Educational learning lab supporting innovation adoption in vocational education

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This article explores the implementation and sustainability of innovative educational practices in a joint collaborative research project involving Estonia and Lithuania. Four interventions following the Educational Learning Lab approach were designed to counteract drop-out from vocational education and training for young people at risk of social exclusion. The study investigates the conditions for vocational teachers' knowledge appropriation leading to sustainable innovation in the empowerment of vulnerable students. Through applying the Knowledge Appropriation Model to the design of intervention cases, data collection and analyses, the article discusses how knowledge maturation, scaffolding, and appropriation practices emerged during the Educational Learning Labs.

1 Introduction

This study explores the implementation and adoption of innovative educational practices in two countries, Estonia and Lithuania in the context of the EmpowerVET project. In Estonia and Lithuania, as in many other European countries, persistent drop-out from Vocational education and training (VET) has been counteracted through various innovative educational practices designed to facilitate student participation and learning, and therefore the students completing their VET studies. However, the adoption of new, innovative practices in education systems tends to be challenging (e.g., Webb and Cox, 2004; Lesnefsky et al., 2025). Very often newly gained knowledge is not adopted and implemented in practice over time (Broadbent et al., 2024) and does not involve the expected long-term effect. Nevertheless, research has in recent years demonstrated that the co-construction of knowledge in practices such as school-university partnerships (in some cases also industry, policymakers, and other stakeholders) in the form of Educational Learning Labs, may lead to more efficient adoption of innovation in education systems (Alderman, 2018). Within the Educational Learning Lab, while collaboratively crossing professional boundaries, new ideas are co-created to address various challenges in education systems (Callaghan and Herselman, 2015). Participating in the Educational Learning Lab may stimulate stakeholders' professional learning and ongoing exploration, as well as further development of the innovations (Ley et al., 2021). Therefore, a more sustainable impact can be expected as stakeholders (teachers, researchers, workplace instructors, etc.) create ownership of changes during the co-creation process.

Various innovative educational practices were designed in Estonia and in Lithuania, following the logic of the Educational Learning Lab model (Ley et al., 2020a). These interventions were aimed at facilitating successful participation and learning for youth at risk of social exclusion, counteracting drop-out from VET, and boosting the professional development of vocational teachers and workplace instructors. In Estonia and Lithuania, a total of four interventions were co-designed and implemented with the aim of enhancing the educational achievements of students and empowering the staff of vocational schools. In Estonia, the intervention focused on supporting teachers in designing a learning environment in VET that supports mental health. In Lithuania, a total of three interventions were carried out in VET centers for: (a) a propaedeutic work-based learning scenario for empowering vulnerable students in a rural VET center; (b) strengthening learner engagement and the school community through scaffolding and service-learning practices; and, (c) piloting a flipped classroom method to help vocational teachers and educators better understand their capacities to enable students at risk of social exclusion to learn and enter employment. All interventions were introduced and implemented between October 2022 and April 2023. Incorporating the four interventions, the study explores the following research question: **What characterizes the conditions for knowledge appropriation leading to sustainable innovations in the empowerment of vulnerable VET students?** By employing the Knowledge Appropriation Model (Ley et al., 2018), the purpose of the study is to understand the characteristics of conditions required for a sustainable school-level effect to be expected. In the following sections we will elaborate the Educational Learning Lab approach as an incubator for co-creating interventions in VET and a Knowledge Appropriation Model as a central conceptual frame to explore how these co-creation efforts are developed, shared, and implemented aiming to empower vulnerable students in vocational education institutions across two countries. In section 4, the overall methodical approach is described, in particular, we will explain how Knowledge Appropriation Model is used to investigate vocational teachers' knowledge maturation, scaffolding and appropriation practices in Educational Learning Labs as a comprehensive approach to professional development and innovation adoption in education. Section 5 Cases discusses four cases explored in the context of this study and the section 6 provides insights following the knowledge appropriation framework, more precisely knowledge maturation practices, scaffolding practices and practices for the appropriation of co-created knowledge to understand the conditions for knowledge appropriation in the Educational Learning Lab that have a potential to empower vulnerable VET students. The article ends with the section 7.

2 Educational learning lab approach

It is expected that educational research will be implemented in schools, ensuring that learners benefit from the latest innovations while teaching practices and the school system operate based on the most current understanding of effective and ineffective methods. However, traditional linear knowledge transfer approaches in education, i.e. research creates new knowledge, it is then packaged into teacher training, teachers apply it in classrooms

and students benefit may not always give the desired result and create sustainable and widespread educational innovations in practice. Instead, innovations in education may be successful if co-created, tested, and validated in practice with researchers and practitioners addressing the actual research-practice gap in education (Sillaots et al., 2024). The Educational Learning Lab approach with an exploratory research-to-innovation-to-practice knowledge construction of educational innovation may push educational systems toward more sustainable, scalable, and evidence-based changes (Ruiz-Calleja et al., 2017). The overall logic of an Educational Learning Lab approach is a systematic co-creation of innovation and building communities of teachers, researchers and other stakeholders. This collaboration facilitates the professional growth of teachers and the continuous development and application of innovation, which are tested in real-world settings and embraced by school communities. For a school system to change, multi-professional teams should be involved, such as teachers, school leaders, other support staff as well as educational researchers and sometimes policymakers (Schenke et al., 2016). However, for learning and change to take place, bringing together different stakeholders might be challenging as it will require engagement in crossing professional boundaries (e.g., teachers participating in research; Akkerman and Bruining, 2016). Successful co-creation and adoption of innovation is hence determined by the transfer of ownership from research to practice, effective dialogue, and the creation of meaningful interaction (Snoek et al., 2017).

For successful implementation of innovation based on Educational Learning Labs a shared environment must be established where innovation, learning, and research can occur simultaneously and support is continuously available for participants to better understand the purpose of innovation. This support can be provided by the university researchers, but also by the school specialist (e.g., educational technologist) or by more experienced colleagues. The support is built around the co-creation activities taking place in teacher-researcher collaboration, in which innovative practices are carried out and the impact of the innovation is monitored. Finally, an active teacher-researcher learning and teaching community is expected to continue to further develop the proposed method, and to carry the innovation beyond its official boundaries (Ley et al., 2020a); thus, resulting in sustainable and wide-spread innovation. The theoretical foundation of the Educational Learning Lab approach is rooted in the Knowledge Appropriation Model explaining how multidisciplinary teams learn and create new practices and knowledge (Ley et al., 2020b). The following section introduces the Knowledge Appropriation Model, which we have utilized as a conceptualization of the theoretical framework of our research and as an analytical framework to study the process of co-creation and innovation adoption in VET-university partnership in our intervention studies.

