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Rethinking transformations in sustainability education: project-based approach to sustainability for primary school student teachers

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Abstract

Purpose – Teacher education is identified as a catalyst in promoting the sustainability transition. Project-based learning (PjBL) approaches are efficient in promoting the sustainability competency of the students. On the one hand, supporting and assessing PjBL as an instructor is not simple or free from contradictions, as assessment tools are lacking. On the other hand, understanding the quality and social nature of the PjBL process is incomplete. This research aims at filling these research gaps.

Design/methodology/approach – The data consist of video recordings and group reports collected during the teaching periods of Sustainability and Outdoor Education–emphasised primary school student teachers ($n = 40$) in 2023–2025. In a reflexive thematic analysis, the learning transformations model is applied in theory and practice. This study introduces the idea that learning sustainability in primary school teacher education during PjBL includes three stages of learning transformations: unfreezing, changing and refreezing beliefs.

Findings – Based on this research, students' socially shared beliefs regarding the teaching profession significantly impact sustainability learning and the acceptance or rejection of the learning demand. Boosting sustainability competency via learning transformations among primary school student teachers requires a forum for discussion for students to reflect not only on their sustainability-related perceptions but also their teacher beliefs.

Practical implications – An assessment tool for teacher educators is proposed for assessing primary school student teachers' sustainability-related learning transformations during PjBL.

Originality/value – In addition to identifying aspects related to acceptance or rejection of the learning demand, this study introduces a concept of practicality ethos to describe the manner students discuss teaching. Engaging in practicality ethos significantly affects the PjBL process.

Keywords Higher education pedagogy, Primary school student teachers, Sustainability competency, Project-based learning, Pre-service teachers

Paper type Research paper

1. Introduction

Global concerns regarding nature loss and climate change indicate the need for a green transition (Cortese, 1999). Also, the survival of humankind depends on maintaining the well-being of our planet's environmental systems (Scott and Vare, 2018). Furthermore, our actions as a society are threatening the possibilities of our children fulfilling their basic needs

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in the future (Cortese, 1999). Consequently, universities globally are committed to the United Nations sustainability development goals through various agreements, like the Bologna Charter. Therefore, they are striving to develop curriculums with shared learning objectives to support the green transition through education and work life (Brundiers *et al.*, 2021; Lozano *et al.*, 2019; Weiss *et al.*, 2021). Most often, these learning objectives are defined through sustainability competency frameworks. Various conceptualisations regarding core sustainability competencies have been elaborated (Bianchi *et al.*, 2022; Brundiers *et al.*, 2021; Wiek *et al.*, 2011), but the five key competencies framework (Wiek *et al.*, 2011, 2016) remains prevalent as the most cited and frequently used conceptualisation. This framework has been widely applied as a basis for educational programmes, including learning objective development (Redman and Wiek, 2021; Wiek *et al.*, 2011, 2016).

As a pedagogical solution, project-based learning (PjBL) is found to be supportive of a broad range of sustainability competencies (Lozano *et al.*, 2019). PjBL is a student-centred learning method characterised by students' autonomy and active role as explorers in a project. Students learn to define their own learning demands and goals, collaborate successfully with others and practice communication and (self) reflection in problems that are based on real-world practices (Chiang and Lee, 2016; Kokotsaki *et al.*, 2016). In addition, in PjBL learners involve themselves actively in the learning process to achieve their own learning goals. Through interactions with group members and instructors, students share knowledge and understanding (Von Kotze and Cooper, 2000). In completing real-world-based assignments, groups can negotiate alternative ideas to solve problems and gain new, collective knowledge (Pan *et al.*, 2019). It is also important that the project topic engages students and creates the motivation to learn (Aldabbus, 2018).

However, there are some identified challenges in PjBL. For example, a lack of validated assessment methods that enable students to show their learning through PjBL (Chen *et al.*, 2021; Hellström *et al.*, 2009) is challenging the instructors. In addition, there are many student-related challenges, such as incompatible schedules between the students, unmatched priorities, uncertainty about the project product or learning during it (Hussein, 2021) and student adaptation to PjBL (Alarfaj *et al.*, 2024). The instructors are addressing the challenges by, for example, structuring student learning, including roles and responsibilities (Hussein, 2021), giving sufficient feedback and providing clear and structured project instructions (Alarfaj *et al.*, 2024). Nevertheless, many problems remain unsolved, such as the complications in the PjBL assessment (Watz, 2020). Exploring the possibilities of PjBL assessment is one of the aims of this study.

Concurrently, the idea and applications of transformative learning (Mezirow, 1978) are trending in higher education. Transformative learning can be defined as a transformation enabling changes in the learner's meaning-making systems or "frames of reference" (Mezirow, 2009). Many expectations and hopes are directed at transformative learning (Thomas, 2009), since the green transition requires cultural and systemic changes in our society. There are several contradictions and complexities when applying transformative learning models in university programmes. For example, applying transformative learning-based approaches to enhance sustainability competency could promote deeper, more meaningful changes in learners (Thomas, 2009), but transformative learning and sustainability are often linked to each other on very light grounds—even in current research literature (Rodríguez Aboytes *et al.*, 2020). This could lead to an instrumental approach to sustainability. In addition, transformative learning is also not free from assessment challenges (Romano, 2017).

As a university programme, primary school teacher education is also experiencing sustainability reforms. Teacher education has an identified potential to enhance the green

transition of society through cultural change (Corcoran and Wals, 2004; Mulà and Tilbury, 2023), since teachers can significantly impact future generations and their sustainability competencies. Unfortunately, higher education teachers and teacher educators still lack instructions and guidance for sustainability competency-promoting pedagogies (Watz, 2020). Therefore, this study is exploring PjBL as one of the effective sustainability education pedagogies in line with current pedagogical research. The study produces information to support higher education teachers in applying sustainability competency-promoting pedagogies in their work.

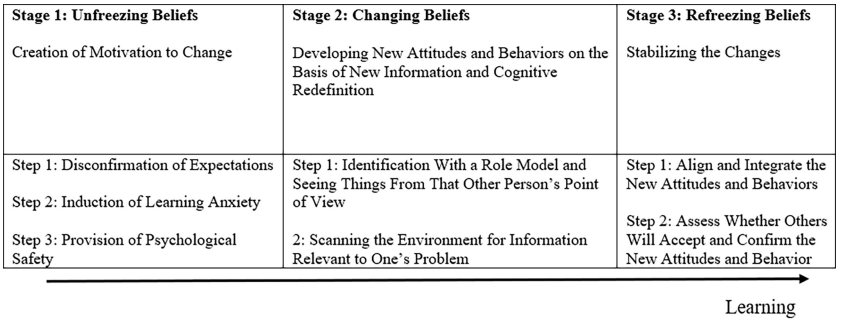
1.1 Theoretical foundations of research

A wide range of research has been conducted regarding the effects of PjBL on the learning outcomes of higher education students (Ayaz and Söylemez, 2015; Balemen and Keskin, 2018; Widarbowo *et al.*, 2023). A meta-analysis on PjBL demonstrated that PjBL can promote creativity and improve students' critical thinking and problem-solving skills (Muzer *et al.*, 2023). Moreover, PjBL can exert a positive effect on students' independence in learning (Parwata *et al.*, 2023) and satisfaction in studies (Sulong *et al.*, 2023). Finally, there are suggestions that PjBL increases students' collaboration skills (Mulyadi *et al.*, 2023).

