

The Co-Supervision Process in Pre-service Science, Technology, Engineering, and Mathematics Teacher Education: Development of a Flexible Model Adaptable to Different European Countries

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ABSTRACT

Integrated into the cross-border teacher education movement, a flexible model of co-supervision was developed and piloted involving 14 Science, Technology, Engineering, and Mathematics (STEM) teacher educators and 13 of their pre-service teachers from eight European countries, within the context of the Erasmus+ project “AcaSTEMy.” The study follows a qualitative and interpretative approach and presents the validation of the flexible model of co-supervision to understand not only its potentialities for pre-service teachers’ and teacher educators’ professional development, but also to discuss its degree of cross-national applicability. All participants answered an online questionnaire at the end of each co-supervision event, and one representative of the teacher educators of each country wrote a guided reflection. The findings highlight a central tension within this type of co-supervision process, having the potential to enhance both pre-service teachers’ learning, fostering critical reflection and promoting some skills development, and supervisor professional development, facilitating peer learning and professional networking. However, its success depends heavily on organizational structure, clarity of roles, and support for intercultural communication. In the end, the study presents some suggestions for the design of international co-supervision models in teacher education, so that co-supervision can promote both academic excellence and internationalization in higher education.

KEY WORDS: Co-supervision; higher education internationalization; pre-service teacher education

INTRODUCTION

Nowadays, cross-border teacher education is one of the major objectives of the European Higher Education sector. Cross-border teacher education refers to any form of teacher education that crosses national boundaries, either physically or virtually. It encompasses programs, policies, and practices designed to train (future) teachers across countries. This includes, among other things, international mobility programs and institutional partnerships, online and distance learning, curriculum and pedagogical transfer, as well as global education standards (Teacher Education for a Future in Flux, 2025).

The goal of cross-border teacher education is the formation of globally competent educators, who combine deep subject knowledge, effective teaching strategies, technological fluency, and strong interpersonal skills to

foster curiosity, problem-solving, and lifelong learning of pre-service teachers, while continually growing as professionals. Indeed, high-quality teacher training should take account of the challenges of a globalized world and prepare future teachers to face the increasingly diverse reality of schools. To prepare future teachers accordingly, learning environments must foster dialogue across borders, encouraging “curiosity, sensitivity, and appreciation for diverse worldviews, languages, and cultures” (Boix Mansilla and Schleicher, 2022, p. 8).

According to Kálmán et al. (2022), moving toward a cross-cultural approach means that mutual learning of different cultures and scientific traditions has been strengthened, and the international diversity of the curriculum has gained focus. Interdisciplinarity, intersectoral collaboration, internationalization, and efforts to improve the quality of thesis

supervision are key directions and strategies for innovating pre-service teachers' education across Europe. This has led to the proliferation of internationalized collaborative and joint post-graduations (de Rosa, 2010), which usually follow a joint or team supervision model (Guerin and Green, 2015).

The main objective of this paper is to develop and pilot a flexible model of co-supervision for pre-service Science, Technology, Engineering, and Mathematics (STEM) teachers' education involving supervisors from different countries, to answer the following research questions:

1. What are the main implications for pre-service teachers' development?
2. What are the main implications for teacher educators' professional development?
3. To what degree could the proposed model be applicable, and under which circumstances, across all countries?

RESEARCH AND REFLECTION AS KEY PROCESSES IN PRE-SERVICE TEACHER TRAINING

Today, in many countries, participation/involvement of pre-service teachers in research is an important requirement for completing an initial teacher training course. According to Tuyan (2023), over the last two decades, Action research for teachers has increasingly been recognized as an empowering professional development activity (Burns, 2010; Burns and Westmacott, 2018). Indeed, investigating and seeking to understand in depth the events that surround us is a powerful way of building knowledge (Ponte, 2008). Research presupposes reflection, in the sense of considering the various aspects of the issues, seeking to understand the origin of the problems and their meaning in the light of different perspectives, and also considering their implications for practice.