3 Knowledge appropriation model as a central conceptual frame

To understand how groups of stakeholders in education generate new knowledge and apply it in practice, this study is based on the Knowledge Appropriation Model. The Knowledge

Appropriation Model (KAM) (Ley et al., 2020b) provides a structured framework for understanding how knowledge is created, shared, and implemented within educational settings. It illustrates the interconnected nature of transformative learning processes within organizations, communities (such as schools), groups, and individuals (such as teachers, managers, etc.) in the context of innovation adoption and clarifies how these processes support the integration of new ideas and practices. KAM emphasizes the interaction between individual and collective knowledge. For knowledge to be appropriated within professional settings (Ellström, 2010) such as in schools, individuals, for instance teachers, support staff, actively contribute to knowledge creation to form collective knowledge (Nonaka et al., 2006) by engaging with and participating in the activities of communities (Maier and Schmidt, 2015), e.g., teachers and support staff focus on a common problem in education. Generated new knowledge is put into practice while collaborating with or working alongside colleagues (Engeström, 2001) guided by the expertise of experienced teachers or researchers or, indirectly, by knowledge artifacts (Billett, 2002). Through this dynamic, teachers and support staff not only enrich collective knowledge how to solve a problem but also develop professionally by engaging in guided experiences with researchers or more experienced colleagues who support their internalization of newly developed evidence-based knowledge (Rogoff, 1995). While co-creating innovations in education and implementing them in practice knowledge maturation, scaffolding and knowledge appropriation practices take place (Ley et al., 2020b).

(a) Knowledge maturation practices involve a structured process where an individual (teacher) adopts an idea, shares it within a group of other teachers, and collaborates to refine it into a shared solution. This idea is then formalized for broader dissemination and eventually standardized into norms or guidelines for wider implementation among colleagues. The more developed knowledge is capable of guiding learning within organizations leading to the transformation and maturation of knowledge (Maier and Schmidt, 2015). (b) Simultaneously, scaffolding practices involve a structured support process where teachers seek help from skilled colleagues when facing challenges. As guidance is provided and competence grows, the support gradually fades, allowing teachers to become more independent with working on the intervention idea. (c) Knowledge appropriation involves raising awareness of new ideas through formal training or informal discussions. Colleagues build shared understanding through negotiation, while solutions are adapted to specific contexts through de-contextualization and re-contextualization. Validation mechanisms, such as community discussions or evidence collection, help assess the impact of new methods before full implementation. Therefore, the extent and quality of knowledge appropriation practices are key for sustainable and widespread innovation adoption in educational institutions.

The Educational Learning Lab approach together with the KAM was used as a theoretical framework for developing intervention studies, exploring development practices and approaches to the empowerment of vulnerable students in vocational education institutions across two countries. Using these approaches as a foundation for research and innocation co-creation ensured a systematic approach to examining stakeholder collaboration, innovation adoption, and the transformation of educational practices potentially leading to sustainable innovation. Implementing KAM allowed to bridge the gap between research and practice, ensuring that newly generated knowledge is tested and refined in real-world settings; to highlight social and collaborative learning, which is essential for professional development among educators and innovation adoption in schools.

4 Method

The intervention studies were conducted as four cases in two countries, one in Estonia and three in Lithuania. The intervention cases were selected by following these criteria: (1) the main target group of the interventions are VET teachers, trainers, and pedagogical support staff working with vulnerable students in VET; (2) interventions deal with the education, training or support practices applied in local VET institutions; (3) interventions involve capacity building of the target group for dealing with the challenges of empowering vulnerable VET students. The focus and design of interventions were co-defined and developed in the Educational Learning Lab to facilitate building communities of stakeholders and promoting ownership. In addition, the Educational Learning Labs enabled participants to follow the stages described in the KAM model: knowledge maturation, scaffolding, and appropriation (Figure 1). For example, during the co-creation process the participants (vocational teachers, trainers) were given the active role of defining the problem and offering solutions, the experts and researchers took the role of being a facilitator of reflection, group discussions, and sharing of good practice. Moreover, experts and researchers were part of the co-creation process of innovation as well, they shared some of the theoretical frames and introduced positive classroom level strategies. Implementing KAM allowed us to analyze how different stakeholders (teachers, administrators, and managers) contribute to knowledge creation and exchange. Consequently, the KAM was also used for creating instrument for data collection and as an analytical framework to study knowledge appropriation and innovation adoption in partnerships involving vocational schools and universities.

The focus of each intervention, participants, intervention characteristics, specific data collection and analysis methods are described in Table 1.

