





Research Article

Authentic learning for soft skills development and environmental sustainability

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Abstract

Soft skills, intra- and interpersonal skills for personal growth, social engagement and workplace success are vital in a changing world, yet their intangible, unpredictable and contingent nature means that soft skills are best learnt experientially. This case study investigates a 15-week course at a Thai technological university, which was based on the principles of authentic learning where students are actively involved in real-world interactions with real-world impacts. Promoting participation in environmental sustainability, the course task required students to propose and implement an innovation with environmental benefits on the university campus. Six proposals were selected by the university community through participatory budgeting, and support systems such as mentors were used to help students make their innovations a reality. The 42 students' reactions and learning were investigated through corpus and qualitative analyses of their reflective journals. Findings showed extensive use and learning of diverse soft skills (particularly organisational, communication and teamwork skills), raised awareness of the environment and workplace practices, and a sense of pride and achievement.

Although challenging and problematic to assess, an authentic learning approach provides beneficial experiences for learning soft skills.

Keywords authentic learning; environmental sustainability; soft skills; Thailand; participatory budgeting

Introduction

This case study addresses two key issues. First, to prepare students for a future world of unpredictability and disruption, soft skills are needed to give students the capacity to deal effectively with new challenges (Heckman and Kautz, 2012). Soft skills, however, are often intangible and difficult to operationalise, meaning that competency-based approaches that emphasise the achievement of specified objectives are likely to be ineffective (Gilyazova et al., 2021). Instead, flexible exploratory approaches are needed for the effective teaching of soft skills, with authentic learning showing promise (Weliwita and Witharana, 2019). Curriculum designers therefore need to identify flexible authentic experiences within which students can learn soft skills.

The second key issue is the need to promote environmental sustainability to mitigate the impacts of climate change. The importance of environmental sustainability for the future means that raising environmental awareness has become a core objective in education. With younger generations increasingly concerned about environmental issues, especially in middle-income countries such as Thailand (VanHeuvelen and Summers, 2019), projects to promote environmental sustainability provide a potential context for authentic learning of soft skills which should engage and motivate students.

In this article, therefore, we present a case study examining the effects on the learning of soft skills of a university course based on the principles of authentic learning where students design and implement projects to promote environmental sustainability.

Defining and developing soft skills

Soft skills, also termed twenty-first-century skills by the United Nations and life skills by the World Health Organization (Gilyazova et al., 2021), are widely acknowledged as being essential for both personal and professional success. In this case study, we take a broad perspective on soft skills defining them as 'intra- and inter-personal (socio-emotional) skills, essential for personal development, social participation and workplace success' (Kechagias, 2011: 33). Such a broad perspective offers several implications for soft skills education. First, soft skills are generalisable across purposes. For example, teamwork skills can be applied in different compositions of teams such as large or small groups, or teams with familiar and unfamiliar members. Second, although soft skills are generalisable, their implementation is context-specific and thus their use can be viewed as contingent on the nature of the context in which they are being applied. For teamwork skills, for example, ship's crew members prioritise different skills depending on the type of vessel they are working on (Bouzón et al., 2023). Third, soft skills are intangible and multidimensional. For instance, successfully working in a team requires certain leadership skills where appropriate, as well as socio-emotional communication skills, and this cannot be packaged into a single box of teamwork skills.

Given that we cannot predetermine a specific set of soft skills that need to be learnt, we need to identify a context relevant to the learners in which soft skills can be developed. This is the basis for proposals to use project-based learning approaches to develop learners' soft skills (for example, Beckingham, 2023; González-Morales et al., 2011; Vogler et al., 2018). A project-based approach to soft skills aims to provide a rigorous experience for students to develop soft skills, perform tasks and solve real-world problems similar to those they might encounter in the workplace and the settings in which the skills will ultimately be used. The key rationale underpinning this approach is that soft skills can best be developed through experiential, hands-on learning opportunities in real-life situations (for example, Beckingham, 2023; González-Morales et al., 2011), especially where these experiences are integrated with disciplinary learning (Gilyazova et al., 2021). In this case study, therefore, we set up a large-scale

project to provide the experiential learning opportunities for developing soft skills within the disciplinary context of environmental education.

Environmental education

The context in which this case study takes place is an elective undergraduate general education course open to students from all faculties. We needed to identify a disciplinary context of interest and relevance to students of all faculties. With the need to address environmental challenges being of particular concern to younger generations (VanHeuvelen and Summers, 2019), we decided to use environmental education as the disciplinary frame within which to develop the students' soft skills. Focusing on environmental issues also allows us to address university policy goals, especially those associated with Green Universities (Tiyarattanachai and Hollman, 2016).