As is evident in the literature, PjBL and sustainability are already applied and studied in the context of education. For example, studies have researched attitude changes towards the environment through PjBL in prospective teachers (Genc, 2014) as well as developing the sustainability competency of pre-service chemistry teachers (Paristiowati *et al.*, 2022), and the sustainability competency of primary school student teachers (Karvonen *et al.*, 2023) and pre-service secondary school teachers (Cebrián *et al.*, 2019) has been reviewed. In summary, previous studies have focused on the learning results of individual students during and after PjBL. However, very little is known about the quality and social dimensions of the PjBL process or primary school student teachers' perceptions of PjBL. The perceptions and beliefs of primary school student teachers need to be considered when supporting their preparedness for work as sustainability education professionals. In addition, the social nature (Gillies and Ashman, 2003) and expressed quality of PjBL require research methods that examine more than an individual student's learning outcomes. The purpose of this research is to fill this knowledge gap.

This study was conducted to understand the social nature and quality of learning transformations (LT) in PjBL rather than the learning impacts of PjBL. The LT model originally proposed by Kurt Lewin (1951) and later developed and researched by Pan *et al.* (2019) was applied. The assumptions behind the application of the LT model are that PjBL processes include learning as a social process, containing situations with competing forces that may encourage students to either accept or reject ideas, and evoke resistance or withdrawal in learners (Pan *et al.*, 2019). Also, it is known that the LT process is intense and requires both expertise from the instructor and structural support (Pan *et al.*, 2019). The LT model enables the researcher to analyse the conflicting forces in student groups during PjBL. It also allows the researcher to describe changes in student groups' learning processes during PjBL for sustainability competency (Pan *et al.*, 2019).

The LT model by Pan *et al.* (2019) presented in Figure 1 consists of three stages: unfreezing, changing and refreezing beliefs. Firstly, during the stage of unfreezing beliefs, the project assignment creates a motivation to change learners' previous beliefs with the support of the instructor, whose role is essential in the PjBL process. Also, the motivation to change previous beliefs is induced through the phases of disconfirmation of expectations, creating learning anxiety and psychological safety. Secondly, in the changing stage, students start to change their beliefs concurrently with learning new knowledge, skills and attitudes as



Source: Lewin, (1951) and Pan *et al*., (2019)

Figure 1. The learning transformation process

they set goals to their actions. Notably, this process starts only if learning demand is accepted through the phases of identifying with a role model and scanning the environment for relevant information. Finally, during the refreezing stage, students stabilise the changes made in their beliefs through integrating them into actions and attitudes. Finally, students assess the social acceptability of their newly developed beliefs.

2. Research methodology

2.1 Aims

Primary school student teachers are defined as teacher students who are studying to become class teachers. After graduating, they teach pupils aged 7–12. In the previous literature, primary school student teachers' sustainability competencies have been studied (Karvonen *et al*., 2023), and PjBL approaches are known to promote sustainability competency (Lozano *et al*., 2019). In addition, many studies have focused on science education (Ayaz and Söylemez, 2015; Balemen and Keskin, 2018) without a clear emphasis on sustainability and primary teacher education. Also, no clear instructions remain on how to assess PjBL in higher education (Chen *et al*., 2021); and concurrently, very little is known about the actual quality of sustainability competency LT during PjBL (Pan *et al*., 2019). Various meta-analyses have been conducted to summarise the effects that PjBL methods have on learning outcomes (Ayaz and Söylemez, 2015; Balemen and Keskin, 2018; Widarbowo *et al*., 2023), but the social nature of learning in groups (Gillies and Ashman, 2003) has been ignored. In this research, these knowledge gaps are addressed with the following research questions:

RQ1. How do primary school student teachers describe the learning transformations that occur when learning sustainability through PjBL?

RQ2. How can the PjBL process be assessed in this context?

2.2 Data

The data for the research were gathered in 2023–2025 in a course entitled Introduction to the Pedagogy of Sustainability and Outdoor Education. The course is a mandatory part of classroom teacher education, namely the Sustainability and Outdoor Education programme (SOE) in the University of Lapland. In total, 40 primary school student teachers participated

in the study. This covers about 20% of the population of second-year teacher students from all the class teacher programmes in the University of Lapland, in this particular univeristy. In addition, participants formed a total of nine PjBL groups. To assess the saturation of the data, the code meaning approach (Hennink *et al.*, 2017, 2019) was applied. To define code meaning saturation criteria, the researcher's full understanding of the codes (Hennink and Kaiser, 2022) to achieve saturation is required. After the third-year data collection, sufficient code saturation was achieved, as the codes were consistent and repetitive each year (Hennink and Kaiser, 2022). For this reason, additional data collection was unnecessary.

The convenience sample was drawn from the population in this research since it provides satisfactory sample in this specific research context while saving the researcher's resources (Golzar *et al.*, 2022). Moreover, other forms of sampling methods would be very challenging to apply in this study mainly because of the study design. Conducting this specific study design requires the researcher to teach the participants throughout a whole course with specific pedagogies described in the introduction and research methodology sections. Regarding time resources, work contracts and varying study programmes and courses in different universities, other sampling techniques would be impossible to conduct. Therefore, the usage of the convenience sample was justified in this research.

The research data consist of 15.5 h of video recordings during the projects, combined with group reports written after the projects. The data were made anonymous with number codes to protect the participants' privacy. Participants signed informed consent forms before taking part in the study. Participants were able to drop out of the study at any time. The data are appropriately stored in accordance with the ethical guidance for research and data collection [Finnish National Board on Research integrity, 2024].

The idea of the course was that primary school student teachers apply PjBL to learn sustainability competency with peer teaching. Students were instructed to plan learning modules as groups to teach each other sustainability competency. The course included 24 h of lectures combined with groupwork. Also, a 4-h-long seminar was held for students to introduce the learning modules to peers. The course was arranged in a similar structural manner three times over three consecutive years. It was designed to support students' LT in accordance with the unfreezing–change–refreezing model depicted in Figure 1.

2.3 Methods

The LT model was applied in this study in structuring the planning, instruction and execution of the course participants attended as well as in analysing the collected data by using the model as a theoretical lens. The data were analysed using reflexive thematic analysis (Braun and Clarke, 2022; Naeem *et al.*, 2023; Riger and Sigurvinsdottir, 2016). The method was chosen to identify and interpret frequent themes and patterns from the data by also embracing the subjectivity of interpretations (Naeem *et al.*, 2023). At its best, thematic analysis (TA) can lead the researcher towards new ideas and understanding regarding the research subject (Naeem *et al.*, 2023). Reflexive thematic analysis is a form of TA highlighting, in particular, the researchers' subjective interpretations during the analysis (Braun and Clarke, 2022). The researcher aimed at ruling out the distorting effect of previous beliefs and theoretical assumptions with continuous self-reflection (Naeem *et al.*, 2023). The viewpoint of reflexive TA was especially adopted, since the knowledge production concerned is situated and context-bound (Braun and Clarke, 2022; Von Kotze and Cooper, 2000). The themes and categories were formed by precisely basing them on the context. In addition, the themes and categories were constructed to describe participants' shared meanings or ideas reflecting their perceptions (Braun and Clarke, 2022). When applying reflexive TA by Braun and Clarke (2022), the researcher can choose whether they want to use qualitative research

analysis software or not since both options are valid (Ahmed *et al.*, 2025). In this research the analysis was conducted manually to ensure researcher's full engagement and familiarisation with the data (Ahmed *et al.*, 2025; Braun and Clarke, 2022).

The approach to the data and analysis perspectives in this study can be described through the following: *orientation towards the data*, *focus of meaning*, *qualitative framework* and *theoretical framework* (Braun and Clarke, 2022). Firstly, the *orientation towards the data* can be defined as deductive, since already-existing theoretical constructs and concepts guided the analysis (Braun and Clarke, 2022; Naeem *et al.*, 2023; Pan *et al.*, 2019). Secondly, the *focus of meaning* can be described as latent, due to the analysis focusing on implicit meanings and meaning structures from the data instead of on the semantic, explicit level (Braun and Clarke, 2022; Byrne, 2022). Thirdly, the *qualitative framework* of the analysis was experimental, as the focus of the analysis was to capture and describe participants' subjective experiences and perceptions (Braun and Clarke, 2022). Finally, the *theoretical framework* was relativistic and constructionist (Riger and Sigurvinsdottir, 2016) to capture the realities and perceptions expressed in the data (Braun and Clarke, 2022).