To understand how these approaches and co-created knowledge have been appropriated, semi-structured interviews with individuals and focus-groups were conducted with the participants of the interventions at the beginning and the end of the intervention period. Previously a survey tool based on the KAM model has been developed and validated (Ley et al., 2020a). However, due to the small sample of participants in the different cases, the qualitative approach was preferred for data collection and analysis. Based on the validated questionnaire, a semi-structured interview guide was developed and piloted. The qualitative approach chosen was expected to provide an in-depth understanding of the participants' experience (Mason, 2002), including barriers to appropriation and adoption. The interviews followed a similar structure in all countries, but the questions were adapted depending on the specific intervention. The interviews conducted at the beginning of the intervention involved questions regarding the prior knowledge and motivation
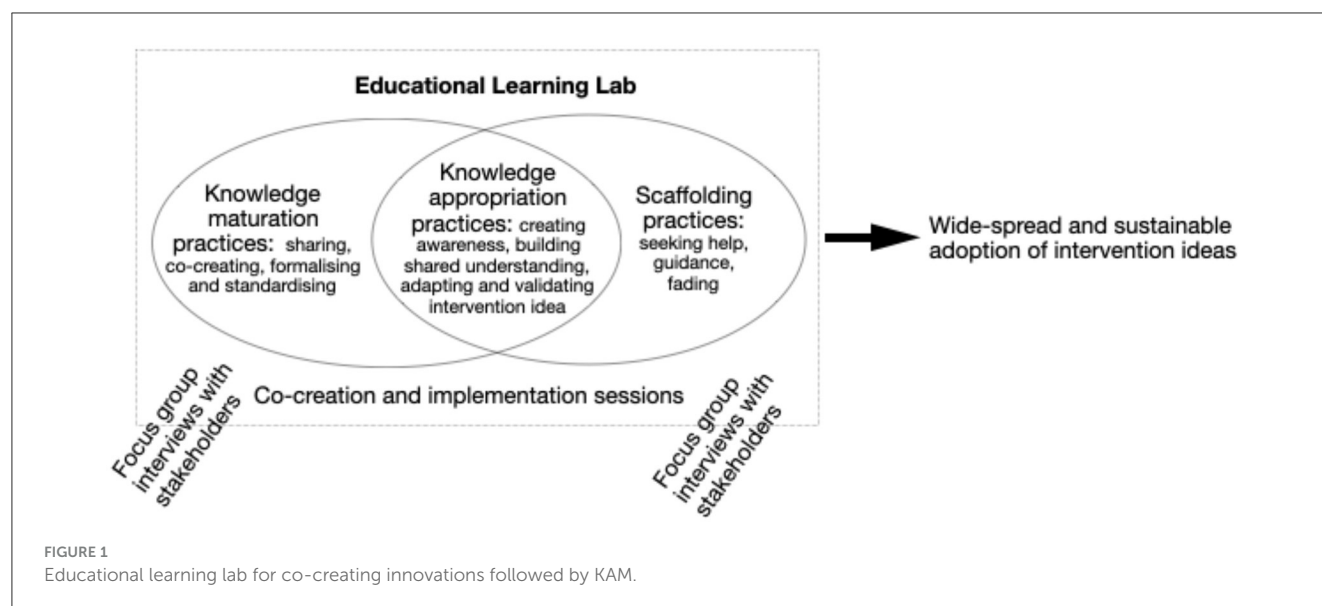
FIGURE 1
Educational learning lab for co-creating innovations followed by KAM.

TABLE 1 The cases in two countries.

Focus of the intervention	Participants	Intervention characteristics	Data collection and analysis of the cases	Cross-case data analysis
1. Designing a learning environment that supports mental health in a vocational educational institution (Estonia)	20 staff from different VET schools (teachers, staff of the dormitory, support unit, etc.)	Five co-creation sessions with experts, piloting of some parts of the intervention	Four focus group interviews in the First and last co-creation session, deductive content analysis guided by the KAM	
2. Propaedeutic work-based learning scenario for empowerment of vulnerable students in the rural VET center (Lithuania)	Four VET teachers, four vulnerable students from one VET center	Co-creation of 4–6 h learning scenarios and piloting.	One focus group discussion in the First co-creation session, 3 online focus group interviews in the last co-creation session, deductive content analysis guided by the KAM	Comparative analysis across each aspect of the Knowledge Appropriation Model, identifaction of emerging categories; category comparison across the entire dataset
3. Strengthening learner engagement and the school community through scaffolding and service-learning practices (Lithuania)	Three VET teachers, three vulnerable students (orphans) + two students with special educational needs from one VET center	Three co-creation sessions with the eight representatives of the school (teachers, students), intervention piloting	One focus group discussion in the First co-creation session, three online focus group interviews in the last co-creation session, deductive content analysis guided by the KAM	
4. Empowering pupils at risk of social exclusion— Vocational teacher/educator (Lithuania)	Vocational teachers working with students at risk of social exclusion (mainly SEN learners), social pedagogues and psychologists from one vocational center	Five co-creation sessions with experts, intervention piloting	Two focus group discussions in the first co-creation session, three online focus group interviews in the last co-creation session, deductive content analysis guided by the KAM	

to be part of the intervention co-creation team, including perceived importance and support from colleagues and management while appropriating, sharing, and formalizing the intervention. The interviews conducted at the end of the intervention involved questions concerning the adoption, adaptation, and application of the co-created new knowledge and intervention, formalizing and sharing it with the wider community, and the perceived support, confidence, and motivation to continue with the new knowledge. Both national teams have analyzed the interview data using deductive content analysis (Bingham, 2023), led by the Knowledge Appropriation Model. At the beginning of the Educational Learning Lab the data analysis focused on aspects related to knowledge maturation such as adoption of

knowledge with respect to prior knowledge, support available, motivation. Data collected at the end of the Educational Learning Lab was analyzed according to the (a) knowledge maturation practices, in particular knowledge sharing, co-creation, knowledge formalization and standardization; (b) scaffolding practices focusing on implementation of the intervention ideas to the local context, help seeking while implementing the ideas and competence building; and (c) appropriation of co-created knowledge with respect to building shared understanding, adaptation of intervention ideas, adoption of innovation and assessment of the knowledge appropriation. Separate reports were prepared for each intervention case. In the next stage, comparative analysis across each aspect of the Knowledge Appropriation Model