Environmental education is a collective effort to educate about how the environment works, and particularly, how humans can manage and protect it. The Tbilisi Declaration states that environmental education is a learning process that increases people's knowledge and awareness of the environment and associated challenges, which develops the necessary skills and expertise to address the challenges and fosters attitudes, motivations and commitments to make informed decisions and take responsible action (UNESCO, 1977). This declaration highlights four key components of environmental education: knowledge, awareness, skills and attitudes. The United States Environmental Protection Agency (United States EPA, 2022) adds a fifth component, namely, participation.

Environmental education, then, is far more than simply providing information about the environment. Of greater importance is the need to instil a sense of agency whereby learners understand that their own actions can have positive impacts on the environment. To do this, the fifth component of environmental education – participation – becomes paramount. The course reported on in this case study emphasises participation by providing the context and resources for students to design and implement their own environmental sustainability projects to have positive impacts in the real world.

Authentic learning to develop soft skills

As our goal is for students to develop their soft skills through experiential learning while having positive real-world impacts on the environment, we decided to take an authentic learning approach.

The literature on authentic learning (Har, 2013; Herrington and Herrington, 2006; Herrington and Oliver, 2000; Lombardi, 2007; McKenzie et al., 2002; Mims, 2003; Pinner, 2016; Roach et al., 2018; Stein et al., 2004) identifies several characteristics associated with the approach:

- Authentic context: learning takes place within a real-world context.
- Real-world relevance: the tasks learners undertake are relevant to the real world, while the real-world context is also relevant to the learners.
- Complex, sustained tasks: learners undertake large-scale tasks over a period of time which involve multiple subsidiary tasks or activities.
- Ill-defined tasks: the tasks are open-ended, allowing learners to provide their own interpretation of the task.
- Authentic activities: each of the subsidiary activities within the main task is itself authentic.
- Flexible outcomes: there is a wide range of valid ways of completing the tasks.
- Teacher as facilitator: the teacher's main role is to provide support and guidance to help students achieve their goals.
- Scaffolding: the teacher provides support where necessary to help students attain levels of performance beyond their ability when working independently.
- Collaboration: students need to work effectively together and with others to complete the tasks.
- Multiple roles: students take on different roles at different stages of the tasks.
- Interdisciplinary: completing the tasks can involve using knowledge and skills from multiple disciplines.
- Tangible authentic product: the outcome of the task is a concrete product that provides real-world benefits.
- Authentic assessment: students are assessed based on real-world performance criteria.
- Reflection: students reflect on their own performance and learning.

A course based on authentic learning typically involves four main stages, with certain characteristics of authentic learning prominent at the different stages (McKenzie et al., 2002). The first stage of setting up the scenario introduces the overall goals of the course, highlighting the *authentic context* and *real-world relevance* of the work the students will do. Second, the task setting introduces the students to the *complex, sustained, ill-defined task* involving several *authentic activities* to reach *flexible outcomes*. Third, in completing the task, the teacher acts as a *facilitator* providing *scaffolding* where necessary, while the students *collaborate*, taking on *multiple roles* and using *interdisciplinary* knowledge and skills. Finally, students will have produced a *tangible authentic product* on which they will be assessed *authentically*. Throughout the process, students will be encouraged to engage in *reflection* on their performance and learning.

There is some variation in the extent to which courses which have been termed authentic learning manifest the characteristics associated with authentic learning. This variation has led Pinner (2016) to propose a continuum of authentic learning whereby courses can be considered as partially or fully authentic. At the least authentic end of the continuum is extrapolation, which involves using authentic materials, such as newspapers and web pages, to create learning tasks, although what students do on the task is not of real-world relevance. Further along the continuum towards authenticity is simulation, where tasks mimic real-world situations but are completed within the classroom. Participation takes authenticity a step further by involving learners with genuine interaction with people or situations in the real world, but where the product of the task has no real-world impact. The most authentic form of learning is termed coevolution, where students are actively involved in real-world interactions to create a product with real-world impact.

Previous reports of courses based on the principles of authentic learning illustrate the various points on the continuum of authentic learning. An example of a simulation is Mekong e-Sim (Baron and Holger, 2004), where students take on the roles of various stakeholders debating the merits of development projects in Southeast Asia. Combining face-to-face and online interaction over six weeks, the simulation encouraged critical thinking and debating skills. Creating a video presentation is an example of a participation authentic learning project (Nikitina, 2011). Some of the videos involved students in collecting information and interacting in real-world environments, but the final videos were only shown within the classroom. For coevolution, an example is a project where statistics students collaborated with an agency promoting independence skills for the blind to improve service provision (Thompson, 2009). In a meta-analysis of 50 previous studies claiming to investigate authentic learning, Nachtigall et al. (2022) identified only three that could be considered coevolution authentic learning, with the majority of studies manifesting fewer than half of the possible characteristics of authentic learning. The lack of studies into coevolution authentic learning is a cause for concern, since learning may 'emerge from the interaction of multiple design elements' (Nachtigall et al., 2022: 1482).