Some studies have indeed shown that involving future teachers in ongoing reflection on classroom experiences promotes their ability to mobilize the theoretical contributions necessary for understanding their own practice (Körkkö et al., 2016). According to the initial model proposed by Korthagen (1985), a systematic reflection is achieved by promoting a constant alternation between action and reflection, through a spiral model consisting of five phases: (i) Action; (ii) analyzing the action; (iii) identifying the essential aspects involved in the action; (iv) creating alternative models of action; (v) testing these new models, and so on, to involve future teachers in a continuous and progressive process of professional development (the ALACT model). Currently, this model has undergone some developments, particularly concerning understanding the nature of reflection that should be promoted in future teachers, namely, which levels or aspects should be addressed. According to Korthagen and Vasalos (2005), this should encompass the different aspects that are an integral part of the teaching profession, namely the

environment, behavior, skills, beliefs, professional identity, and the mission of being a teacher. These different layers, which together represent a model of levels of reflection (known as "The onion model", Korthagen, 2004), can be described as follows:

- The environment involves the whole school and classroom setting, the subject matter, the school culture with all its implicit and explicit norms, and so forth
- Behavior refers to what the teacher does, how he or she copes with the challenges in the school or classroom context
- Competencies involve what the teacher is competent at doing
- Beliefs refer to what the teacher believes about the situation she/he is dealing with
- Identity refers to teachers' assumptions about themselves, their self-concepts, and the professional roles they see for themselves
- Mission is concerned with what inspires each one, and what gives meaning and significance to our work as teachers.

In this model, the essential and deeper reflection level should involve these last two levels (identity and mission) and their relationship with the other levels considered. Indeed, in the center of the onion model, we locate the teacher's core qualities, such as enthusiasm, curiosity, courage, steadfastness, decisiveness, openness, flexibility, and so forth (Korthagen, 2014). The core reflection provides a means to integrate the multiple dimensions of our wholeness as humans and to bring the full power and potential of that wholeness to bear upon the experiences of teaching and learning (Korthagen et al., 2013). As such, the core reflection approach connects the personal and the professional in teaching.

A FRAMEWORK FOR THE CO-SUPERVISION PROCESS IN INITIAL TEACHERS' EDUCATION

Research supervision is a facilitative process requiring support and challenge. The research activity, although including and presupposing reflection, it is a process of a different nature, involving deliberate planning, the establishment of an objective at the outset, and the pursuit of methodical work to collect and analyze information with a view to achieving that objective (Ponte, 2008). It involves providing diverse educational tasks and activities, besides those directed to pre-service teacher development, as a person and a professional, such as progressing the candidature, mentoring, coaching the research project, and sponsoring student participation in academic practice (Pearson and Kayrooz, 2004). The way the supervision process is conducted varies among supervisors and/or the type of situation they are facing. Based on the work of Lee (2008; 2018) and Pearson and Kayrooz (2004), we could identify five different approaches that supervisors use and combine, depending on their preference, which could serve as a basis for

enabling critical reflection on supervisory practice in academic development programs:

Facilitating or the Functional Approach

The supervisor as facilitator provides guidance that enables the student to manage their candidature until its end, negotiating a program of study and research that is appropriate for the student. It includes ensuring that the student meets official requirements, such as ethics clearance and annual reports, and that progress is being made in a timely fashion. According to Lee (2008; 2018), this approach focuses on achieving objectives, emphasizes performativity, and offers the opportunity of measuring progress through project management tools, risk analysis, milestones, and record-keeping.

Sponsoring or the Enculturation Approach

The supervisor as sponsor assists the student in gaining the necessary access to resources and opportunities for their learning and research activity. This approach is mainly focused on inclusion, emphasizing being part of a group and offering a sense of belonging (to the cohort, the discipline, the culture).

Reflective Practice or the Relationship Development Approach

The supervisor, as a reflective practitioner, models openness to new ideas and encourages critical discussion on research practice, including their own, and the supervisory process. This approach is mainly focused on affective support, emphasizing friendship, wisdom in managing boundaries, agreeing on expectations, and preventing conflicts (Lee, 2008; 2018).

Expert Coaching or the Critical Thinking Approach

The supervisor, as an expert and coach, provides expertise on the research topic, research methodology, and in writing the thesis. Effective coaching includes assisting students to become aware of their own processes in problem-solving and to develop their professional repertoire and judgment as a research practitioner (Pearson and Kayrooz, 2007). According to Lee (2008; 2018), critical thinking is strongly promoted within this approach, based on intellectual rigor, offering the opportunity to think in new ways, and encouraging the ability to analyze and recognize flaws in arguments. Moreover, creates an environment that promotes a reflective stance.