FIGURE 2
Cases.
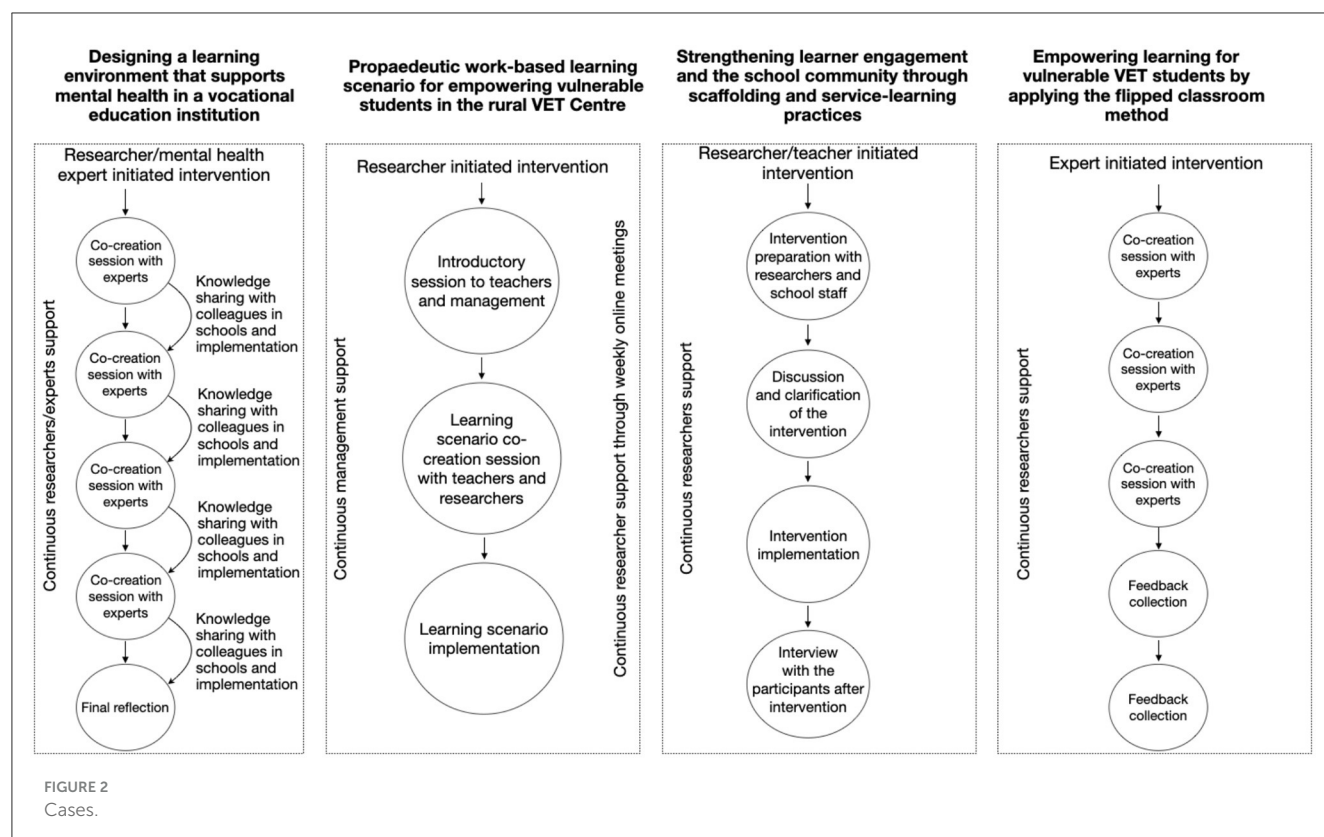
was carried out, in which emerging categories were identified and compared across the entire dataset. The four cases of educational intervention will be presented based on the main elements of the KAM model.

5 Cases

The study involved four cases from two different countries (Estonia, Lithuania; Figure 2).

5.1 Designing a learning environment that supports mental health in a vocational education institution (Estonia)

The focus of the intervention was to enhance vocational teachers' competence in creating a learning environment to support the general wellbeing and mental health of the students. The intervention was initiated by the researchers, as well as mental health experts. During the intervention, various initiatives were co-created concerning how to design a supportive environment at classroom level, as well as for the entire school. For instance, the participants were asked to discuss with their colleagues at their own school about the specific mental health related issues in their school; to make a step by step plan for implementing changes in their teaching practice. The experts (educational psychologists/researchers) facilitated reflection in group discussions, sharing good practice examples, as well as

theoretical frames. Five training sessions were designed where participants raised issues of practical relevance for their own work. Reflections and discussions in smaller groups provided an opportunity to process, practice, and experience that was subsequently shared in larger groups. Home tasks were designed, directed to reflect on, and apply the new knowledge and involve non-participating colleagues and group discussions.

5.2 Propaedeutic work-based learning scenario for empowering vulnerable students in the rural VET center (Lithuania)

VET centers in Lithuania are characterized by limited workplace learning opportunities for vulnerable vocational students. The intervention focused on enhancing VET teachers and trainers to create access to meaningful work-based learning for vulnerable VET students. A learning scenario of preparatory work-based learning in the field of construction decoration was co-created by a team of researchers and VET teachers and conducted in a rural VET center in northern Lithuania. The intervention was supported by the management of the VET school. The participants first met when researchers visited the school and explained the intervention to the VET teaching staff and school management (about 40 individuals). Based on joint discussions with stakeholders the learning scenario was drafted. Subsequently, a smaller team of three VET teachers and school administration representatives was established for conducting the prepared scenario. Students were invited to participate in the

learning scenario and an agreement for practical training was signed with a local construction company. The conducting of the scenario was monitored and consulted by the researchers through weekly online meetings with the team at the VET center. During these meetings the representatives of the VET center described the progress of the intervention and indicated challenges. The researchers provided suggestions on how to address problems as necessary.

5.3 Strengthening learner engagement and the school community through scaffolding and service-learning practices (Lithuania)

This intervention encouraged VET institutions to support students at risk of social exclusion to become more actively involved in the school's learning communities. The idea was based on service-learning practices, such as the organization of an exhibition about support for dogs and dog shelters and collecting and distributing support to dog shelters. The intervention followed a co-creative approach, involving older students who acted as mentors and provided scaffolding for students with disadvantaged backgrounds. The goal was to engage learners in the learning process, to strengthen collaboration and teamwork, to strengthen the community through service-learning activities, and to practice scaffolding and peer learning among students. The intervention was organized in multiple steps: First meeting—Preparation for an intervention together with the EmpowerVET team and the representatives of the school; Second meeting—Discussion and clarification of the intervention plans and timeline with the school representatives; Third meeting—interview after the interventions. During the intervention there were constant consultations between the researchers and VET teachers in the school.