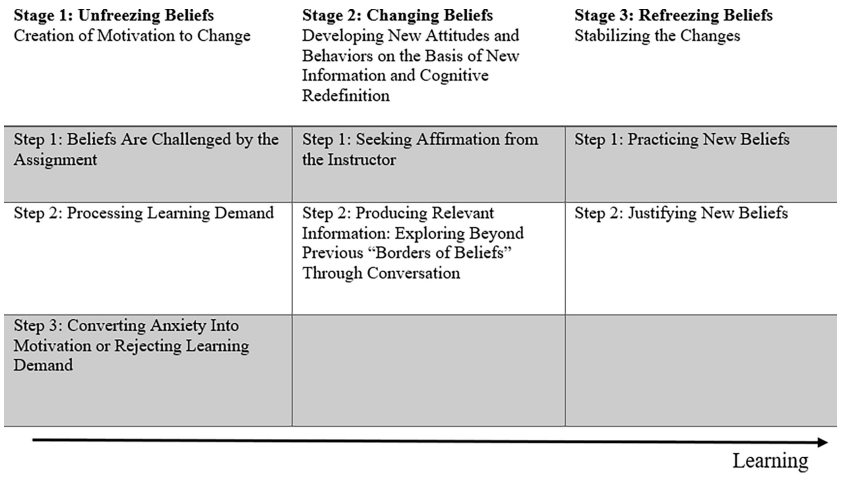
The analysis progressed through the phases of:

- familiarisation;
- coding;
- generating initial themes;
- developing and reviewing themes; and
- refining, defining and naming themes (Braun and Clarke, 2022).

The data sets from three separate years were first analysed differently, directly after the data collection. The first data set was analysed in 2023 and the last in 2025. In the *familiarisation* phase, the data were listened to and read through multiple times to gain analytic sensibility of the implicit meanings in the data. After the first step, the *coding* process progressed from very specific, narrow concepts such as *avoiding the task*, *challenging task*, *trying to "get off easy"* towards more substantial themes such as *negotiating demand for learning* or *rejecting learning demand*, combining the narrow ones together. Parts of the data as well as the whole data set were coded multiple times to ensure the functionality of the codes. Next, *generating initial themes* to combine codes to form themes such as *learning demand* was conducted using visual mapping. This was followed by *developing and reviewing themes* with the supervisor to ensure inter-coder reliability (Braun and Clarke, 2022). Finally, after all three years of data collection and analysis, the themes were *refined, defined and named* to present the findings clearly and accurately. Finally, the data sets from different years were compared to each other and combined into one data set to ensure code and theme function after the data collection ended in March 2025 (Braun and Clarke, 2022). The long analysis process gave the researcher a chance to deeply understand and reflect the data multiple times during the years 2023–2025 to gain deep insights on the phenomenon.

3. Results and discussion

The result of the analysis is comparable to the model of Pan *et al.* (2019). After an extensive analysis, the following categorisation is proposed in Figure 2 to describe the LT process primary school student teachers experienced and expressed when learning sustainability competency with PjBL.



Source: Author's own elaboration based on Lewin (1951) and Pan *et al*., (2019)

Figure 2. Primary school student teachers' learning transformations during Pjbl when learning sustainability

3.1 Stage 1: Unfreezing beliefs

The first stage of the LT process depicted by Lewin (1951) and Pan *et al.* (2019) is unfreezing beliefs. This stage is defined by creating a motivation to change students' previous beliefs. The PjBL began with lectures familiarising students with sustainability themes as well as giving instructions for the project. Shortly after, all nine groups discussed the assignment. Interestingly, all groups expressed confusion about the assignment, clearly in relation to the target group being peers:

> Student 9: This is a difficult exercise.
>
> Student 18: We need to produce material for peers to teach pupils.
>
> Student 6: Is our target group third-graders?

Interestingly, all nine groups understood the assignment incorrectly and started preparing the teaching module with special reference to the children:

> Student 6: Well, I guess you could start from that because we're classroom teachers; from an educational point of view, how can you prepare pupils for, I don't know, for the future?.
>
> Student 10: The knowledge, skills and attitudes that children need and we make them aware of—.

Two groups also tried to base their projects on the national core curriculum for children:

> Student 3: Now wait a second, we need the national core curriculum – well, we probably need some national curriculum for this, too!

These quotations indicate confusion created by the assignment representing Step 1 at the "Unfreezing Beliefs" stage. Even though the instructor guided students clearly to teach peers instead of pupils, all nine groups expressed enormous confusion regarding the assignment.

The students seemed to be reluctant to abandon the idea of primary school student teachers teaching pupils and refused to see any other options.

This disconfirmation of expectations with regard to the target group may be explained by discussing previous research. Pre-service teachers' perceptions about the teaching profession have been studied frequently throughout the world (Balyer, 2017; Çakmak and Bulut, 2005; Fajet *et al.*, 2005; Khalid *et al.*, 2017; Lim and Chan, 2007; Minor *et al.*, 2010; Richardson, 2002; Wall, 2016; Wan *et al.*, 2011; Witcher *et al.*, 2001). It is noteworthy that while previous research has examined the preconceptions of pre-service teachers, not all studies have explicitly clarified whether the term refers exclusively to primary school student teachers or includes pre-service teachers from other educational levels. Unfortunately, there are no established practices on how to unambiguously define the concept of *pre-service teachers* between various countries and the concept can include all student teachers at varying school levels in international literature. Therefore, comparisons of the results with previous literature about pre-service teachers' beliefs should be made with caution.

Still, studies have revealed that students' own school experiences, referred to as "apprenticeship of observation" (Lortie, 1975), significantly affect the beliefs and practices pre-service teachers construct during their education (Fajet *et al.*, 2005; Lim and Chan, 2007; Richardson, 2002; Wall, 2016). This apprenticeship leaves students with persistent beliefs about what it is to be a teacher (Fajet *et al.*, 2005). Also, it is highly probable that these experiences are not in line with modern pedagogies and schools' practices, even though they are accepted as "school and teacher prototypes" (Fajet *et al.*, 2005). According to Pajares (1992), teacher candidates' own school experiences significantly influence their knowledge acquisition in training in addition to how they understand and interpret assignments. In conclusion, students may not have witnessed anything but teachers teaching pupils in previous life experiences, which gave no room to alternative ideas.

After the initial disconfirmation of expectations, all nine groups expressed and negotiated the evoked learning demand:

> Student 3: So it's challenging for us too, because we don't know anything about this subject.
>
> Student 32: We have to think about from what theme we have the most to give. Yes, or do we have anything to give at all?

As a result, the statements revealed the existence of conflicting forces: rejecting or accepting the learning demand and represented Step 2: processing learning demand. The groups had two kinds of reactions. Two of the groups accepted the learning demand by embracing the need to develop their sustainability competency and, also, additional pedagogical knowledge to master peer teaching:

> Student 19: We need to consider the fact whether (peers and we have) enough initial knowledge to go that far.

Alternatively, seven of the groups rejected the learning demand. The common theme in their learning demand rejecting-conversations was to control the workload of their studies:

> Student 37: This is exactly what's needed, like acquiring content information – but, after all, there are interesting topics, but you can also think a little about how to get this done easily.

Interestingly, in step 3, certain aspects in the video record data and in the group reports indicated that two groups accepted the learning demand during the project whilst, on the contrary, the lack of the same aspects were clearly associated with rejecting the learning demand by seven of the groups. These aspects are presented in Table 1.