Mentoring or the Emancipation Approach

The supervisor as mentor supports the student's development in the context of their evolving personal and career goals, and links them to appropriate research, academic, and professional networks. A mentor can offer both personal and professional support. In this type of model, which has a core value of enabling the student to become autonomous, the research is seen as "A personal journey of discovery, possibly leading to transformation" (Lee, 2008).

All these approaches could be operationalized through a set of actions performed by the supervisor (Table 1).

However, when considering a co-supervision process across different countries, some of the approaches identified may not

Table 1: Actions involved in supervision approaches (Pearson and Kayrooz, 2007)

Facilitating

- Negotiates a program of study and research
- Displays sensitivity to gender differences in interactions
- Directive when needed
- Negotiates explicit ground rules for supervision
- Ensures official requirements are met, e.g., Ethics clearance, annual reports
- Devotes sufficient time
- Promotes good interaction and learning among students and staff
- Listens with attention
- Respects the knowledge and expertise
- Approaches supervision flexibly
- Puts effort into a good start
- Provides information on availability
- Initiates contact
- Negotiates their availability

Sponsoring

- Assists in obtaining resources for seminars and conferences
- Assists in meeting administrative requirements in an efficient and timely manner
- Keeps informed about procedures and issues related to intellectual property rights
- Assists in accessing essential technical support
- Advises about resources and other funding sources

Reflective practice

- Models effective research practice
- Open to different research approaches
- Open to critical discussion on research practice
- Periodically reviews supervision
- Carries out supervisory duties professionally
- Encourages open/critical discussion on research practices

Expert coaching

- Challenges intellectually
- Assists in formulating a research topic
- Helps plan and refine the project
- Encourages the development/evaluation of one's own ideas
- Provides specialist/technical expertise
- Introduces the relevant current literature
- Encourages writing early
- Advises on problem framing+solving
- Advises on critical aspects of research
- Provides advice on the logistics for producing a thesis document

Mentoring

- Demonstrates genuine interest in well-being
- Approachable, responsive, and affirming
- Encourages publishing
- Directs to leading researchers
- Encourages networking within the university
- Introduces to professional networks
- Helps arrange for presentations at seminars and conferences
- Assists in progressing career goals
- Advises on opportunities for relevant experience

be involved in the process, as they are closely related to the institutions where the future teacher is pursuing their course,

such as the facilitating and sponsoring approaches, and/or require intense and continuous work over time, such as the reflective practice and the mentoring approaches. Hence, for the type of co-supervision involved in this project, only the expert coaching approach seems more reasonable when thinking of the supervisor's actions.

METHODS

The current exploratory study aimed to conceptualize and pilot a flexible model of co-supervision for pre-service STEM teachers' education that involves supervisors from different countries. The study follows a mixed quantitative and qualitative approach, which involved STEM teacher educators and their pre-service teachers from eight European countries to explore participants' experiences and the meanings they attribute to the phenomenon under investigation, to gain an in-depth understanding of participants' perspectives within their social and contextual settings (Creswell and Poth, 2018).

Context of the study

The study was developed within the Erasmus+ project "AcaSTEMy - Trans-national STEM teacher education focusing on transversal competences and sustainable education" (<https://www.acastemy.eu/>), which aims to create a sustained European partnership of STEM teacher education and training providers with a broad geographical coverage, as well as partnerships and networks of STEM teachers. The acaSTEMy consortium, consisting of academic institutions, practice schools, policymakers, out-of-school learning institutions and private sector representatives from eight countries, Estonia, Croatia, Finland, Germany, Hungary, Latvia, Portugal, and Turkey, targets university pre-service teachers, teachers, policymakers, as well as experts of various profiles in the science and science-related subject areas.

Flexible model of co-supervision implemented

The common general model proposed for the co-supervision process in each country, to be implemented by the project team, was the following:

Selection of the research topic and thesis

- The topics chosen by pre-service teachers in each country were collected in a table shared between partners and supervisors from other countries who have expertise in the chosen topic and volunteer to co-supervise the thesis
- The thesis should be defended in the home institution (in one's own language)
- The front cover of the thesis work only includes the name of the official supervisor from the home university; nevertheless, the joint supervision should be acknowledged in the thesis (if allowed by the University).