5.4 Empowering learning for vulnerable VET students by applying the flipped classroom method (Lithuania)

This intervention aimed to expand the capacities of VET teachers in providing learning support to vulnerable students by applying the flipped classroom method in teaching vocational modules. This was initiated by appropriating knowledge about a flipped classroom method. The intervention involved two groups of vocational teachers and support staff educating special educational needs (SEN) students in two different programs: a VET program for cooks and a VET program for construction workers. During the intervention, vocational teachers, and support staff became familiarized with the flipped classroom method so they could apply it in their work. They developed a flipped classroom learning plan based on a predefined template. Co-creation was supported through the intervention sessions. The participants of the intervention during the first two sessions received training about the flipped classroom method and a template for preparing a learning plan. During the third session the participants had the opportunity to ask questions, discuss their doubts, reflect on

their regular practices, and what the flipped classroom method may change and promise for them. After this, they were engaged in planning the intervention, preparing learning materials for home learning, and then organizing classroom learning. The fourth and fifth sessions were dedicated to collecting feedback from interview participants.

6 Results

We analyzed the cases to understand the conditions for co-creation, knowledge appropriation, and adoption of innovation in different cases in the Educational Learning Lab's settings. Taking the insights from the group interviews in the following sections we will present different examples that emerged from different cases in relation to the knowledge appropriation model: participant *knowledge maturation practices* during the Educational Learning Lab interventions through idea appropriation, sharing and co-creating; *scaffolding practices* while implementing interventions; and participants' *knowledge appropriation* through building a shared understanding, and adapting and validating intervention ideas to local needs. These will be used to evaluate how the changes introduced in VET establishments have been appropriated and adopted by participants, and whether sustainable school-level effects could be expected.

6.1 Knowledge maturation practices

Knowledge maturation involves structuring work around knowledge artifacts (Ley et al., 2020b). When facing new situations and problems, one starts to experience, explore, and experiment with new ideas. In our intervention studies, knowledge maturation practices started by appropriating an idea during the Educational Learning Lab co-creation sessions with experts and researchers to allow the participants to acquire knowledge and skills on the topic. By gaining individual experiences through training, knowledge can then be shared with other colleagues, which helps the knowledge to evolve into a more developed form.

The prerequisite for any adoption is interest and motivation to deal with the topic. The interview data shows that internal motivation, such as a need for one's professional development, has been the main source of trigger to the majority of the participants to participate in Educational Learning Labs and the participants considered interventions as a new arena for their professional development. One of the participants in Case 4 explained about her motivation to participate: "*Because everything is changing, the children themselves are changing, we often use old methods, but they are no longer acceptable for children.*" Apart from the motivation for professional development, recognizing and being conscious of the issue addressed by the intervention is a key requirement for knowledge maturation, and appropriation in subsequent stages. As a rule, the participants in all the cases, obviously the most motivated ones, were aware of and had acknowledged the problems the interventions tried to address. One of the participating teachers of Case 3 shared her view: "*I think it's not a big challenge to work with the students at risk. But especially with autistic children, there is a new issue. I think we lack the knowledge of children with special needs*

on how to integrate them. It is easier to integrate those with physical disabilities, but we do not know exactly how to work with students who have other special needs and disabilities.…" However, there are also staff in schools, as admitted by some of the participants of Case 1, who don't acknowledge that there are, for instance, mental issues and problems among students and staff. One of the participants expressed the view: "*We don't have children with special needs, but we have uneducable children, they should be punished.*" Moreover, innovation in education can be successful if the management of an organization also recognizes the problem and jointly contributes to finding solutions. In Case 1, the management support as outlined by the participants tended to vary. Management can be supportive or not care at all. In Case 4, the main support mechanism seems to be institutional agency which shapes a favorable climate for professional development, for the professional and social capital of teachers. Without question, recognizing and acknowledging the existence of a problem by a larger group of teachers, and the management is an essential prerequisite for knowledge maturation and working toward a successful intervention explained by the majority of participants.

For knowledge to mature, a shared understanding of the problem and a solution co-created for the local context is necessary. To evolve and distribute knowledge gained from the Educational Learning Labs and from the discussions with experts, for instance, in Case 1 it was recommended that many participants from the same vocational school take part in the interventions. "*We already have several people from one school, which is already a strong basis for this co-creation, it is not like one suddenly comes and starts doing something there. If there are already several people, it creates more trust,*" as one of the participants argued. In these cases, the knowledge was shared particularly widely. On the other hand, some teachers in Case 1 hesitated to share the new knowledge and involve colleagues in their school or only discussed it in very small groups. One of the teachers experienced strong resistance and ignorance while trying to share the knowledge with colleagues in his school. Personal reasons and generational differences were perceived as the main reason for not being interested in the topic, as stated: "*In my opinion, this also gives an idea that those people who have been in the same place in the same job for a very long time, that they also have a certain comfort zone, that every innovation initially causes protest.*" By contrast, in Case 3, the VET center identified that their knowledge and strength is in their community and acknowledged that further knowledge is needed. Knowledge sharing was based on identifying existing practices and finding ways with the researchers for how existing practices/projects/initiatives, focused on community strengthening, could be enhanced, or implemented in a slightly different way to have better engagement from and the inclusion of all learners.

A good example of co-creation can be seen in Case 4, where co-creation happened among the participating VET teachers working in the same program and the support staff (a special pedagogue and psychologist), who had also been invited to the intervention group. The support staff offered the teachers their counseling, advice, and recommendations. One of the teachers shared his experience: "*We had many discussions not only about the teaching/learning material, but also about presenting it to the students, considering the abilities of each one. After that, we discussed in detail how the*

lessons went." Therefore, the intervention served as an opportunity to better understand their learners and to learn from peers. An essential aspect of, but also a precondition for, co-creation is collegial support.

Furthermore, among others, Case 2 demonstrated a good example of successful researcher-teacher partnership. Consultations with the researchers provided knowledge of possible methodical approaches and solutions to the problems and challenges. These consultations worked as part of the co-creation of knowledge emerging during common discussions of the problems encountered in implementing the learning scenario by providing methodological inputs and guidance. The researchers supplied the theoretical and methodological know-how in this process, especially in terms of the inclusive vocational didactics of work-based learning. VET teachers helped contextualize this know-how in the local institutional and educational context by taking into consideration the limitations it imposes (e.g., duration of the company visits, planning the shadowing sessions, and motivation of the company to get involved in this activity).