However, we are not arguing that courses at the more authentic end of the continuum are necessarily better; rather, the appropriacy of the various approaches depends on the goals of the course. Where the objective is for students to develop a single predefined soft skill (such as critical thinking), a simulation may provide a productive environment for learning. However, where the main objective is for students to develop a range of intangible soft skills relevant to future workplaces, we believe that coevolution authentic learning has the most potential.

Research purposes

In this article, we describe a coevolution authentic learning course at a Thai university which exhibits nearly all of the characteristics of authentic learning and results in tangible student-designed and implemented real-world products with clear impacts on environmental sustainability. Using the students' reflections through the course, we look for evidence of the learning and development of soft skills, especially during the third stage of the authentic learning course.

The context

This case study took place in Thailand. Based on Hofstede's (2011) six dimensions of culture, Thailand is notable for exhibiting high power differences, both in society in general (Buriyameathagul, 2013) and in education (Watson Todd and Darasawang, 2021). One goal of the authentic learning course, therefore,

was to empower undergraduate students to take the lead in promoting environmental sustainability at the university. One feature of Thai higher education is the dominance of outcome-based education where theoretically 'the result or outcome is clearly identified and the achievement of it is guaranteed' (Tanprasert, 2018: 120). In using an authentic learning approach, we are challenging this paradigm, since soft skills are intangible and their learning is difficult to predict (Gilyazova et al., 2021).

The authentic learning course was implemented in King Mongkut's University of Technology Thonburi (KMUTT), a well-respected technological university, which has had policies promoting a green university since 2005 and has a unit called the Office for Sustainability, which provides guidance and support where necessary. The university has several undergraduate and postgraduate degrees related to environmental sustainability, and students studying on a relevant master's degree (Environmental Social Science) were asked to join the project to act as mentors for the undergraduate students. In addition, the Buildings and Grounds Division of the university responsible for institutional infrastructure is progressive and supportive of student initiatives.

The course focused on in this case study is an existing general education course called Humans and the Environment, which was adapted to manifest the principles of authentic learning. It is an elective course for third- and fourth-year students of science and engineering, and it runs for 15 weeks with three contact hours per week. In total, 42 students (named Student 1 to Student 42 to identify the source of quotations) joined the course in two sections and, given the loose Covid-19 pandemic regulations at the time, the course used blended learning, with students only coming on to campus when it was essential. The course outline is given in Table 1, which shows the content of each of the 15 weeks of the semester, the stages of authentic learning, the characteristics of authentic learning that became salient through the course and the times at which students were asked to write reflective journals.

The task which forms the core of the authentic learning course was for students, in groups of three, to come up with an innovative project promoting environmental sustainability that they would actually implement at the university. The criteria set to guide the students were:

- The project should have a high likelihood of having a positive impact on the environment or other sustainability issues at the university.
- The project should address the Green University metrics or be clearly linked to one of the United Nations' Sustainable Development Goals (SDGs).
- The project should cost between 5,000 and 200,000 baht (\$150 to \$5,900).
- The project should be able to be implemented within five weeks.
- The project should not require specialised workers to be implemented.

The end goal was intentionally open-ended (*ill-defined task and flexible outcomes*) to encourage students to be creative, to provide motivation by giving a sense of ownership of the project and to allow students to follow their own interests. Given the real-world nature of the tasks, substantial support for practical issues, such as budgeting and gaining reimbursement, was provided.

The first stage of the task was to present their proposals for projects to an audience which included a staff member from the Buildings and Grounds Division and an environmental science expert who could give feedback on the feasibility of the projects. At this stage, some students needed to change their projects as their first proposals were not feasible.

The next stage was for students to prepare brief summaries and videos presenting their projects. Since the total budget available for implementing projects was 600,000 baht (\$17,600) and the total budget for all proposed projects was 1,139,332 baht (\$33,500), not all projects could be implemented. To select the projects to be implemented, participatory budgeting was used (Bartocci et al., 2022). A website (<https://sola.pr.kmutt.ac.th/gump>; note that this website is in Thai. A similar website in English is <https://sola.pr.kmutt.ac.th/meg/>) was created which allowed all KMUTT staff and students to vote on the projects they wished to see implemented (see Watson Todd, 2023, for details). The projects proposed and those selected are shown in Table 2, with their budgets. Students on teams whose projects were not selected were assigned to join successful teams in implementing their projects.

