (Rittel & Webber, 1974). Our point in this paper is that sustainability needs to be considered in all the steps in the design process, and responsibility needs to be taken for how the designed artifact will be used over time.

## 2.2 Digital ecosystems

As technology has evolved from isolated expert systems to complex interconnected systems (Márton, 2021; Star & Ruhleder, 1996; Tilson et al., 2010), new sociotechnical relations are emerging, and we face new challenges to design sustainable and responsible systems. The digital ecosystem literature is a stream of research that conceptualizes this sociotechnical development. Digital ecosystems can be understood as complex, ever-changing, sociotechnical systems that enable value-creating interactions

and allow multiple stakeholders to organize their services and content (Constantinides et al., 2018, p. 381), enabling a robust digital ecosystem. The systemic behavior of ecosystems involves emerging, non-local phenomena. Digital ecosystems have the capacity to change and adapt by themselves, self-organize, and self-regulate; hence, they have flexibility in their functionality and are, thus, not finished by design (Constantinides et al., 2018; Kallinikos et al., 2013; Yoo et al., 2010). Unlike their predecessors, digital ecosystems are not limited to a single purpose. Instead, their content is generated after they have been put into practice, often in ways that were not anticipated or intended by their creators (Yoo et al., 2012; Zittrain, 2006). Corresponding to this technological development, new types of markets of voluntary participants in the ecosystems have emerged (Eaton et al., 2015; Márton, 2021; Tiwana, 2013), e.g., Airbnb with guests and hosts and self-monitoring patients and medical doctors. Overlooking challenges of heterogeneous relationships and governance in these new digital ecosystems may give rise to health and well-being problems of users of the systems, such as sleep deprivation in the business of streaming video where platforms like Netflix compete with users' sleep and mental and physical health (Márton, 2022).

Márton (2021) synthesizes research on digital ecosystems and outlines three principles of digital ecosystem: part-of-ness, systemic wisdom, and information ecology: i) Part-of-ness relates to the fact that digitalization is always part of a larger ecosystem and that systems are relationships. Every actor is part of an ecosystem, and patterns of interaction and communication build the ecosystem (DeLanda, 2016; Harries-Jones, 2002). There is a difference in meaning between “being stuck in the traffic and being part of the traffic” (Márton, 2021); ii) Systemic wisdom relates to the fact that ecosystems have limits and cannot grow forever. Ecosystems are like music; they have a rhythm and a melody rather than bricks in a wall or a seamless carpet. They are dynamic and processual. In ecosystem thinking, the focus is on patterns of processes rather than on actors, i.e., we can study how processes change in a patterned fashion; and iii) Information ecology relates to the fact that ecosystems are not mechanical but informed cognitive systems motivated by information. An ecosystem is an ecology of ideas and connections; for example, children and parents are different, which defines their relationship. These ideas travel along patterns of processes. This principle highlights that information is understood as mutual relationships and connections, creating connections between ecosystem actors.

To sum up, the development of emerging complex interconnected systems, combined with more complex, often wicked problems, calls for more research to understand how systems should be designed to protect and include all participants in a system on equal terms. In this paper, we respond to this call by developing ideas for the design of sustainable digital ecosystems. Combining the Nordic approach to design of sociotechnical systems with literature on digital ecosystem thus helps to target great sustainability challenges, such as societal integration, which is the focus of this paper. In the following section, we outline the method used, and after that, we discuss the results.

### **3 Method**

This paper reports from an ongoing research project on designing a digital ecosystem for language learning and integration. Following the traditional case study approach, the methodology is based on qualitative methods and complementary data collection forms (Yin, 2013). The case study involves engaging students as designers as part of the research project, with the purpose of integrating sustainability into IS higher education. including information about the data collection and analysis method.

#### **3.1 The case study**

During the past five years, a multi-disciplinary team of researchers and practitioners have worked closely with recent immigrants in Sweden with the aim of developing a platform that supports language learning and provides information and support needed when searching for and starting a new job in a

country one may recently have entered. As part of this work, foreign-born persons have been interviewed about their use of digital tools and level of digital literacy, as well as prototype testing of various designs of digital support (see, e.g., Bradley & Al-Sabbagh, 2022). The main objective of the project has been to decrease the distance between individuals and employment, provide support through the job searching process, and allow these immigrants to be integrated into Swedish society to a larger degree. Also, there has been a formulated ambition to provide scientific contributions to sustainable design. The project aligns with several sustainability goals outlined in the United Nations' Agenda 2030, including Goal 4 for inclusive and equitable education, Goal 5 for gender equality, specifically sub-goal 5b for promoting the use of technology to empower women, Goal 8 for sustainable economic growth, full employment, and decent work, and Goal 9 for resilient infrastructure, inclusive industrialization, and innovation, including sub-goal 9.c for increased access to technology.