In summary, the personal and community need for professional development to keep up the changes in education; acknowledging the problem the intervention tries to target by most stakeholders (teachers, staff, and management) resulting also in knowledge sharing, trust, and confidence in working on the problem; and collegial support are important conditions for knowledge to mature that lead to a sustainable school-level effect.

6.2 Scaffolding practices

Implementing new co-created knowledge in concrete local settings quite likely requires different levels of scaffolding practice, such as seeking support and guidance from a more experienced colleague or an expert allowing the person to gain competence, thus reducing the need for guidance. Scaffolding practices enable us to gain insights into how individuals participate in these collaborative learning processes and how this assistance is provided to individuals within organizations if they require support.

Most of the participants in all the cases had not yet managed to carry out large-scale implementations in their VET schools, since the new knowledge has not matured enough and met any standardization to promote broader distribution and adoption. Therefore, they had mainly tested out at an individual level or on a small scale by applying co-created idea-plans into everyday teaching practice. One reason for this could be the limited timescale of the intervention as a Case 1 participant said: "*Actually, I have implemented less in practice than I would have liked, but this is an impulse for the future.*" The small-scale implementations have been executed mainly in a very autonomous way, however, in collaboration with experts and researchers. For instance, weekly online meetings with the researchers in Case 2 were dedicated to the open discussion of problems and challenges, but in most cases the team of VET teachers already had the solutions and just needed to discuss them with the researchers for further confirmation. To implement new ideas and practices, it is important to engage in open discussion and sharing, as mentioned by one of the

participants: "*In order to learn, freely available information, discussions, and sharing of experiences are very important.*" Another added: "*We get a lot of help from ourselves as well. From the same resources, what we have, what we can.*" One participant in Case 1 in the role of lead-teacher argued that she tries to share her knowledge with the co-teachers that need support: "*I have to help my colleagues….*" Case 4 participants felt that they have good peer connections with the other teachers and the support staff (special pedagogue and psychologist). One of the social pedagogues shared: "*Without a doubt, there are colleagues with whom one can discuss emerging problems and ask for help if there is a need.*"

In Cases 3 and 4, in addition to colleagues and researchers, who were more observers and consultants in the process and less facilitators, the participants reflected that they also received support from the school administration: "*The management of our school is always open to innovation. Many of our teachers are actively involved in project activities. A lot of attention is paid to it. Teachers participating in this activity always received approval and support.*" The management's role in creating a supportive climate was also mentioned by the participants in Case 1: "*I have gained a lot from the training, but I am starting to lose hope for my school…how much can I, as a person, influence it if I am not a leader. The leader can do the most.*" It seemed that by the end of the intervention period, the teachers were more critical of the school management. This may be related to their increased awareness of the topic of the intervention (mental health) and that they were pushed to think about it in the context of the whole school environment. As new ideas are put into practice, one begins to recognize the need for a deeper understanding of the intervention. Although already acquainted with the intervention topic, the participants in Case 4 identified that they need more activities and new knowledge on the topic. In particular, the participants reflected that they lack knowledge about appropriating training material for their students so they could learn at home. Therefore, there is room for further professional development and testing ideas extensively in real learning situations, as well as ongoing support and facilitation.

In conclusion, for knowledge to mature for practical intervention and be applied in practice, time is essential. Successful implementation is more likely when a group of teachers collaborates on the same intervention and has access to experts and researchers. This collaborative environment fosters a sense of security, ensuring that individuals do not feel isolated in their efforts and can consistently seek confirmation of being on the right track. A key factor in this process is the approval and supportive climate created by school management. Equally important is the opportunity for ongoing professional development related to the intervention topic.

6.3 Practices for the appropriation of co-created knowledge

Knowledge appropriation practices are the key to sustainable and widespread innovation adoption in vocational institutions: building a shared understanding, adapting innovation ideas to the specific local context, accepting the new ideas as well as validating the implementation of innovation. Establishing and maintaining a shared understanding occurs through the process of negotiation and grounding among colleagues. However, it can be challenging. One of the participants in Case 1 explained that colleagues in her vocational school are senior citizens; therefore, it was demanding to convince them that the topic (mental health issues) is important and needs attention: "*I am young in the group, so somehow through these home tasks we could talk about the importance of mental health, but I had to think a lot about how to talk, because the group is actually of such an older age that they wouldn't understand why this topic should be dealt with in school.*" Nevertheless, most participants in Case 1 did not highlight significant challenges during the process of establishing a shared understanding. In addition, according to the Case 2 participants, there were no challenges and problems in building a shared understanding of the intervention idea with the VET teachers, mainly because there was a similar understanding of the targeted problem and the role of propaedeutic work-based learning measures in empowering vulnerable students for learning and work. The building of a shared understanding occurred through the contextualization of the methodological ideas of the propaedeutic work-based learning suggested by the researchers in the conditions of the concrete VET center and its environment. In addition to involving teachers in building a shared understanding, the students were also engaged in Case 1 and Case 3. In some of the schools in Case 1, the students were invited to be involved in building a common understanding through the feedback questionnaire and by actively contributing and giving ideas on improving the situation in their school. In Case 3, the students were engaged in implementing intervention ideas in practice.

Overall, the participants in all the cases were highly encouraged to adopt the ideas from the training into their current and future teaching practice. In addition, they also acknowledged their role in sharing and spreading the innovation ideas to other colleagues. However, adopting new knowledge required time, as explained by Case 2 and 3 participants. It was acknowledged by Case 3 participants, that although the innovation was in general adopted positively and provided inspiration for new projects in the VET center, implementing the ideas from the training and adopting the innovation requires extra time. The interventions were based on incremental (small) innovations, but they required additional preparation from the teachers, more planning in their work and more knowledge sharing with colleagues. As one of the participants stated: "*This involves additional work for the teachers. This is not an ordinary lesson, preparation, reflection, the formation of teams. On the other hand, teachers receive community hours for the different organization of the work.*"

Moreover, the introduction of innovation sparked some skepticism. For instance, the intervention ideas in Case 3 were slightly surprising for both teachers and students. However, support, discussion between the participants and consultations with researchers helped to design interventions in such a way that they were feasible to implement. One of the participants explained: "*I thought it would take us a long time here. The most interesting thing was with the older students because they alone did everything. Especially on the part of the students, there was skepticism, but it was replaced by the new experience.*" Similarly, the Case 2 participants had some doubts in the beginning, but through reflection with the researchers and their own internal

discussion they were encouraged to try things out. In addition, as a sign of the sustainability of the change, the Case 2 intervention continues and the VET school has prepared and launched an internal project "Work-based learning—a new possibility for me," which is implemented with the researchers. The VET teachers in Case 2 are confident that the methodical and organizational know-how on the implementation of the propaedeutic work-based learning measures for vulnerable students will be useful in future training activities, especially considering the growing volume of vulnerable students and increasing attention of local employers in developing work-based learning and apprenticeship schemes. Such measures can also be prepared in the other VET programs and sectors. However, it is important to consider the specific skill requirements for enterprises in each sector and their potential implications for propaedeutic work-based learning.