Table 1. Course outline for authentic learning

Week	Teaching focus	Stage of authentic learning	Salient characteristics of authentic learning	Reflective journal
1	Introduction: Overview of the course; introducing issues of climate change, environment and sustainability; introducing SDGs and Green University metrics	Setting up scenario	Real-world relevance	Journal 1
2	Students present previous environmental and sustainable innovations implemented at universities around the world			Journal 2
3	Presentation on the university's current environmental and sustainable projects and needs; criteria for student projects		Complex, sustained task Ill-defined task Flexible outcomes	
4	Students (in groups of three) present proposals	Task setting		
5	Guidance on budgeting, including how to estimate budgets and how to claim reimbursement		Authentic context Authentic activities Teacher as facilitator	
6	Students write and submit their proposals in three formats: 1. Brief two-paragraph overview covering the origins of the proposed project and the problem it solves 2. Extended proposal including justification and budget 3. One-minute video presenting their proposed project	Completing the task	Scaffolding Collaboration Multiple roles Interdisciplinary	
7	Creation of online tool; voting for participatory budgeting			
8	Announcement of winning proposals; assigning non-winning students to groups			
9	Specific guidance on how to plan and implement their project			Journal 3
10	Project implementation			
11	Project implementation			
12	Project implementation			
13	Project implementation			
14	Project implementation			Journal 4
15	Project reporting	Task product	Tangible product	

The successful teams were given five weeks to implement their projects, including planning the construction of the innovation, purchasing materials and gaining permissions where necessary. To help students implement their projects, the teachers provided support and scaffolding, and each team was assigned a master's degree student as a mentor, as well as a member of the Buildings and Grounds Division. Nevertheless, the students were highly autonomous and took full responsibility for their decisions and actions. All accepted projects were successfully implemented, and the final products can be seen at <https://kmuttsola.wixsite.com/gump/gump-project>.

Table 2. Projects proposed by students and selected by KMUTT members

Project title	
Projects selected to be implemented	Budget
Clean water (drinking water dispensers)	75,500 baht
Smart sprinkler for improving water usage	5,900 baht
Solar-powered motion-sensor lights	52,500 baht
Vertical garden bench for absorbing pollutants	25,722 baht
Pool bin for removing refuse from ponds	16,827 baht
Green pocket garden	133,070 baht
Projects proposed but not selected	
Braille block pavement for the visually impaired	190,975 baht ¹
Covered way (to provide shelter for pedestrians)	180,000 baht
Green bike (more bike shelters for bicycle sharing)	44,203 baht
Standing exercise bikes for circulating water in ponds	159,095 baht
E-bus booking application	94,340 baht
On-campus wind-power generator	161,200 baht

Note: ¹ The Braille pavement was initially selected from the participatory budgeting votes, but it was later rejected as impractical by the university.

Methodology

To evaluate the impact on the students' soft skills of the authentic learning course focusing on environmental innovations, the four journals of the 42 students were used as the data source. This research project has been reviewed and approved by KMUTT's Institutional Review Board (KMUTT-IRB-2022-1214-026) to ensure compliance with standards of human research ethics.

Student journals

As seen in Table 1, students were asked to write four reflective journals through the course. The journals served three purposes:

1. To provide information for teachers about the students' progress and challenges to enable scaffolded interventions where appropriate.
2. To provide a source of continuous assessment as part of the student evaluation.
3. To provide insights into students' learning and reactions to the course.

To allow the three purposes to be met, the journals took the form of a series of guiding questions, each of which had different purposes. For this study, the questions serving the third purpose provide the data. The relevant questions in the four journals are:

- Journal 1: How do you feel about the course project? What expectations do you have about benefits, uses and problems with the project?
- Journal 2: What do you feel about the progress of the course project?
- Journal 3: What work have you done for completing the course project? How have you made progress towards achieving your goals? What obstacles have you encountered that have prevented the work from progressing as intended? How have you dealt with these obstacles?
- Journal 4: How do you feel about your progress and your project? What are you proud of or excited about with your work? Please explain how you worked and what you learnt from the project.

The journals were written in Thai and submitted electronically. The amount of data as word counts is given in Table 3.

Table 3. Word counts for the journals

Journal	Word count
Journal 1	2,571 words
Journal 2	3,720 words
Journal 3	6,008 words
Journal 4	12,926 words
All journals combined	25,225 words

Data preparation

Students' reflections on the courses and their learning experiences were analysed using corpus analysis techniques (Scott and Tribble, 2006), primarily word frequency counts and keyword analysis (Culpeper and Demmen, 2015). The corpus processing tool used for the analysis was AntConc (Anthony, 2019). AntConc deals with texts which have clear word boundaries, such as the spaces between words in Latin-based languages such as English, French and Spanish. Since Thai does not have clear boundaries between words, some extra text preparation stages were required before the data could be analysed:

1. Thai tokenisation 3.1 (Aroonmanakun, 2012), a web-based tokeniser, was used to identify boundaries between word items. The output shows word items separated by a vertical bar, for example, ดีใจและตื่นเต้นเพราะจะได้มาเจอเพื่อนใหม่ๆ.
2. All vertical bars were replaced by a single space in Microsoft Word and the segmented text was saved in a plain text format (.txt), which is a compatible format for AntConc.