For this paper, we involved second-year undergraduate students taking a five-week course in Sustainable Design as part of the three-year bachelor program Digital Media, which has a focus on Nordic perspectives on design. We engaged the students in ongoing research related to the above-described project and asked them to develop and present ideas and prototypes on concepts, functions, and features supporting our aim to design a sustainable digital ecosystem for language learning and integration. The students followed the phases involved in a design process as formulated by Löwgren and Stolterman (2004), which include research, exploration, composition and evaluation. In addition, they were presented with a digital prototype previously designed by the research group in the research project. The prototype was designed from extensive effect mapping (Nobles et al., 2022) a method used to understand the dynamics and impacts of an intervention where stakeholders (in this case, recent immigrants and actors working with them) take part in testing the effects of the intervention in iterations.

We asked the students to focus on providing ideas related to language learning, communication encouraging features, and how one may connect users wanting to learn with those wishing to mentor. We also asked them to suggest ideas on providing possibilities for users to share their produced content, such as dynamic portfolios and CVs. Within available systems owned by authorities and municipalities, the functions are often limited in this regard since the possibilities to share content outside traditional government systems are usually poor. Users often have little to no influence in terms of how information can be shared outside of these ecosystems. We imagined that the digital solution we aimed to create as a research group would imply a change on a systemic level, where users, to a more significant degree, own their information and control how it is stored and shared.

### **3.2 Data collection and analysis**

For this paper, we rely on data collected from the abovementioned case study. The course, for which the students provided us with their ideas, took place during the fall semester of 2022. A total number of 29 students took part in the course. At the beginning of the course, they were divided into six groups (four to five people per group) and were given information about the project. They were provided with a written brief describing the context of the research project in which their contribution was to be made, some documentation of previous findings generated within the research project, and they were given the task of designing a digital system supporting language learning activities. In addition, the students were given an oral presentation of the case and had the opportunity to ask questions for clarification from representatives from the research group. Also, the students were given information about the primary target group, i.e. foreign-born men and women who lack the language skills needed to enter the Swedish job market, the secondary target group, i.e., municipality representatives, employers, and civil society. Keeping these users in mind, they were asked to develop and present a prototype of a digital artifact meeting the aims presented above. The students were also asked to document their design process by keeping 'design journals' for the research group to take part in when the course ended. They were instructed to write, maintain, and organize notes on activities and reflections crucial to their design process. At the end of the course, each group was asked to present their ideas to representatives of the research group, and they were asked to provide an individually written report of reflections made during their design process. This resulted in six group presentations, six design journals, and 29 reflection

reports. The final results were presented as digital artifacts, applications, and websites (see Section 4.1 for examples).

The data collected and used for this paper consists of written and analyzed reflections made by the students as they engaged in the sustainable design of a digital ecosystem for language learning. The analysis is also informed by longitudinal engagement with the project and secondary data collected within the research project (such as project documentation, previously published papers, informal communication, and material). We used an abductive approach to our analysis shifting focus between the empirical material and theoretical reasoning (Alvesson and Sköldbberg 2018), guided by our interest in sustainable design. We particularly focused our analysis on how the students structured their design efforts by incorporating practical features such as colors, buttons, and menus as well as user experience and service value. Additionally, we focused on how they integrated sustainability into their design.

## 4 Findings

In this section, we present findings from the students work of designing sustainable systems for language learning and integration. We present three levels of design realizations that emerged during the design work: First, the practical level, which focuses on the technical functions of the systems. Second, the abstract level which focuses on services and visions of the design. Third, the sustainable ecosystem level highlights the interplay of technical and social aspects in its context from a sustainable design approach.

### 4.1 Practical level of design

Within this theme, we present examples of how the most practically-oriented level of design was envisioned by the students as applications and features. They proposed a diversity of applications such as mobile apps, websites, add-ons, and plug-ins for the already existing app prototype designed by the research group supporting the project aim. One group, for example, gave the following suggestion on an application: *“The application will train foreign-born people in Swedish through language tests that they should be able to use to get work”* (Mia, Group 5).