Another sign of the sustainability of the intervention ideas was revealed in Case 1, where the participants were highly motivated to participate in follow-up training on mental health issues. The participants themselves created an informal teacher community that would continue to come together informally to discuss and share experiences. The participants regarded themselves as a core group in their school dedicated to the issues and ready to promote them in their school and involve, and train other colleagues to build a more supportive environment in the school both for students and school staff. The general understanding shared was that the successful adoption of innovation can happen if management is engaged and committed during all phases of the intervention (co-design, implementation). As argued by one of the teachers: "...*the management interprets it as a problem, which is not a soft matter, or the thinking that they are coming from the university again and want to do something…should be so that we set a focus on what is important. In general, the management doesn't forbid us from doing things, but the question is whether everybody is on the same page and understands in the same way. Soon there is no choice, but the management must take this topic into focus as they have to monitor the mental health of both students and teachers.*"

On the other hand, the management in some schools in Case 1 is highly active, providing training and workshops on the topic: "*The management was more active than the teachers. Now we must think about how to involve the teachers as well.*" Without question, the school leaders have a strategic role in creating a supportive school environment and shared understandings among school staff to endorse the adoption of the innovation and provide a platform for sustainable development.

The adoption of the innovation will be better achieved if one perceives that professional development has been attained. Case 4 participants felt that their capacities had developed with the help of the intervention: "*The experience of testing the innovation promotes the professional development of the teachers, allows them to improve the quality of vocational education for the youth groups at social risk.*" Moreover, based on reflections by some of the teachers, the intervention revealed several positive aspects and helped overcome barriers. For instance, one of the teachers argues: "*the initiative helped to engage learners and also helped students to overcome some of the learning barriers.*" In Case 3, it was recognized that new co-created knowledge about learner engagement and about scaffolding activities can be implemented not only by teachers but

collaboratively between teachers and students. In this case, the VET Center team was surprised that older and academically stronger students were so supportive and willing to scaffold their peers from vulnerable groups. It was a big challenge to engage learners who are detached, less motivated, but joint efforts were successful.

In summary, broadening the range of stakeholders is crucial for the success and sustainability of interventions, along with consistent management support throughout all phases motivating ststakeholders to continue with the intervention, fostering encouragement, and alleviating skepticism. Additionally, involving students—who are typically the primary beneficiaries of interventions—in the co-creation process can be beneficial, and in some cases even essential. Consequently, a whole-school approach is likely to ensure sustainable innovation, recognizing that professional development occurs within Educational Learning Labs.

7 Discussion and conclusions

The aim of the study was to understand, based on four intervention cases in vocational establishments, what the conditions are for successful knowledge appropriation leading to sustainable innovation in VET. Creating and implementing innovative ideas in VET education systems is a challenging endeavor. In recent years, it has been proposed that forming research-practice partnerships is a feasible option for bridging the research-practice divide (Coburn and Penuel, 2016), having the potential to design and create long-lasting innovations.

The four cases presented above followed the Educational Learning Lab approach that emphasizes co-creation as a key in developing, implementing, and adopting educational innovations in practice. The cases described varied largely in terms of the context and local circumstances of the intervention, and therefore the implementation of the KAM model followed a different and specific logic in each Case. Maturation, scaffolding, and appropriation were emphasized in the cases and reflected differently. However, various elements of the KAM play a vital role in facilitating the adoption of educational innovations and fostering long-term, sustainable changes. All the cases can be characterized by multi-professional partnerships, which refer to collaborations that involve researchers or experts, practitioners, and other stakeholders, all intending to examine a topic of interest and develop plans or solutions for dealing with real-world problems (Reardon and Leonard, 2017). Multi-stakeholder groups have been perceived as among the key elements in acknowledging problems and the need to create and implement innovative ideas. However, based on our study we can argue that knowledge appropriation and innovation adoption also depend on the starting point in creating and implementing new ideas or practices. The starting point in the cases presented above differed, which influenced the entire knowledge maturation, scaffolding, and knowledge appropriation process. In Case 1, the initiative for the innovation came from researchers. In this case the focus of the innovation emerged from the real situation in VET schools and through the Educational Learning Lab approach was introduced to VET school staff. On the other hand, in Case 3