Data analysis

Treating the students' reflections as a corpus, there were two main stages in the data analysis process: (1) identifying frequent words and keywords and (2) identifying salient extracts from the students' reflections that provide insights into key issues.

Word frequency and keyword analysis techniques (Culpeper and Demmen, 2015) were conducted to explore students' reflections collected at different stages of their learning process. These techniques identify frequent words and keywords (words found significantly more often in the reflections than in a comparison corpus). Five lists of keywords were generated. The first four lists treated each of the journal corpora separately and compared one set of journals with the other three sets (so the Journal 1 corpus was compared to a comparative corpus consisting of the combined journals 2, 3 and 4). These four lists highlight how students' perceptions of the project differed at each stage. The fifth list was generated by comparing the combined four journal corpora against a large corpus representing general Thai language use, the Thai National Corpus (TNC) (<https://www.arts.chula.ac.th/ling/tnc3/>; Aroonmanakun et al., 2009). These keywords highlight students' overall perceptions of the project.

Differences in the relative frequencies of words in the target corpus compared to the comparative corpus were measured using log likelihood (LL), with words with high positive LL values (that is, words used with a much greater than expected frequency in the target reflections) being identified as keywords. These keywords are indicative of the main themes in the reflections.

Concordance lines that show the contexts in which the keywords appear in the reflections (Adolphs, 2006; Tribble, 2010) were examined to see what keywords were used or mentioned in the reflection corpus, and how they were used. Examining the concordances allows us to identify the students' perspectives on the themes and provides the basis for selecting the quotations presented in the findings. The original Thai quotations have been translated into English for presentation purposes.

To gain insights into the overall experience of the students, we examined two keywords from the combined journal corpus in more depth. To understand how the students felt about the whole project and what they learnt, we conducted a collocation analysis for *feel* and *learn*. Using *t*-score to highlight common patterns of associations (Martínez, 2008; Oakes, 2020), we identified words following *feel* and *learn* at a frequency higher than expected.

Results

To examine the effects of the authentic learning curriculum on the students, we will start by presenting the data from the journals chronologically through the course. This allows us to see how the expected characteristics of authentic learning were manifested in practice.

Journal 1: setting up the environmental sustainability project

Journal 1 was written after the first lesson, which had three main objectives. First, the concepts of environmental sustainability and the SDGs were presented to students. Second, the course project was introduced. Third, students were encouraged to start thinking about their projects by identifying areas or aspects of the university that could be improved.

The top 25 keywords in Journal 1 highlight two key issues. First, the students, as might be expected, were focused on issues of a *sustainable* (LL = 22.84) *environment* (LL = 21.89). Second, several verbs where the students are the subjects were highlighted: *explore* or *survey* (LL = 154.42), *walk* (LL = 116.45), *look* (LL = 38.77), *notice* (LL = 30.49), *understand* (LL = 20.97) and *see* (LL = 20.79). These verbs relate to the third objective of the lesson, where students identified what needs to be improved in the university, as can be seen in the following quotation from Journal 1:

We *surveyed* the university which normally we would just pass by without thinking. But this time, I learned more about things around me, that there were both advantages and disadvantages, in order to think about it for my project ... *Exploring* makes us see the real problems and can be used to plan further. And, of course, it's better than having the teacher take a picture and show the students on Zoom. *Seeing* it with my own eyes made it possible to generate more ideas. *Looking* for problems in the university and thinking of ways to develop and improve was very helpful. (Student 15)

Even in the first lesson, one characteristic of authentic learning, namely, real-world relevance, becomes apparent. Introducing the project could have seemed theoretical and distanced from the students, but by encouraging the students to explore the university to identify problems, the project becomes a concrete experience with potential impacts on the real world. Rather than education being an intangible classroom exercise, education becomes a way of making the real world a better place.

Journal 2: proposing a project

The second journal covered seven weeks during which the students generated ideas for their projects, wrote proposals, calculated budgets and prepared a video presenting their projects. The proposals were voted on by university members in a process of participatory budgeting, and the projects which would be funded and implemented were announced. In the lesson before the journal was written, students who had proposed non-winning projects were reassigned to work with teams whose projects would be implemented.

The keywords for Journal 2 highlight the voting process for selecting projects: *vote* (LL = 72.82), *choose* (LL = 34.80), *announce* (LL = 28.29) and *select* (LL = 22.98); and the teamwork needed to develop proposals: *group/team* (LL = 87.31), *members* (LL = 27.00) and *friends* (LL = 26.62). Students whose projects were selected often stated that they were *surprised* (LL = 19.15) that this had happened.