Tasks of the foreign co-supervisor

- Support in the literature research
- Support with research methods to investigate the given problem

- Participate in the discussion of the analysis process and of the results.

Implementation process

- Co-supervision will be provided via online meetings between:
 - supervisors and pre-service teachers
- Proposed meeting schedule adopted as the basis for organizing the co-supervision process:
 - First meeting: The pre-service teacher presents his/her topic, research objective and/or research problem (and research questions) and the respective research design (participants, data collecting instruments,...) – both supervisors analyze and discuss the research plan, suggesting relevant literature and methods to investigate the given problem to help pre-service teachers to refine and develop the plan of the project (in particular relating with the methods for collecting data)
 - Second meeting: The pre-service teacher presents the obtained data and the first ideas for analysis – both supervisors give suggestions and help him/her in the analysis and discussion of the results (in particular relating to its implications for answering the research problem and for the topics currently under research)

The visualization of the suggested model is presented in Figure 1.

The number of meetings is not fixed. The proposed model has to be done in the framework of the already existing national supervision models (see section 4.4).

Considering the co-supervision processes implemented:

- Most co-supervision processes involved two meetings (sometimes only one) (Table 2).
- The meetings typically followed this sequence:
 - First meeting: Discussion of research questions, instruments, or early design
 - Second meeting: Discussion of results, interpretation, and/or preparation for the public presentation of the thesis
- The majority of the cases began only after starting data collection or near completion of the thesis.

In general, the purpose of the first meeting was to provide feedback on the data collection process and results, and the purpose of the second meeting was to prepare for the public defense of the pre-service teachers' work.

Participants

A total of 13 co-supervision processes were analyzed, which involved 13 pre-service teachers from the eight participating countries. Some of the processes had more than one co-supervisor (Table 2).

A total of 14 teacher educators, from the eight countries involved in the project, participated in this process, both as supervisors and/or co-supervisors (three from Portugal; two

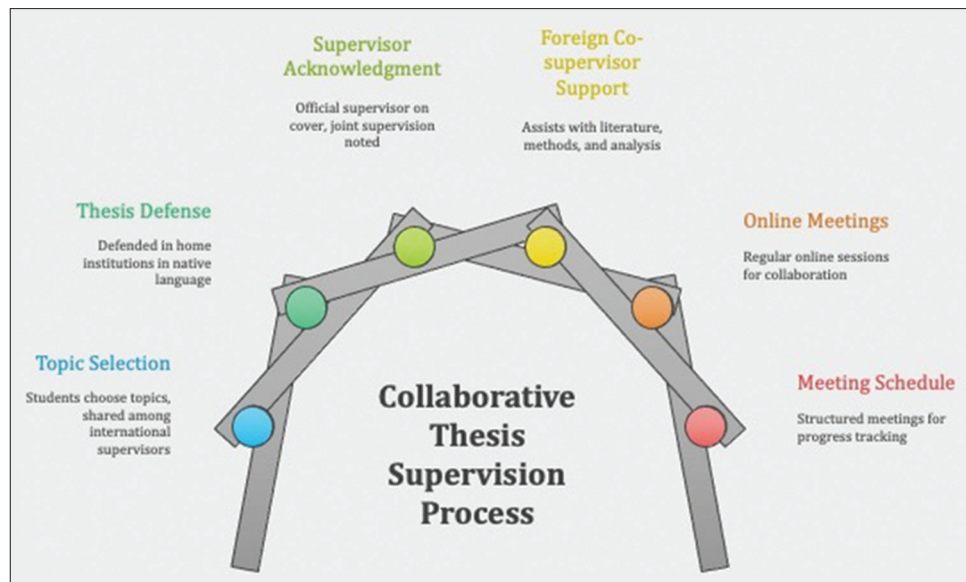


Figure 1: Visualization of the flexible model of co-supervision

Table 2: Overview of co-supervision processes

Nationality			Number of meetings
Supervisor	Co-supervisor	Pre-service teacher	
Portugal	Hungary	Portugal	2
Portugal	Hungary	Portugal	2
Hungary	Portugal	Hungary	2
Turkey	Portugal	Turkey	1
Portugal	Estonia	Portugal	2
Hungary	Turkey	Hungary	2
Portugal	Croatia and Germany	Portugal	2
Hungary	Latvia	Hungary	1
Croatia	Turkey and Estonia	Croatia	2
Croatia	Turkey and Estonia	Croatia	2
Germany	Portugal and Turkey	Germany	2
Germany	Portugal and Turkey	Germany	2
Germany	Finland	Germany	2

from Estonia, Hungary, Germany, and Turkey; and one from Croatia, Finland, and Latvia).