FIGURE 3
Conditions for knowledge maturation, scaffolding, and appropriation practices.
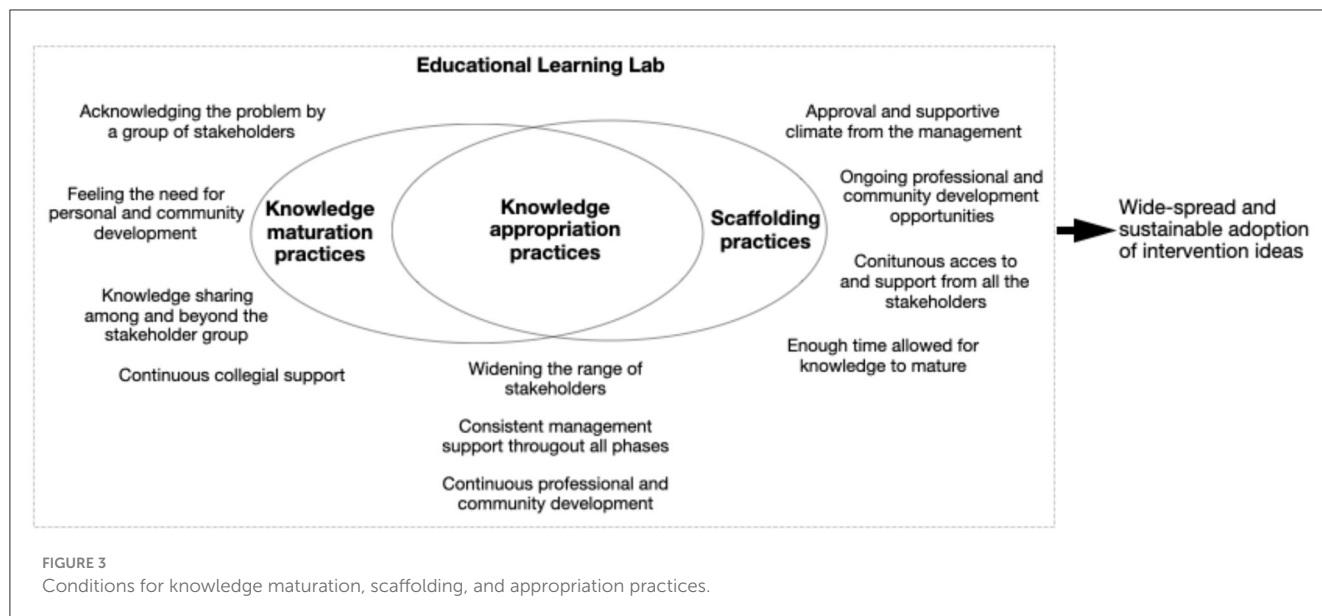
for instance, the innovation idea emerged from the VET center incorporating researchers and experts to design and implement innovative scenarios. In the latter case, the problem that the intervention tried to resolve was already acknowledged and appropriated by the participating teachers; therefore, the teachers were highly motivated to share their experience, find solutions together and engage in further professional development. The Educational Learning Lab approach created the conditions for different stakeholders, including teachers, to be engaged in the co-creation as well as implementation of educational innovation. In the Educational Learning Lab settings, the teachers perceived themselves as equal partners with other stakeholders and seemed to gain ownership of the co-developed innovation. In Case 1 and Case 3, even the students as co-creators of innovation were involved, forming a successful teacher-researcher-student multi-professional partnership. Multi-stakeholder partnerships have also been key for making innovation ideas meaningful to all stakeholders through consistent dialogue.

Furthermore, studies (e.g., Siriwattana and Wirot, 2023; De Jong et al., 2024) indicate that teachers gain advantages from engaging in collaborative practices while working on innovative ideas because collaborative efforts encourage them to support each other and lead them to increase their willingness to take risks, even if they are initially skeptical toward the innovation. Case 1 demonstrates that involvement in interventions with a larger team from a single school can potentially have a broader influence and could lead to the widespread adoption of innovation throughout the entire school, particularly when the management is engaged, provides support, and encourages teachers who are skeptical about the innovation. The larger the team of innovators, the easier it becomes to co-develop successful and enduring innovations.

It is crucial for participating vocational teachers to acknowledge their professional development during their involvement in innovation activities and beyond. Multi-stakeholder co-creation involves boundary crossing, and through continuous discussion, all stakeholders actively participated in a learning process.

The developed innovative ideas can be seen as boundary objects (Akkerman and Bakker, 2011), initially appearing as an inconsistency between various practices. We can see how knowledge was developed in the project and transferred between different arenas and actors as a boundary object with the help of the teachers. Our research illustrates that initiating intervention studies with many colleagues and involving the management from the beginning is particularly beneficial for the co-creation and adoption of innovation within an organization. Furthermore, these cases demonstrate successful examples of co-creating and implementing innovations moving toward appropriating new knowledge and adopting innovations if expert and researcher support is available throughout the knowledge maturation, appropriation, and adoption processes. Continuous support from the management throughout the entire process is equally important in aiding its swift and smooth implementation. Referring to the specific nature of pedagogical interventions designed for the empowerment of vulnerable VET students, this research disclosed the following conditions as important for the effective and sustainable implementation of such interventions: (1) genuine motivation of the VET teaching staff to get involved in supporting vulnerable students; (2) mutual engagement of the VET teaching staff, external experts (researchers), and vulnerable students in the design and implementation of the innovative pedagogical measures; (3) trusting in the capacities of the vulnerable VET students to actively participate in the pedagogical empowerment processes and practices; (4) broad contextualization of the interventions by considering not only pedagogy and didactics, but also the socioeconomic, institutional, and psychological factors of VET provision (Figure 3).

However, on the other side, some risk factors and barriers may appear during the knowledge maturation, scaffolding, and appropriation practices, such as not reaching shared agreement and common understanding of the innovation need, staff's resistance to change, limited stakeholder engagement, and poor capacity building as well as limited time to carry out a thorough

implementation. In addition, contextual constraints and systemic barriers such as limited resources, rigid curricula, and lack of administrative and expert, researcher support for implementing new ideas may hinder successful knowledge maturation. Young people at risk of social exclusion may struggle with confidence, motivation, or external pressures that prevent them from fully engaging, thus preventing the intervention from being completed.

To conclude, the cases demonstrate that knowledge appropriation and innovation adoption has happened on an individual level and no wider, whole school adoption cannot be observed yet due to the short-term Educational Learning Lab period. However, these successful initiatives provide a good basis for further large-scale implementation and dissemination. In the cases, there is currently limited observable research on the effects of innovation implementation. This can also impede widespread adoption of interventions, in addition to limited knowledge formalization and standardization. Therefore, in future initiatives, greater emphasis might be placed on gathering evidence regarding the implementation of innovation and its impact on the intended target groups.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

TV: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. MÜ: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Writing – original draft, Writing – review & editing. KL: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Writing – original draft, Writing – review & editing. IB: Data curation, Formal analysis, Writing – original draft, Writing – review & editing. SD: Data curation, Formal analysis, Writing – review & editing. LK: Data curation, Formal analysis, Writing – review & editing. LV: Data curation, Formal analysis, Writing – review & editing. GG: Data curation, Formal analysis, Writing – review & editing. VT: Data curation, Formal analysis, Funding acquisition, Writing – review & editing.

Funding

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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