In preparing their proposals, students learnt that simply having a good idea was not enough. They also needed to make sure that others could understand their ideas and that they could persuade others that the project was worth voting for. This concern for how potential audiences perceived their work can be seen in the following extract:

The main thing I learnt is about preparing projects so that others can understand, presenting solutions that align with others' perspectives, and developing feasible project ideas that everyone wants to work on. If others do not understand a project or perceive it as difficult, it may not receive votes. (Student 33)

During this second phase of the course, some soft skills essential for a successful project became apparent. These include the need to plan the process of work, the need for clear communication within teams, and the need to control and make use of one's own emotions:

Once you receive the votes, there must be clearer work processes, planning, assigning roles within the *team* – everything becomes the foundation for future work. From various suggestions and the assistance of the postgraduate mentors, making the new *members* feel welcome and keeping positive relationships between new and old *members* within the *group* is crucial. To achieve these goals, the mentors suggested that we should communicate, not leave anyone behind, or let someone work alone. These are all beneficial for the future. Collaborating with others is very important in our work. (Student 33)

It's important to maintain mindfulness to control intense emotions and let negative emotions, such as anger, subside. Since emotions, when used in moderation and controlled with mindfulness or ethical principles, can help deal with various situations or problems, they can lead to better outcomes. (Student 35)

One potential point of concern during this stage was how students whose projects were not selected would react. From the journals, students accepted the results and were still motivated to work on the new projects to which they had been reassigned, even though the projects were not their own:

Today I had the opportunity to talk to *friends* who were not in the same *group* from the beginning. I used more listening skills and asked more about the new project that I wasn't familiar with. It felt good because the new *friends'* project was an interesting project and I wanted to do it. (Student 38)

Even though this second stage was still largely classroom-oriented and perhaps akin to a simulation model of authentic learning, the context created a need for students to develop their soft skills. These include soft skills which we had not expected to become apparent in this project, such as emotion control, highlighting the contingent nature of soft skills.

Journal 3: implementing the project

The third journal covered the five weeks of implementing the project in the real world. This stage is an example of the coevolution form of authentic learning where students have a clear real-world impact.

Keywords at this stage fall into three categories. First, some keywords relate to the work processes of implementing the project: *location* (LL = 31.99), *app* (LL = 25.84), *contact* (LL = 25.19), *progress* (LL = 20.09) and *prototype* (LL = 14.35). Second, there are keywords relating to soft skills, particularly teamwork and time management: *time* (LL = 37.45), *fast* (LL = 32.73), *talk* (LL = 23.33), *cooperation* (LL = 11.65) and *manage* (LL = 11.56). Third, the highest ranked keyword for Journal 3 was *mentor* (LL = 63.74), a key component in the support system helping the students to implement their project.

The process of implementing the projects included many diverse authentic activities requiring students to take on multiple roles to complete their projects, as the following extract shows:

Contacting the Building and Grounds department to schedule a viewing of the installation site and confirm the *location*. Calculating the budget adjustments for equipment and *contacting* the furniture factory and contracting services. Also, *contacting* a plant store for decorative plants. Due to the different responsibilities assigned to various officials in each area of the university, it is necessary to *contact* multiple individuals and departments in overlapping areas. This may cause delays in the workflow. It is advisable to *contact* the furniture factory, contracting services and the plant store as soon as possible to plan and calculate the budget without the need to make revisions or adjustments later on. (Student 37)

As this extract shows, teamwork and effective collaboration were essential to the success of the project. Working in a team, especially with unfamiliar teammates, provided opportunities for learning and personal development:

I feel delighted to have met friends from different departments. I have high hopes of adopting efficient work methods from my teammates since each of them possesses unique talents and individual differences. It would be beneficial for me to adapt their working approaches and apply them in my daily life for maximum benefit. (Student 16)

Given the complexities and novelty of implementing an environmental sustainability project in the real world, support and scaffolding was provided to ensure success. Two key players providing support to project groups are the postgraduate students who acted as mentors to each group and the Buildings and Grounds department:

The group *mentor* is really excellent. He helps with tasks, reviews proposals, and helps resolve issues related to *contacting* [the budgeting staff]. He also frequently reminds us about our tasks to keep the group active. The building department staff provide great guidance, and we have discussed various topics to determine the direction we should take. Currently, we are considering how we should proceed with the work. (Student 20)

Despite the complexities of the project and severe time constraints, the support systems and effective teamwork enabled all groups to install their innovations within the timeframe and so successfully implement their projects.