Table 1. Aspects related to accepting or rejecting the learning demand

Aspect	Accepted learning demand (2)	Rejected learning demand (7)
Conversations	Innovative (2)	Schematic (7)
Resistance	Momentary (2)	Prevalent (7)
Motivation	Intrinsic (2)	Extrinsic (7)
Practicality ethos	Discussed and challenged (1)	Prevalent (8)
Group dynamics	Good: supportive and humorous (5)	Challenging (4)
Group report	Displays acceptance (2)	Displays rejection (7)

Source(s): Author's own elaboration based on the data, Lewin (1951) and Pan *et al.* (2019)

Table 1 presents the aspects related to accepting or rejecting the learning demand. Numbers in the parentheses represent the number of groups displaying each aspect. As a result, aspects that indicated the acceptance of learning demand during the group work process were innovative conversations during groupwork; momentary resistance to the assignment that turned into accepting the learning demand; excitement and intrinsic motivation for the assignment; negotiating *the practicality ethos* critically; and good, supportive and humorous group dynamics. The role of the group reports will be discussed later in the Results and Discussion section.

Firstly, innovative conversations in the groupwork typically reflected good group dynamics bolstered by humour and sharing experiences, along with trust in one another:

> Student 41: – Funny, and that's why he says just about anything that pops into his head, like some random things, then someone always comes up with them and develops them!.

During these conversations, groups clearly negotiated their beliefs regarding both sustainability competencies and teaching. Among the two learning demand-accepting groups, the conversations clearly made them explore options and solutions beyond previous beliefs:

> Student 28: But I'm not sure now, but we discussed this here; we're doing that – the problem is that our task is too vague. That is, we need to specify, because otherwise, will these come out a little like, were these questions too big to be given for that task?.
>
> Student 5: We can keep the old ones, but we can also come up with two new ones.

Secondly, the resistance expressed regarding the learning demand was only momentary, and learning anxiety was successfully converted into motivation. Two of the groups expressed only momentary resistance:

> Student 41: First, we need to familiarise ourselves with it (the sustainability topic) in more detail.

The two groups also expressed intrinsic motivation and excitement about the project. Intrinsic motivation can be defined as one's motivation to fulfil their psychological needs without the presence of an external reward (Ryan and Deci, 2002):

> Student 15: Somehow you can get a certain amount of enthusiasm from it. Well, actually, I'm waiting for this (project work) right now – I'm really interested!.

Interestingly, intrinsic motivation and enthusiasm in PjBL have been studied previously. In these studies, PjBL projects tended to make students fascinated and excited about learning (see Parwata *et al.*, 2023; Sulong *et al.*, 2023).

A practicality ethos was identified and brought into the negotiation in only one of the learning demand-accepting groups. Based on this study, *a practicality ethos* is defined as a

socially shared scheme or manner primary school student teachers use to speak about pupils or teaching. It consists of an emphasis on child-centredness (Wilson and Cameron, 1996) and on practical, child-level thinking. This finding resonates with former research about the importance of child-centredness in pre-service teachers' perceptions (Witcher *et al.*, 2001). The data were showing that eight groups constantly reminded themselves and others that the projects should stay at a child's level and be as practical, relatable and everyday life-related as possible, regardless of the target group. Only one learning demand-accepting group recognised this manner and actively started changing it:

> Student 11: We don't need to consider them (pupils) in this assignment, because this has more to do with us working with kids rather than with (the kids themselves).

In addition, good group dynamics and humour were observed in total five groups. Fascinatingly, the good group dynamics in two groups encouraged students to continue their learning process and accept the learning demand while also evoking motivation and excitement:

> Student 31: I am here but not really present (all laughing).
>
> Student 1: I'm looking forward to our project's product.
>
> Student 13: I'm encouraged now.

Nevertheless, humour and good group dynamics were unable to encourage three learning demand-rejecting groups to accept the learning demand based on other criteria used. Interestingly, this research suggested that good group dynamics alone are insufficient to promote acceptance of the learning demand if other aspects are lacking.

On the other hand, the rejected learning demand was expressed in seven groups through schematic groupwork with no innovative conversation, frustration with the assignment and prevalent resistance to changing beliefs, no excitement for the assignment and expressed extrinsic motivation, not negotiating the practicality ethos and challenging group dynamics. The schematic conversation flow held by seven groups was revealed through conversations such as:

> Student 19: What's this? I don't know how to title that.
>
> Student 38: As long as you put some structure into it (presentation).

Through these conversations, students aimed at completing the project as quickly and easily as possible, which can be seen as a sign of an extrinsic motivation driven by completing the course (Ryan and Deci, 2002). Also, resistance to the assignment and rejecting the learning demand were clearly expressed by these seven groups:

> Student 16: Well, if we're being honest. It's too complicated for me.

Extrinsic motivation by the seven groups was displayed in conversations that did not include any reflections about challenging or negotiating previous beliefs. Students even tended to reject any attempts other group members made regarding innovative conversation, just to complete the project:

> Student 23: We have half an hour. First. Well, please suggest something.
>
> Student 6: So, four minutes. And would it also take four minutes or so to go through? Where if there were[…]let's go with the easiest; that is, the five plus five that would take five minutes and I would think of them and use five minutes.

The seven learning demand–rejecting groups and also, one of the learning demand-accepting groups had conversations that were declarative in nature, including socially accepted and shared beliefs about what good teaching is (Çakmak and Bulut, 2005; Fajet *et al.*, 2005; Minor *et al.*, 2010; Wan *et al.*, 2011; Witcher *et al.*, 2001) and what it is not. These eight groups engaged in discussion marked by the importance of practicality, time management and the practical structure of the presentation. The *practicality ethos* was revealed especially through statements highlighting child-centredness during the projects:

> Student 23: I know it's for peers, but let's just think this through the kids first – what would we teach to them about this?
>
> Student 17: We have these sustainability competencies that include knowledge, skills and attitudes: now we need to get the kids to recognise the idea.
>
> Student 8: This could be just as good for children. It's somehow quite essential or something like that. And that's probably the easiest way to understand.

In particular, the seven learning demand–rejecting groups engaged in a child-level *practicality ethos*. It was evident that the *practicality ethos* hindered the learning of sustainability competency by challenging the acceptance of the learning demand. As a result, it seemed that teaching sustainability competency to peers did not fit well in prevalent beliefs of what it is to be and act as a teacher. Still, one of the learning demand accepting groups also engaged in the prevalent *practicality ethos*. Interestingly, their project as a whole displayed learning demand acceptance. Possibly, other aspects in their PjBL process supported the acceptance of the learning demand enough to reach the goal of PjBL. This suggests that engaging in the *practicality ethos* alone does not totally prevent accepting the learning demand.

Finally, four of the groups experienced groupwork challenges during the project. Three of these groups ended up rejecting the learning demand, whereas one group managed to accept the learning demand, regardless of the challenging group dynamics. With respect to the rejection of the learning demand, bad group dynamics or the lack of resources were evident in the recordings and manifested through the lack of humour, tiredness (e.g. yawning) and a mechanical and linear style to progress with the groupwork without negotiating beliefs:

> Student 5: OK, it's Friday afternoon, so this won't go anywhere.
>
> Student 42: THIS kind of conversation doesn't really start today.

Notably, it has been reported that group dynamics can be a central challenge in PjBL. For example, Aldabbus (2018) stated that if some students "take over" the project without letting others participate, it weakens the willingness of "outsiders" to work in the project. Also, the uncertainty with the project assignment challenges collaboration during PjBL (Hussein, 2021). It is necessary to consider whether students' abilities to tolerate uncertainty affected acceptance of the learning demand.