While some of the students developed full-version applications, some focused on formulating specific functions and features that could support integration and language learning, such as audio functionality and language tests, while also relating them to long-term goals: *“A free technical solution, text in both Swedish and mother tongue as well as an audio function where all design choices have been made to promote social sustainability and sustainable goal number 4 related to qualitative education for everyone”*. (Inga, Group 2). The following quote illustrates an additional example of a feature that would trigger interest in usage: *“We also created a feature that we call “Of the day” [in Swedish “Dagens”] which each day will suggest a word, a challenge, or a trivia about Sweden. This is to specifically integrate them into Swedish culture”* (Mia, Group 5).

Typically, the envisioned applications were prototyped using “wireframes”, “interface sketches”, and “prototypes” (some even mentioned “dynamic digital prototypes”). At the technical level, features can be graphical and interactive elements that allow for interaction with the app. Figures 1-3 illustrate how specific micro and technical functions in the apps are designed to ignite engagement and motivation through notifications and graphical design elements.

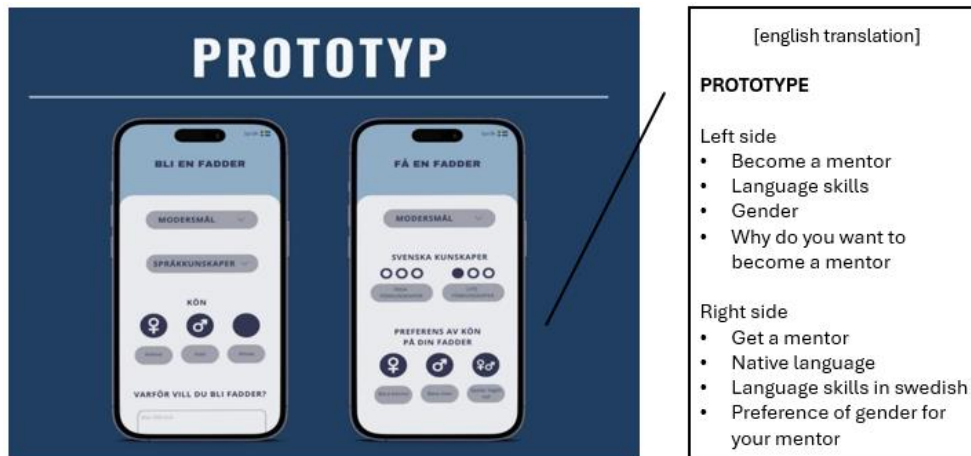


Figure 1. Prototype of a mentor application



Figure 2. Prototype of a job match-making application.



Figure 3. Prototype of "Swedish thing of the day" application

## 4.2 Abstract level of design

This theme illustrates a more abstract design level and shows how the designers put together the applications and features at the practical design level to design a service adjusted to the specific context of language learning and integration. The focus for the users should, according to the students, be to learn the language rather than learning how to navigate the interface. The focus for users should be the



service, not the use of the application: *“The app should help enable users to get a job, for example through learning Swedish and receiving tips”* (Inga, Group 5).

To design a service rather than a tool with buttons to click, the students suggest enabling a flow of engagement (to learn a language) through closeness, informal contacts, and role models, along with engaging and motivational social features. In the following example, one group presented a role model service which they described as follows:

*“Our primary focus has been on the Role Model service. This is a service that, in short, consists of a lot of role models who are there to help the user. By role models, we are not referring to Zlatan or Greta Thunberg, but people who have been in the same or similar position as the users are in. Foreign-born people who have immigrated to Sweden, with not the best Swedish skills, but wanting to enter the job market. The idea with the role models is that they should be there as a pillar of support for the individuals, to show sort of a “If I can do this, so can you!”* (Oliver, Group 6).

Further, designing for motivation was articulated by the students in these two following examples. The first example focuses on the connection between motivation and learning: *“We also find that our solution is sustainable as interest-based learning is a long-term solution because it starts from the individual as a person. Learning is based on motivation and will which is parked by an interest in sharing it with others”* (Inga, Group 5). In the second example, motivation is brought up as an overarching term to frame the entire project: *“The final vision was an app (a digital artefact) with a particular focus on motivation. One of the needs expressed by the target group was the desire to become integrated into Swedish society, but there was also the need for a supervisor/mentor who can provide guidance”* (Sandra, Group 6).

At the abstract level of design, the students also bring in a sustainability perspective. The following example shows that the designers had the Agenda 2030 sustainable development goals (SDGs) in mind, here addressing SDG 4, Providing quality education for all, and SDG 10, Reducing inequalities and ensuring no one is left behind, which are aspects that lead to empowerment: *“[...] to come up with new ideas that will help women and men born abroad to acquire knowledge of the Swedish language and become more integrated within the Swedish society”* (Alex, Group 3).