Journal 4: completing the project

The final journal was written at the end of the course, when students had completed installing a tangible product to promote environmental sustainability at the university. In summarising the project, many students described the process of work (as in Journal 3) by using keywords such as *install* (LL = 33.17), *assemble* (LL = 25.67) and *repair* (LL = 18.73). The most salient keyword, however, was *proud* (LL = 42.83):

It makes me feel *proud* that something I conceived and designed has become a real piece of work, *installed* and seen by people who come to play sports and sit and rest. It truly fills me with a great sense of *pride*. (Student 4)

What I'm *proud* of in my work is the ability to program and control the sprinkler system myself. It is a challenge because there are multiple conditions that need to be met in order to satisfy the criteria. For example, connecting to the university's two-tier login system via Wi-Fi, as well as implementing code and setting appropriate humidity values to calculate the average of the maximum and minimum values measured. This has allowed me to develop my programming skills and is a source of great *pride* for me. (Student 7)

Students were proud of both the tangible product that was being used in authentic contexts, and of the development of the interdisciplinary skills they needed to complete the project. Their sense of pride was clearly linked to the real-world impacts that their projects had, the key feature of authentic learning that they had not experienced before in their education:

The positive thing I have learned is that learning from real-life experiences and getting hands-on is more challenging than just coming up with ideas and presenting them casually. This applies not only to the aspect of planning, which requires more detail and thoroughness, but also to the use of coordination skills. (Student 7)

The authentic nature of the project also encouraged students to use and develop their workplace skills and soft skills. As students who had been in full-time education throughout their lives, working in an authentic context proved eye-opening in terms of the expectations of workplaces:

[The budgeting staff] provided details on budgeting, fund disbursement and reimbursement, and also gave me a manual to read and study for further understanding. I learned that in order to request fund disbursement, especially for purchasing various equipment, I need to have complete and proper tax invoices. This new-found knowledge has taught me that in both public and private organisations, detailed and clear financial documentation is essential. (Student 16)

Frequently mentioned soft skills include communication skills ('We should have negotiation skills and good communication abilities to ensure smooth operations and minimise issues that may arise during work', Student 4), time management skills ('The lesson learned from this project is time management due to the occurrence of external factors related to time', Student 21) and leadership skills ('The team leader plays an important role in managing the distribution of work to ensure fairness and evaluate performance based on individual capabilities appropriately', Student 35). The most notable soft skill developed through the project was teamwork, about which students showed a highly nuanced and deep understanding:

Working as a team, if there is a task that we have not done before, we can delegate it to someone who is more experienced. Additionally, working in a sequential manner allows for faster workflow. We simply focus on doing our part of the work excellently, and then pass it on to our teammates to continue. This speeds up the overall process. ... Furthermore, working as a team allows for diverse perspectives. Having multiple individuals contribute to the thought process leads to a variety of ideas that can be applied more effectively. Everyone has a role in the decision-making process to seek the best possible outcome. (Student 35)

Overall feelings and learning

Using an authentic learning project with real-world impacts provided motivation, instilled a sense of pride and promoted the development of workplace skills and soft skills. The complex sustained task promoted the learning of numerous skills, while the tangible real-world product generated positive feelings. From the combined corpus of all four journals, two notable words are *feel* (LL = 237.59) and *learn* (LL = 182.20). For these two verbs, we conducted a collocation analysis to identify the most salient complements of the verbs using *t*-scores. The most salient collocates of *feel* are *good* ($t = 4.81$), *happy* ($t = 2.80$), *worried* ($t = 2.76$), *proud* ($t = 2.59$) and *excited* ($t = 1.67$). Students' feelings about the authentic learning project were largely positive, with the negative feeling of *worry* most commonly appearing early in the course. The most salient collocates of *learn* show that students developed their abilities in *working* ($t = 3.27$), *planning* ($t = 1.93$), *communication* ($t = 1.40$), *analysis* ($t = 0.99$) and *noticing* ($t = 0.98$), highlighting the workplace and soft skills essential for project completion.

Discussion

The findings show that running a course based on the principles of authentic learning where students design and implement projects to promote environmental sustainability has several notable impacts. First, six projects were implemented to improve the environment at KMUTT. The long-term environmental impacts of these projects are currently being investigated. Second, in being able to initiate and implement their own projects, the students clearly had feelings of involvement, pride, ownership and accomplishment. The real-world nature of the tasks stood in clear contrast to the students' previous educational experiences of 'just coming up with ideas and presenting them casually'. Third, both encouraging low-status students to initiate innovations and the participatory budgeting procedures challenge the power inequalities inherent in Thai society. Fourth, the students clearly exhibited the use and learning of soft skills.

The soft skills used through the course were diverse. At a broad level, the most commonly cited soft skills concerned organisation (especially planning and time management), communication (interactive with their peers and with units in the university, as well as unidirectional in persuading an unknown audience of the value of their projects) and teamwork (including leadership and responsibility). While these broad skills might be expected to be required, other soft skills mentioned could not have been predicted, including relationship building ('keeping positive relationships between new

and old members within the group is crucial') and emotion control ('maintain mindfulness to control intense emotions').