3.2 Stage 2: Changing beliefs

The second stage of the LT model is "Changing Beliefs". This includes Step 1: seeking affirmation from the instructor, which can be seen as a form of identifying with a role model (Pan *et al.*, 2019), and Step 2: producing relevant information by exploring beyond previous "borders of beliefs" through conversation. The two learning demand-accepting groups went through these steps successfully. Conversely, the seven learning demand rejecting groups did not fully engage in seeking affirmation or having explorative conversations.

The two learning demand-accepting groups displayed their affirmation seeking through statements such as:

> Student 14: Fortunately, we asked (the instructor) about this topic, because now it turns completely upside down and completely the other way round than this, so yes.

Previous research has shown that the intrinsic motivation of the instructor in the project theme predicts students' intrinsic motivation in it (Lam *et al.*, 2009), so the role of the instructor is essential in awakening student motivation. The difference between the learning demand-accepting and rejecting groups was that rejecting groups did not ask for guidance at all or did not appreciate the feedback given, whereas accepting groups actively sought guidance and affirmation.

Scanning the environment for information was displayed as negotiating with other groups and searching for sources, such as books or articles, to learn more about the subject and produce relevant information. The learning demand rejection delimited the information scanning in seven groups:

> Student 37: If I understood correctly, the learning demand is probably quite low now, because we're all university students here.

> Student 9: I am not using (sustainability education) theory, because a simple thing is enough.

> Student 39: We don't know as much as others do, so let's participate with them (peers) and have a lot of discussions.

Instead, the two learning demand-accepting groups started seeking relevant information:

> Student 8: Then we can discuss next that – as you probably noticed – we know quite little (about the subject).

> Student 38: There is a lot of, you know, scientific literature we can use in the planning.

The rejected learning demand clearly hindered students' PjBL progress and prevented them from exploring beyond the borders of their beliefs. The learning demand rejection may be explored and understood through pre-service teachers' perceptions about the teacher's profession (see, e.g. Çakmak and Bulut, 2005; Fajet *et al.*, 2005; Minor *et al.*, 2010; Richardson, 2002; Wall, 2016; Witcher *et al.*, 2001). When the perceptions are combined with the nature of sustainability competency–enhancing pedagogies, such as PjBL, the combination might cause a disconfirmation of expectations (Pan *et al.*, 2019). As Moore (2005) concluded, the traditional learning process is considered subject-oriented and related to knowledge that can be "transferred" to students through lecturing. However, teaching and learning the problem-solving skills needed for the current sustainability crisis is nothing like the previously pictured idea. Moreover, pedagogies supporting a broad range of sustainability competencies found in previous studies often lean on problem-based approaches (Lozano *et al.*, 2019). These pedagogies are defined by student-centredness and students' autonomy regarding their learning goals and results (Chiang and Lee, 2016; Kokotsaki *et al.*, 2016). Also, the learning process is far from linear with controlled outcomes (Evans and Ferreira, 2019). In addition, sustainability crises are often called "wicked problems", due to their complex, uncontrollable and systemic character (Waddock, 2013), which makes them hard to grasp and understand properly. As a result, it could be wondered if the foundation that primary school student teachers have built through their own school experiences is even relevant when considering modern teachers' expertise.

Researchers have identified qualities that pre-service teachers often report as "effective" or "good" teacher qualities. These are having good content knowledge about the subject;

having friendly and good relationships with pupils; the personal characteristics of the teacher; pedagogical skills; and classroom management skills (Witcher *et al.*, 2001). Also, student-centredness and ethicality are often mentioned (Minor *et al.*, 2010; Witcher *et al.*, 2001). Related to the effectiveness of teaching, pre-service teachers also highlight a nurturing and caring attitude towards pupils instead of teachers' own academic competence (Mahlios and Maxson, 1995). Moreover, these preconceptions are often resistant to change (Wall, 2016; Wan *et al.*, 2011). As a result, this study suggests that sustainability competency–enhancing pedagogical methods collide with students' previous beliefs. For example, pursuits to control and manage the classroom and learning outcomes become challenging, since the sustainability crisis is anything but familiar, pupil-centred, or easy to grasp (Waddock, 2013). In addition, when up-to-date sustainability knowledge develops constantly, it is hard to keep up with content knowledge about the wicked problems as a teacher:

> Student 2: So, should they (peers) also be given the opportunity to make some of their own (preferred themes), or would it be bad, because then we can't learn about it (the theme) in advance ourselves?

In the data, four groups expressed concerns about staying up to date with sustainability information as well as their aims to stay in control during the learning experience.

3.3 Stage 3: Refreezing beliefs

During the final seminar, group projects were implemented into practice. All nine groups practiced their new or prevalent beliefs through executing the projects, as described in Stage 3, Step 1. Also, all nine groups received feedback from the instructors and other groups. They also made self-assessments to support their learning transformations. Moore (2005) stated that it is essential that teacher educators practise "ideals of sustainability" in classrooms, to give students real experience in learning sustainability. Also, as noted earlier, modern sustainability pedagogies driven by PjBL and transformative learning approaches probably shatter the teacher beliefs acquired through the "apprenticeship of observation" (Lortie, 1975). It is unreasonable to believe that students would acquire pedagogical skills that they have had no chance to practise in their educational programme. Therefore, offering alternative experiences for students is essential.

Regardless of whether the learning demand was accepted or not, all nine groups finished their projects with the product of a teaching module. To protect the privacy of the participants, the discussion about project outcomes regarding ranking and contents is excluded, as it is non-essential in meeting the aims of the current research. Nevertheless, a brief description of the finished products would support the interpretations about the differences between learning demand-accepting and rejecting groups.

The final decision about whether the groups seemed to accept or reject the learning demand was based on the combined information from the video recordings and group reports. The five group work process aspects from Table 3 described earlier in Results and Discussion acted as a guiding tool to complement the data received from group reports. Ultimately, the group reports displayed the rejected or accepted learning demand based on the criteria below:

- *The language used in the reports.* The accepted learning demand displayed as a language that includes mentions about students, peers or adults. On the other hand, the rejected learning demand was displayed in language including mentions of pupils or children, evidently expressing misunderstanding of the assignment.

- *The justification of choices* (Stage 3, Step 2 in Table 2). All groups justified their choices to assess the social acceptability of their beliefs. The learning demand-accepting groups (2) assessed their changed beliefs through consistent references to the scientific, educational and pedagogical literature suitable for adult learners. They produced learning modules including pedagogically justified learning activities supporting their peers' understanding about the chosen sustainability subject through, for example, action-based teaching. Their group reports highlighted theoretical orientation and the choice of pedagogical solutions suitable within this specific context of adult education.

On the contrary, the rejected learning demand (7) was displayed through the lack of any justification for pedagogical choices compensated as opinions or preferences. These groups could not convincingly justify the choices made during the project or profoundly base their thinking on pedagogical reasons or models on their group reports. In conclusion, these seven groups ended on repeating their prevalent beliefs.

When the social acceptability of beliefs was discussed in all nine group reports, it was mostly related to feelings of success, identified learning demands and pedagogical, future-oriented thinking:

> Group 1: We as teachers were required to know various pedagogical models in order to get the lesson created as interesting, motivating, and increasing as well as strengthening students' skills. We also had to study different kinds of theories concerning sustainability and nature education in order to complete the task.

> Group 6: We think that we managed as a group to create a functional entity around the topic that interests us. We got an idea of the theme we chose, what issues are related to it, and how it could be handled with pupils in the future as well.

- *The project description in the report.* The learning demand-accepting groups (2) clearly articulated that the purpose of their project was to educate peers about sustainability competencies with pedagogies suitable for adults. However, the learning demand-rejecting groups (7) did not express their aims clearly, or they reported a completely different purpose. For example, some groups were not actually trying to teach their peers sustainability knowledge during the learning module, at least on a deeper level. Instead, they offered peers material packages ready to use in the class with pupils. In this case, the learning module consisted mostly of educating peers in how to use their materials for children, rather than deepening the critical thinking or content knowledge of their peers.