### 4.3 Sustainable ecosystems level of design

The final theme suggests a more holistic view on designing for sustainable digital ecosystems and highlights how the students situate their design into a larger, existing context. The examples in this section include reflection on sustainable design, further illustrating how they took, or failed to take, sustainability into account before, during, and after the design process. One way of situating the design within the larger context in which the design was highlighted by mentioning that taking on a sustainability approach is not only related to environmental concerns but also to a larger societal context:

*“[...] one must also connect the doctrine of sustainability to all the societal subjects. It means that one must anchor the idea of sustainability in politics, equality and social class, since these are factors that may affect non-sustainable development. This means that sustainability has several aspects as one must keep in mind to think sustainably”* (Stefano, Group 4).

An interesting reasoning in regard to sustainable design was an idea on how sustainability elements could, and sometimes should, be looked upon as potential enablers of sustainability within other dimensions rather than as costly and restraining, arguing for reasons that companies should consider sustainability throughout their entire organization. The same designer argued for how “sustainability fosters sustainability” and how different dimensions of sustainable design are linked together and need to be understood in a less abstract sense and rather be understood as an integrated part of a greater

system: *"You need to show how all dimensions are connected and how it actually affects concretely [...] not only the target group would benefit from increased integration, but the whole society"* (Stefano, Group 4).

While some mentioned that they kept sustainability in mind throughout the whole design process, others admitted to being quite far along in their design process when considering sustainability perspectives in relation to their work:

*"Throughout the entire work process, sustainability has been a major focus to promote healthy development, both short-term, "in the present," as well as long-term for future generations"* (Omar, Group 5).

*"[...] without taking the emotional support into account, and only focusing on language learning, we don't think the solution would have provided sustainable learning"* (Stefano, Group 4).

*"At the beginning of our work, we went through the goals from Agenda 2030 that we received from the course's teachers and identified these and the other goals that existed. After that, we didn't discuss sustainability for a while going forward and focused more on the parts that belonged to the respective progress report to stay on track"* (Emelie, Group 2).

Other groups reasoned around varying aspects of sustainability analysis as well. Technical sustainability and the importance of keeping this perspective in mind while designing was central for many. To some, this was understood as developing "sustainable systems and artefacts". Another group, who developed a mobile phone application, found this perspective especially useful while analyzing how sustainable their application could be considered in terms of long-term usability and adaptation to future development within a larger context:

*"The application has a high usability and it is easy to develop it with features that might be requested in the future. From the start, the application is timeless. It has no features that won't work in the future. What may need to change are the language tests and the profile page. There may be new types of documents that are important when, for example, applying for a job. This is easy to add as the application has a collection page for all documents"* (Mia, Group 5).

Some groups mention valuable lessons they have made throughout their design for this case study. One key lesson mentioned was to keep sustainability in mind throughout the whole design process; do not save it to last. One explanation for not considering sustainability throughout the design process could be that the students had difficulties grasping the concept of "sustainability". Some admit to having difficulties doing so, so applying it was challenging.

*"We all found the concept of sustainability pretty difficult to understand"* (Oliver, Group 6).

*"Sustainability can say a lot and it can also say almost nothing about a very wide and complex subject"* (Frederic, Group 6).

*"Since sustainability is complex and the sustainability goals are quite broadly defined, it was sometimes difficult to interpret them. In addition, some goals go against each other. However, we managed to interpret some and adapted the app based on these"* (Inga, Group 5).

When reasoning on their finished design work, one designer in training highlighted the lessons he had learned throughout their process:

*"The lessons that I will personally take with me in future projects are, among other things, to consider sustainability thinking throughout the entire design process [...] Another lesson is how sustainability should saturate whatever is created and how adaptively it can be done. What has really been experienced in understood from recessing and discussion is that everything and everyone can do something for a more sustainable world, big or small, it's just a matter of knowing what you can contribute"* (Alex, Group 3).

## 5 Discussion: Designing sustainable ecosystems

In this paper, we engage in a critical discussion and reflection on the creation of sociotechnical systems aimed at societal integration and language learning, with students participating as designers. Through the theoretical lens of Nordic perspectives on sociotechnical design (Bansler, 1989; Mumford, 2006, Sarker et al., 2019) and sustainable digital ecosystem (Star och Ruhleder, 1996; Márton, 2021), as well as researchers' engagement in students' sustainable design work, this study contributes to an understanding of how heterogeneous, complex, unbound, and interconnected systems need to be designed to be sustainable. Inspired by principles of digital ecosystem, outlined in Márton (2021): part-of-ness, systemic wisdom, and information ecology, below we suggest a conceptualization of sustainable sociotechnical ecosystems.