It could be argued that, in some cases, the students were simply using their pre-existing soft skills, although in itself this is likely to be beneficial, especially when combined with reflection (Ferreira Lemos and Brunstein, 2023). There is some evidence, however, of active learning of soft skills ('I have high hopes of adopting efficient work methods from my teammates'). The meaningful real-world context in which the students are invested in success provides the experiences necessary for promoting the use and learning of intangible contingent soft skills.

In addition to some of the soft skills, another unexpected outcome was raised awareness of workplace practices. This emerged most clearly with the procedures required for procurement, budgeting and reimbursement, but it was also apparent in the need for gaining permissions to implement the projects. As the students were nearing graduation, such preparation for the workplace is likely to be beneficial for their futures.

As we have seen, the real-world nature of authentic learning stood in clear contrast to the students' previous educational experiences. The impacts of authentic learning were apparent even in the first lesson, where students were introduced to the course and saw their surroundings in a new light. The impacts on the students appeared to multiply through the course as new characteristics of authentic learning came into play and students took more control over their work. While the students were largely in control in the later stages of the course, the support systems to aid the students in implementing their innovations proved essential, especially given the multiple new roles that the students were taking on in the project implementation stage. A facilitative and supportive institutional environment is needed, and we were fortunate in receiving substantial support from the Buildings and Grounds department and from the budgeting staff. Even in such a supportive environment, the guidance and facilitation of the mentors enabled successful project implementation. The mentors were postgraduate students with experience in workplaces, which greatly helped the students to negotiate the maze of administrative requirements to implement their projects. Acting as mentors also proved beneficial to the postgraduate students. From informal conversations, the mentors' own environmental awareness was raised, and they gained communication and helping skills. In setting a task as challenging as implementing a real-world environmental sustainability innovation in a few weeks, setting up support systems is crucial for success. Other factors were also key to the successful implementation of the authentic learning course. Most notable are the need for a substantial budget to fund the projects and the computing abilities to set up a participatory budgeting tool.

As we have seen, there are very few previous studies of coevolution authentic learning, so we believe that the case study reported here may be valuable in terms of both presenting a possible model of authentic learning course design, and describing an approach for facilitating the employment and acquisition of intangible soft skills. A further weakness with the existing literature is that previous studies do not 'disclose how their participants perceive the implemented authenticity' (Nachtigall et al., 2022: 1507). Such perceptions are a key focus of the current study, which aims to partly redress this omission.

Of the 14 characteristics of authentic learning, the one that proved most difficult to implement is authentic assessment. There are valuable suggestions in the literature for methods of assessing authentic learning. For example, Greenstein (2012) offers guidance on assessing collaboration, leadership and workplace skills, and Tumilty et al. (2022) provide three instruments for assessing teamwork, but these proved problematic for two key reasons. First, using an assessment instrument to measure a specific focus assumes that there are predetermined objectives to be met, yet in the authentic learning course, the contingent nature of soft skills meant that much of the learning could not be predicted. Second, institutional constraints on evaluation meant that full-blown authentic assessment could not be implemented. Ideally, the students' work on the course would be evaluated by all stakeholders (including the Buildings and Grounds department workers, the mentors, the users of the finished products, and the students themselves), but doing this would conflict with both Thai culture and institutional regulations. Further work on assessing authentic learning, especially within the constraints of a conservative institutional culture, is sorely needed.

From a research perspective, this study is limited by its reliance on students' self-reports of learning. There are potential issues of validity and trustworthiness with self-reports (Kerr, 2018), especially as the students' reflections formed one component for evaluation in the course. However, given the indeterminacy of learning because of the unpredictable contingent nature of soft skills, more focused

and reliable methods of collecting data concerning student learning would not provide the broad, open-ended scope of reflective self-reports.

Conclusions

This case study has shown how using a coevolution authentic learning approach can have wide-ranging impacts, and we believe that the course we present can provide a model for other contexts. For the students, taking the authentic learning course led to development of soft skills, raised awareness of environmental sustainability issues and workplace practices, and a sense of pride in making a difference. The soft skills developed included both expected outcomes, such as planning and teamwork, and unexpected outcomes, such as relationship building and emotion control, preparing students for the uncertain future. The impacts of the course went well beyond the classroom, with the university benefiting from the installation of innovations promoting the environment and the university community becoming involved through participatory budgeting. Although such an approach is challenging and requires funding, the wide-ranging benefits mean that authentic learning provides a model for sustainable education in a changing world.

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Declarations and conflicts of interest

Research ethics statement

The authors declare that research ethics approval for this article was provided by the Institutional Review Board of King Mongkut's University of Technology Thonburi (IRB-2022-1214-026).

Consent for publication statement

The authors declare that research participants' informed consent to publication of findings – including photos, videos and any personal or identifiable information – was secured prior to publication.

Conflicts of interest statement

The authors declare no conflicts of interest with this work. All efforts to sufficiently anonymise the authors during peer review of this article have been made. The authors declare no further conflicts with this article.

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