Interestingly, there was one particular belief about teaching and learning sustainability that all of the nine groups agreed on at the end of the course: the important and various roles of conversation during the project work:

> Group 12: Openness was brought to our teaching session by the functional tasks and the discussion, which we used to involve other students.

> Group 8: As the only way to follow the flow of thoughts of peers during the assignments, I had to go round the class and try to listen to what kind of goals they were talking about.

> Group 7: At the end of a lesson, the teacher can produce a test or analyse the discussion and various course tasks by comparing the students' knowledge to the baseline test.

In conclusion, it is vital to research the role of conversation in refreezing newly acquired beliefs after the change process. Compellingly, the role of conversation in learning and meaning-making is studied among health care workers (Jordan *et al.*, 2009), which suggests that learning and sense-making are enhanced through conversation. In addition, research about academics developing as teachers through conversation (Thomson and Trigwell, 2016) has found that conversations with colleagues support academics developing as teachers in multiple ways (Thomson and Trigwell, 2016). Both informal and formal conversations with peers are important in learning how to teach (Thomson and Trigwell, 2016).

4. Conclusion

In this study, primary school student teachers expressed their learning experiences during PjBL in a manner compatible with the LT model. The study revealed aspects about the PjBL process that affect both the learning experience of the students and the resulting product. It would be interesting to apply the LT model in pre-service teacher education generally and research its applicability in transdisciplinary fields. Moreover, this research has explored the social nature of LT bringing a new, important understanding of students' socially shared learning transformation processes to complete the individual, transformative learning emphasis (Mezirow, 1978, 2009). This information is crucial in supporting the sustainability reform in education by understanding the role of the social norms students share. Even so, the possibility of considering revision of these norms requires further discussion. Fascinatingly, the *practicality ethos* of primary school student teachers appeared to hinder the learning of sustainability. The ethos links reasoning to a practical level, leaving no room for collective growth beyond the borders of vocational competency. Higher education aims to promote primary school student teachers' sustainability competency. As a result, it should be considered whether primary school student teachers' initial beliefs about teaching should be challenged during their educational programme.

Also, the role of the instructor cannot be highlighted enough to encourage students to challenge their beliefs by creating psychological safety through structure and interaction. In brief, the instructor has a crucial role in motivating and exciting students in PjBL (Aldabbus, 2018). Therefore, if the aim is to change primary school student teachers' beliefs about the teaching profession, the instructor should encourage students to embrace the learning demand rather than reject it. Also, teacher educators need to be informed on how to instruct during projects. Finally, the role of conversation in transforming beliefs should be noted. In conclusion, this research encourages universities to offer instructed discussion arenas for primary school student teachers, since challenging their old beliefs and refreezing new ones through dialogue are required.

4.1 An assessment tool for PjBL on sustainability

The assessment of the PjBL process is challenging, and shared instructions are lacking (Chen *et al.*, 2021). The findings of this research provide some suggestions on how to assess the sustainability competency learning process during PjBL. Interestingly, the acceptance or rejection of the learning demand affects the PjBL process and the final products of the project. Therefore, it can be suggested that Table 1 could be applied as an assessing tool for LT during PjBL because the aspects of Table 1 indicate if beliefs are challenged or remain preserved. As a result, the following conceptualisation is proposed as an assessment protocol for PjBL in pre-service teacher education:

- What kind of conversations do groups have during the project? Are they innovative or schematic in nature?
- How is resistance tolerated and processed? Can it be turned into an accepted learning demand?

- What type of motivation do groups display?
- Can groups discuss and overcome the *practicality ethos*?
- What is the quality of group dynamics?
- Does the group report display learning demand acceptance or rejection?

The proposed assessment tool could offer higher education teachers the much-needed support and instructions asked for (Watz, 2020). Still, it is important to remember why assessment tools and instructions for PjBL are lacking. From the viewpoint of an instructor, PjBL includes the challenge of assessing students' individual learning outcomes after the projects (Hellström *et al.*, 2009). Since the PjBL is based on the self-determined learning objectives (Von Kotze and Cooper, 2000), it is challenging to ensure student learning. It also needs to be ensured that students' efforts can be compared and evaluated. Therefore, it should be considered if it is at all reasonable to assess students' individual learning outcomes over PjBL or whether the assessment should be drastically modified. Even so, letting go of the individual student assessment would require a huge reform in higher education structures. Moreover, if the assessment reform was to take place, it would be required to inform the students about the change.

4.2 Limitations

While being a justified sampling choice, a convenience sample is also prone to errors such as sample biases and, can limit the generalisability of the results (see e.g. Golzar *et al.*, 2022). The fact that participants were taking part in the SOE programme was likely affecting the results of this study. It may be assumed that participants were already fascinated by sustainability themes. Still, the course was an initial introduction to further studies in the SOE programme, suggesting that the students had a knowledge base comparable to peers outside the programme. In addition, it is important to note that the prototypical PjBL progression presented in the results is a theoretical simplification of the LT process interpreted by the researcher based on the data analysis. The simplification highlights some aspects that affected the students' learning experience without being absolutely conclusive. Also, the division between learning demand-accepting and rejecting groups is based only on researcher's observations and the data analysis.

This research includes various forms of data and, video recordings combined with the group reports written by the participants provide a robust outlook to answer the research questions. Still, in the future studies, it would be important to give participants a chance to explain their own experiences using their own words. Therefore, to ensure the communicative validity (see e.g. Onwuegbuzie and Burke Johnson, 2006) of the results with studies to come, additional data should be collected from the participants with, for example, structured interviews. Also, it is essential to research whether primary school student teachers' beliefs differ significantly from those of other pre-service teachers to scale the results in the fields of teacher education.

Interestingly, it is possible that in this study, a different study design might have provided different results. For example, if applying participant interviews instead of the video recordings, the concept of "practicality ethos" might have left undiscovered since constructing the concept was a result of years-long researcher's observations and reflections. As a result, introducing this new concept can enable researchers and students to describe their experiences in the future studies in a way that has not been possible before due to the lack of concept.

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References

Ahmed, K., Mohammed, R., Nashwan, A., Ibrahim, R., Abdalla, A., Ameen, B. and Khdhir, R. (2025), "Using thematic analysis in qualitative research", *Journal of Medicine, Surgery, and Public Health*, Vol. 6, pp. 1-6, doi: 10.1016/j.glmedi.2025.100198.

Alarfaj, M., Mohamed, S.R., Chtourou, S., Enshasy, H., Aboulnaga, A. and Hassan, M. (2024), "Experience of project-based learning: challenges, assessment, and analysis", *International Journal of Engineering Pedagogy (iJEP)*, Vol. 14 No. 3, pp. 123-139, doi: 10.3991/ijep.v14i3.43849.

Aldabbus, S. (2018), "Project based learning: implementations and challenges", *International Journal of Education, Learning and Development*, Vol. 6, pp. 71-79, available at: https://eajournals.org/ijeld/vol-6-issue-3-march-2018/project-based-learning-implementation-challenges/

Ayaz, M. and Söylemez, M. (2015), "The effect of the project-based learning approach on the academic achievements of the students in science classes in Turkey: a meta-analysis study", *Education and Science*, Vol. 40 No. 178, pp. 255-283, doi: 10.15390/EB.2015.4000.