**Design to enable part-of-ness:** According to ecosystem thinking, there is no such thing as outside. Instead, everyone in an ecosystem is in the system and is part of the system. Against this background, we argue that designing a system for integration and language learning means designing a digital ecosystem where the language learners are the ones who design and govern the system, and also those who are part of the system and benefit from it. The opposite would be a top-down implemented and governed language learning system where users utilize the system and where system owners profit from the users. Being part of a digital ecosystem for integration means being engaged in integration, such as communication activities and language learning. What individuals do have consequences for the future development of the ecosystem. Márton (2021) refers to this approach as self-referential design. Our findings provide examples of practical functions designed with the specific purpose of enabling relations for inclusion and a sense of belonging among foreign-born persons. Involvement and heavy engagement make people feel part of an ecosystem. New activities designed for this case need to be incorporated into the existing ecosystem of socialization. These examples highlight how the design of the digital app is part of a larger social context and relationships (dynamics, engagement, and motivation) that need to be taken into consideration through patterns of interaction and communication (DeLanda, 2016; Harries-Jones, 2002).

**Design to enable systemic wisdom:** Engagement and inclusiveness can create a natural flow in an ecosystem, like the rhythm of music. For example, the design of the mentorship app is based on functions that create engagement and motivation on a practical level. On the more abstract design level, it connects the service and the vision to sustainability through a conceptualization of the service of mentoring in the situated context, e.g., language learning, heterogeneous user groups, different cultures, languages etc. The findings illustrate the importance of focusing on patterns of processes rather than on actors. This can be viewed as systemic wisdom in terms of associations that create togetherness, highlighting that learning a new language is achieved through engagement. The system (mentor app) becomes a bridge that enables this.

**Design to enable an information ecology:** On a practical level, our findings show how the students incorporated specific functions that enable mutual relationships and connections, which are especially important in the context of integration and language learning. On a service or vision level, features need to be designed together to form a service that enables information ecology. Such service could be a

mentor relation where newcomers meet people who have been in Sweden for a longer time and who have the same experience as the newcomer. This connects to the principle of designing for information ecology, highlighting how language learning is a mutual relationship and connection, where the information creates connections between actors in ecosystems. Altogether, the three principles of an ecosystem can be linked to sustainability to further our understanding of the design of sustainable digital communication. As outlined in the previous section, the designers reflected upon sustainable design, further illustrating how they took or failed to take sustainability into account before, during, and after the design process.

In sum, the attributes and qualities on a practical level and the services and visions on a more abstract design level form an ecosystem. Here, we need to design for part-of-ness, information ecology, and systemic wisdom. This extends the understanding of user involvement in the Nordic sociotechnical school where designers and users are separate actors and users participate in the design. It also extends the traditional economic paradigm where we favor those who already have power (e.g., platform and business owners such as Netflix, Facebook, or Amazon) but not those who actualize the system with their activities and user-generated data (e.g., Zuboff, 2015).

As part of a digital ecosystem, a designer and a governance manager, for example, can affect parts of the system but not the whole system. New design activities are needed to critically design systems that benefit all in an ecosystem, as everyone within the ecosystem is responsible for their participation, and everyone is accountable for engaging others to be active and take responsibility. Everyone is part of a relationship that, in turn, is part of a more extensive system (Márton, 2021). This links to the Nordic perspective of sociotechnical design, emphasizing that the people create the system, not the technology, but people and technology together enable participation and relationships.

Digital ecosystem is also a way to assess prevailing systems critically. By following these principles, we can design sustainable ecosystems that are resilient, innovative, and flexible and create value for all actors involved. In all, this highlights why we need to extend existing sociotechnical and design perspectives to include digital ecosystems and sustainability thinking.

## 6 Conclusion

In this paper we discuss three principles of digital ecosystem: part-of-ness; systemic wisdom and; information ecology, and relate them to our findings on a practical, abstract and sustainable ecosystem levels of design. The paper contributes an extended understanding of the design of sustainable sociotechnical ecosystems by combining Nordic sociotechnical perspectives and theories on digital ecosystem. Moreover, the paper contributes an illustrative example of how to engage students in a real-life project, introducing them to a larger sustainability challenge. Engaging students in sustainable design aligns with the Nordic sociotechnical approach to design and its core essence of involving stakeholders in the design and development of information systems. For future research, it would be interesting to explore more in-depth the potential and mutual learning effects between students, teachers, and external stakeholders and how such knowledge can be used both to inform the design of educational programs as well as to better support shared learning in design processes related to grand sustainability challenges.

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