Balemen, N. and Keskin, M. (2018), "The effectiveness of project-based learning on science education: a meta-analysis search", *International Online Journal of Education and Teaching*, Vol. 5, pp. 849-865, available at: https://files.eric.ed.gov/fulltext/EJ1250564.pdf

Balyer, A. (2017), "Pe-service teachers' perceptions of their competency for the teaching profession", *Cumhuriyet International Journal of Education*, Vol. 6 No. 2, pp. 230-248, available at: https://dergipark.org.tr/en/download/article-file/348159

Bianchi, G., Pisiotis, U. and Cabrera Giraldez, M. (2022), "GreenComp —the European sustainability competence framework", in Punie, Y. and Bacigalupo, M. (Eds), *Eur 30955 En*, Publications Office of the European Union, Luxembourg, available at: https://publications.jrc.ec.europa.eu/repository/handle/JRC128040

Braun, V. and Clarke, V. (2022), *Thematic Analysis: A Practical Guide*, Sage, London.

Brundiers, K., Barth, M., Cebrián, G., Cohen, M., Diaz, L., Doucette-Remington, S. and Zint, M. (2021), "Key competencies in sustainability in higher education—toward an agreed-upon reference framework", *Sustainability Science*, Vol. 16 No. 1, pp. 13-29, doi: 10.1007/s11625-020-00838-2.

Byrne, D. (2022), "A worked example of Braun and Clarke's approach to reflexive thematic analysis", *Quality and Quantity*, Vol. 56 No. 3, pp. 1391-1412, doi: 10.1007/s11135-021-01182-y.

Çakmak, M. and Bulut, M. (2005), "The perceptions of pre-service teachers about effective teaching and effective teachers", *Mediterranean Journal of Educational Studies*, Vol. 10, pp. 73-89, available at: www.academia.edu/87779057/The_perceptions_of_pre_service_teachers_about_effective_teaching_and_effective_teachers?uc-sb-sw=25735567

Cebrián, G., Pascual, D. and Moraleda, Á. (2019), "Perception of sustainability competencies amongst Spanish pre-service secondary school teachers", *International Journal of Sustainability in Higher Education*, Vol. 20 No. 7, pp. 1171-1190, doi: 10.1108/IJSHE-10-2018-0168.

Chen, J., Kolmos, A. and Du, X. (2021), "Forms of implementation and challenges of PBL in engineering education: a review of literature", *European Journal of Engineering Education*, Vol. 46 No. 1, pp. 90-115, doi: 10.1080/03043797.2020.1718615.

Chiang, C.L. and Lee, H. (2016), "The effect of project-based learning on learning motivation and problem-solving ability of vocational high school students", *International Journal of Information and Education Technology*, Vol. 6, pp. 709-712, doi: 10.7763/IJIET.2016.V6.779.

Corcoran, P.B. and Wals, A. (2004), "Higher education and the challenge of sustainability. Problematics, promise, and practice: an introduction", in Corcoran, P.B. and Wals, A. (Eds), *Higher Education and the Challenge of Sustainability*, Springer, Dordrecht, Netherlands, pp. 3-6, doi: 10.1007/0-306-48515-X.

Cortese, A. (1999), *Education for Sustainability: The Need for a New Human Perspective*, Second Nature, Boston, MA.

Evans, S. and Ferreira, J. (2019), "What does the research evidence base tell us about the use and impact of sustainability pedagogies in initial teacher education?", *Environmental Education Research*, Vol. 26 No. 1, pp. 1-16, doi: 10.1080/13504622.2019.1703908.

Fajet, W., Bello, M., Ahwee Leftwich, S., Mesler, J. and Shaver, A. (2005), "Pre-service teachers' perceptions in beginning education classes", *Teaching and Teacher Education*, Vol. 21 No. 6, pp. 717-727, doi: 10.1016/j.tate.2005.05.002.

Finnish National Board on Research Integrity TENK (2024).

Genc, M. (2014), "The project-based learning approach in environmental education", *International Research in Geographical and Environmental Education*, Vol. 24 No. 2, pp. 105-117, doi: 10.1080/10382046.2014.993169.

Gillies, R.M. and Ashman, A.F. (Eds) (2003), *Co-Operative Learning: The Social and Intellectual Outcomes of Learning in Groups*, Routledge.

Golzar, J., Noor, S. and Tajik, O. (2022), "Convenience sampling", *International Journal of Education and Language Studies*, Vol. 1 No. 2, pp. 72-77, doi: 10.22034/ijels.2022.162981.

Hellström, D., Nilsson, F. and Olsson, A. (2009), "Group assessment challenges in project-based learning – perceptions from students in higher engineering courses", *Paper Presented at 2:A Utvecklingskonferensen För Sveriges Ingenjörsutbildningar*, Lund, Sweden, available at: https://portal.research.lu.se/en/publications/group-assessment-challenges-in-project-based-learning-perceptions

Hennink, M., Kaiser, B. and Marconi, V. (2017), "Code saturation versus meaning saturation: how many interviews are enough?", *Qualitative Health Research*, Vol. 27 No. 4, pp. 591-608, doi: 10.1177/1049732316665344.

Hennink, M., Kaiser, B. and Weber, M. (2019), "What influences saturation? Estimating sample sizes in focus group research", *Qualitative Health Research*, Vol. 29 No. 10, pp. 1483-1496, doi: 10.1177/1049732318821692.

Hennink, M. and Kaiser, B, " (2022), "Sample sizes for saturation in qualitative research: a systematic review of empirical tests", *Social Science and Medicine*, Vol. 292, pp. 1-10, doi: 10.1016/j.socscimed.2021.114523.

Hussein, B. (2021), "Addressing collaboration challenges in project-based learning: the student's perspective", *Education Sciences*, Vol. 11 No. 8, p. 434, doi: 10.3390/educsci11080434.

Jordan, M.E., Lanham, H.J., Crabtree, B.F., Nutting, P., Miller, W., Stange, K. and McDaniel, R. (2009), "The role of conversation in health care interventions: enabling sensemaking and learning", *Implementation Science*, Vol. 4 No. 1, p. 15, doi: 10.1186/1748-5908-4-15.

Karvonen, R., Ratinen, I. and Kemi, U. (2023), "Promoting sustainability competency and self-efficacy in class teacher education", *Frontiers in Sustainability*, Vol. 4, pp. 1-10, doi: 10.3389/frsus.2023.1205680.

Khalid, A., Dukmak, S., Dweikat, F. and Fayez, I. (2017), "Pre-service teachers' perception of their educational preparation", *International Journal for Research in Education*, Vol. 41 No. 1, pp. 273-303, available at: https://scholarworks.uaeu.ac.ae/ijre/vol41/iss1/9

Kokotsaki, D., Menzies, V. and Wiggins, A. (2016), "Project-based learning: a review of the literature", *Improving Schools*, Vol. 19 No. 3, pp. 267-277, doi: 10.1177/1365480216659733.

Lam, S., Cheng, R. and Ma, W. (2009), "Teacher and student intrinsic motivation in project-based learning", *Instructional Science*, Vol. 37 No. 6, pp. 565-578, doi: 10.1007/s11251-008-9070-9.

Lewin, K. (1951), *Field Theory in Social Science*, Harper, New York, NY.

Lim, C. and Chan, B. (2007), "microLESSONS in teacher education: examining pre-service teachers' pedagogical beliefs", *Computers and Education*, Vol. 48 No. 3, pp. 474-494, doi: 10.1016/j.compedu.2005.03.005.

Lortie, D. (1975), *Schoolteacher: A Sociological Study*, University of Chicago Press. USA, London.

Lozano, R., Barreiro-Gen, M., Lozano, F.J. and Sammalisto, K. (2019), "Teaching sustainability in european higher education institutions: assessing the connections between competences and pedagogical approaches", *Sustainability*, Vol. 11 No. 6, p. 1602, doi: 10.3390/su11061602.

Mahlios, M. and Maxson, M. (1995), "Capturing preservice teachers' beliefs about schooling, life, and childhood", *Journal of Teacher Education*, Vol. 46, pp. 192-198, doi: 10.1177/0022487195046003005.

Mezirow, J. (1978), "Perspective transformation", *Adult Education*, Vol. 28 No. 2, pp. 100-110, doi: 10.1177/074171367802800202.

Mezirow, J. (2009), "An overview on transformative learning", in Illeris, K. (Ed.), *Contemporary Theories of Learning*, Routledge, London and New York, NY, pp. 90-105.

Moore, K. (2005), *Effective Instructional Practices: From Theory to Practice*, McGraw-Hill, New York, NY.

Mulà, I. and Tilbury, D. (2023), "Teacher education for the green transition and sustainable development", *EENEE Analytical Report*, available at: https://data.europa.eu/doi/10.2766/144189

Mulyadi, A., Mustofa, R. and Diella, D. (2023), "The effect of a project-based learning model on learning outcomes and collaboration skills", *Bioeduca: Journal of Biology Education*, Vol. 5 No. 2, pp. 65-78, doi: 10.21580/bioeduca.v5i2.16964.

Muzer, F., Husin, M. and Raddhin, R. (2023), "The effectiveness of project-based learning (pjbl) on learning outcomes: a meta-analysis using jasp", *JIPF (Jurnal Ilmu Pendidikan Fisika)*, Vol. 8 No. 3, pp. 327-336, doi: 10.26737/jipf.v8i3.3701.

Naeem, M., Ozuem, W., Howell, K. and Ranfagni, S. (2023), "A step-by-step process of thematic analysis to develop a conceptual model in qualitative research", *International Journal of Qualitative Methods*, Vol. 22, pp. 1-18, doi: 10.1177/16094069231205789.

Onwuegbuzie, A. and Burke Johnson, R. (2006), "The validity issue in mixed research", *Research In The Schools*, *Mid-South Educational Research Association*, Vol. 13 No. 1, pp. 48-63, available at: www.researchgate.net/publication/228340166_The_Validity_Issues_in_Mixed_Research

Pajares, M.F. (1992), "Teachers' beliefs and educational research: cleaning up a messy construct", *Review of Educational Research*, Vol. 62 No. 3, pp. 307-332, doi: 10.3102/00346543062003307.

Pan, G., Seow, P.-S. and Koh, G. (2019), "Examining learning transformation in project-based learning process", *Journal of International Education in Business*, Vol. 12 No. 2, pp. 167-180, doi: 10.1108/JIEB-06-2018-0022.

Paristiowati, M., Rahmawati, Y., Fitriani, E., Satrio, J. and Putri, H.N. (2022), "Developing preservice chemistry teachers' engagement with sustainability education through an online project-based learning summer course program", *Sustainability*, Vol. 14 No. 3, p. 1783, doi: 10.3390/su14031783.

Parwata, I., Ratnaya, I. and Artayasa, I. (2023), "The influence of project-based learning on entrepreneurial crafts learning outcomes through learning independence", *Interdisciplinary Social Studies*, Vol. 2 No. 10, pp. 2501-2516, doi: 10.55324/iss.v2i10.510.

Redman, A. and Wiek, A. (2021), "Competencies for advancing transformations towards sustainability", *Frontiers in Education*, Vol. 6, pp. 1-11, doi: 10.3389/feduc.2021.785163.

Riger, S. and Sigurvinsdottir, R. (2016), "Thematic analysis", in Jason, L. and Glenwick, D. (Eds), *Handbook of Methodological Approaches to Community-Based Research; Qualitative, Quantitative and Mixed Methods*, Oxford University Press.

Rodríguez, A., Gustavo, J. and Barth, M. (2020), "Transformative learning in the field of sustainability: a systematic literature review (1999-2019)", *International Journal of Sustainability in Higher Education*, Vol. 21 No. 5, pp. 993-1013, doi: 10.1108/IJSHE-05-2019-0168.

Romano, A. (2017), "The challenge of the assessment of processes and outcomes of transformative learning", *Educational Reflective Practices*, No. 1, pp. 184-219, doi: 10.3280/ERP2017-001012.

Ryan, R.M. and Deci, E.L. (2002), *Handbook of Self-Determination Research*, University of Rochester Press.

Scott, W. and Vare, P. (2018), "The world we'll leave behind", *Grasping the Sustainability Challenge*, Routledge.

Sulong, W., Sermsook, K., Sooknit, O. and Worapun, W. (2023), "Project-based learning in general psychology class for undergraduate students", *Journal of Education and Learning*, Vol. 12 No. 6, pp. 82-89, doi: 10.5539/jel.v12n6p82.

Thomas, I. (2009), "Critical thinking, transformative learning, sustainable education, and problem-based learning in universities", *Journal of Transformative Education*, Vol. 7 No. 3, pp. 245-264, doi: 10.1177/1541344610385753.

Thomson, K. and Trigwell, K. (2016), "The role of informal conversations in developing university teaching?", *Studies in Higher Education*, Vol. 43 No. 9, pp. 1536-1547, doi: 10.1080/03075079.2016.1265498.

Von Kotze, A. and Cooper, L. (2000), "Exploring the transformative potential of project-based learning in university adult education", *Studies in the Education of Adults*, Vol. 32 No. 2, pp. 212-228, doi: 10.1080/02660830.2000.11661431.

Waddock, S. (2013), "The wicked problems of global sustainability need wicked (good) leaders and wicked (good) collaborative solutions", *Journal of Management for Global Sustainability*, Vol. 1 No. 1, pp. 91-111, doi: 10.13185/2244-6893.1018.

Wall, C. (2016), "From student to teacher: changes in preservice teacher educational beliefs throughout the learning-to-teach journey", *Teacher Development*, Vol. 20 No. 3, pp. 364-379, doi: 10.1080/13664530.2016.1149509.

Wan, W., Low, G. and Li, M. (2011), "From students' and teachers' perspectives: metaphor analysis of beliefs about EFL teachers' roles", *System*, Vol. 39 No. 3, pp. 403-415, doi: 10.1016/j.system.2011.07.012.

Watz, M. (2020), "Using group model building to foster learning for strategic sustainable development", *Sustainability*, Vol. 12 No. 20, p. 8350, doi: 10.3390/su12208350.

Weiss, M., Barth, M. and von Wehrden, H. (2021), "The patterns of curriculum change processes that embed sustainability in higher education institutions", *Sustainability Science*, Vol. 16 No. 5, pp. 1579-1593, doi: 10.1007/s11625-021-00984-1.

Widarbowo, D., Nofirman, N., Jasiah, J., Surur, M. and Astuti, E. (2023), "Meta-analysis study for the use of project based learning models in teaching and learning activities", *Journal on Education*, Vol. 5 No. 4, pp. 16306-16311, doi: 10.31004/joe.v5i4.2781.

Wiek, A., Bernstein, M.J., Foley, R.W., Cohen, M., Forrest, N., Kuzdas, C., *et al*. (2016), "Operationalising competencies in higher education for sustainable development", in Barth, M., Michelsen, G., Rieckmann, M. and Thomas, I. (Eds), *Handbook of Higher Education for Sustainable World*, Routledge, London, pp. 241-260.

Wiek, A., Keeler, L. and Redman, C. (2011), "Key competencies in sustainability: a reference framework for academic program development", *Sustainability Science*, Vol. 6 No. 2, pp. 203-218, doi: 10.1007/s11625-011-0132-6.

Wilson, S. and Cameron, R. (1996), "Student teacher perceptions of effective teaching: a developmental perspective", *Journal of Education for Teaching*, Vol. 22 No. 2, pp. 181-195, doi: 10.1080/02607479620340.

Witcher, A., Onwuegbuzie, A. and Minor, L. (2001), "Characteristics of effective teachers: perceptions of preservice teachers", *Research in the Schools*, Vol. 8, pp. 45-57, available at: https://eric.ed.gov/?id=ED438246

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