All STEM teacher educators held a PhD in Education or a related area. All have extensive expertise in Master's and PhD students' supervision, being involved in STEM teachers' education for more than 10 years (in some cases, more than 20 years).

Overview of the Master's Thesis Development across the Different Partners

The context for doing the Master's Thesis in the different countries involved is very similar (Figure 2). Indeed, the research practices are integrated into initial teacher training in similar ways. In general, future STEM teachers are required to carry out a small research project or action research about a particular topic, chosen together with the supervisor (except in Estonia, in which the topic is given by the supervisor), to be implemented in the school. The topics are varied and may

be more focused on learning aspects related to teaching a given subject, acquiring cross-curricular research skills, or the integrated development of the future teacher's identity. In all countries involved, Master's students are expected to read peer-reviewed research papers for the literature review. For data collection, they are expected to develop a valid instrument suitable for solving the research problem, and for data analysis, they are expected to demonstrate competence in quantitative and/or qualitative research methods.

Data Collection

The validation of the flexible model follows the idea of obtaining and analyzing complementary perspectives, using two data sources (questionnaires, with closed and open questions, for pre-service teachers and educators, and written reflections, in the case of the educators) from all participants of each supervision process (supervisors, co-supervisors and pre-service teachers).

Instrument 1: Questionnaire

For systematic validation of the model of co-supervision developed and implemented, at the end of each co-supervision event, each participant (supervisor, co-supervisor, and pre-service teacher, if present) answered an online questionnaire, with both closed and open questions (Appendix 1). The questionnaire includes three parts. The first one allows the identification (role and country) of the respondent; the second section is dedicated to the description of the co-supervision process (number of meetings, dates), and the third one focuses on the potentialities and limitations of the co-supervision process. The objective was to understand how the model was implemented, its main added values and limitations, from each perspective, and how it could be improved (open questions).

In addition, each participant had to rate, on a scale of 1 – 6 (1= Not at all to 6= A lot), the contribution of the co-supervision process to the following aspects:

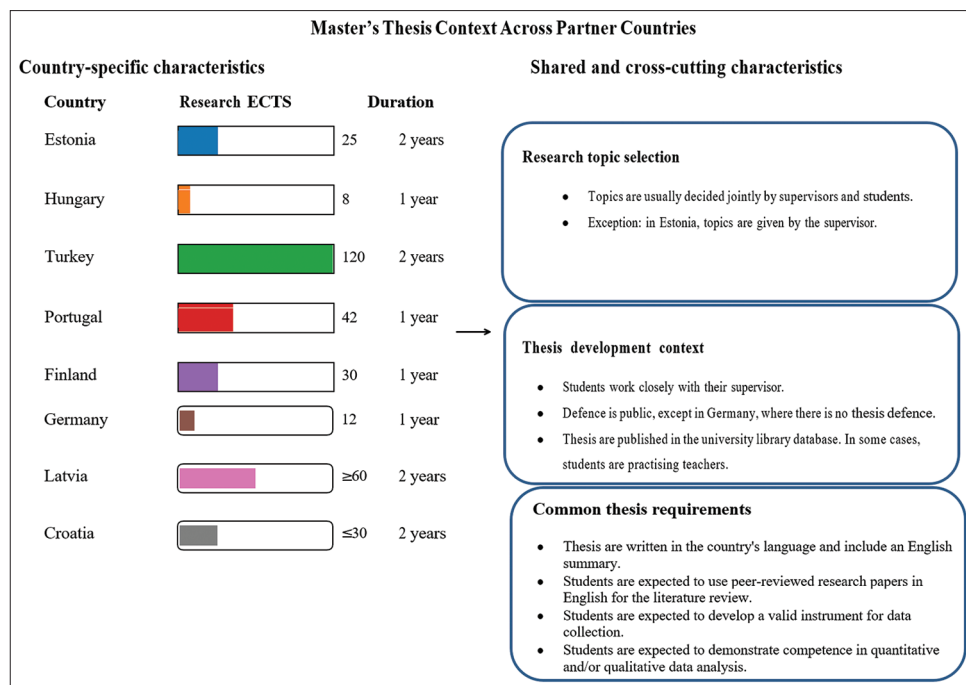


Figure 2: Master's thesis context in the different partner countries. The figure distinguishes country-specific variation in research ECTS and duration from shared thesis development contexts and requirements.

- To read the relevant current literature
- To compose the research question
- To design the project and refine the methods used
- To evaluate the results and draw conclusions
- To provide methodological and technical expertise
- To advise on identifying and solving problems
- To advise on critical aspects of research
- In terms of intellectual challenge
- To encourage the development and evaluation of original ideas

Instrument 2: Written reflection

Finally, each (co)-supervisor (one per country) answered a guided written reflection (Appendix 2) in order to deeply understand the potentialities and difficulties of the co-supervision flexible model implemented, not only for pre-service teachers, but also for their educators. This reflection was guided by the following topics (interconnected with the three research questions): Potentialities for pre-service teachers' development as researchers (taking into consideration the diversity of perspectives, i.e., *disciplinary, methodological, cultural, or institutional*); Implications for teacher educators' professional development (taking into consideration the diversity of perspectives, i.e., *disciplinary, methodological, cultural, or institutional*); and global appreciation of the process, considering the main challenges, influence of the international dimension and suggestions for change for international implementation.

Data Analysis

For the analysis of the questionnaire, a statistical descriptive analysis was made for the closed-ended questions, considering

the different roles of the respondent (supervisor, co-supervisor and pre-service teacher). Some participants (supervisors and co-supervisors) completed the questionnaire on more than one occasion because they participated in multiple co-supervision processes. Descriptive statistics are therefore presented at the level of the participants' role, rather than the participant level.

To analyze the open-ended questions of the questionnaire and of the written reflection, a mixed content analysis method was used (Sherman and Webb, 2004). The initial categories were based on the initial questions, which overlap between both data collection instruments, but through an iterative process of reading and rereading the responses, these were further explored and deepened, with new categories emerging from the analysis itself, according to the different meanings present (Tables 3-6).

To analyze and discuss all this data, and considering that we are dealing with pre-service teachers, who are in the process of creating and developing their own identity as education professionals, we developed a tentative model of interrelating the actions in the supervision approach (Table 1), related with their development as a researcher, with its potential to act at the different levels of reflection considered important for their development as educators, according to the Korthagen's Onion model, namely the environment, behavior, skills, beliefs, professional identity and the mission of being a teacher. This intersection, presented in Table 7, may contribute to a deeper understanding of how one's identity as a researcher and one's identity as a teacher could be developed simultaneously through the co-supervision process. This interconnected framework will be the basis

Table 3: Added values of the co-supervision process for pre-service teachers' development (Questionnaire analysis)

Role	Category	Sub-category	Description	Freq.
Supervisor	Research development	Research design	Discussing/interpretation of results; Refining ideas; literature suggestions; structuring work	12
		Objective analysis	Outside perspective; independent evaluation	3
Co-supervisor	Personal development	Support and Guidance	Motivation; guidance for advanced research skills	3
	Research development	Research design	Providing complementary expertise; advice on research methods	9
		Objective analysis	Critical feedback	9
Pre-service teacher	Research development	Skills Development	Improved presentation; analytical precision	6
		Objective analysis	Seeing work from another perspective; reflection promotion	5
	Personal development	Support and Guidance	Specialized support; continuous feedback	3

Table 4: Added values of the co-supervision process for pre-service teachers' development (Reflection analysis)

Subcategory	Description	Illustrative excerpts
Methodological rigor	Strengthening research design and methodological quality through multiple perspectives	<i>"Improved methodological rigour"</i> (F, P); <i>"More rigorous refinement of the research framework"</i> (T, E); <i>"Helped to structure their work"</i> (G)
Theoretical broadening	Exposure to diverse disciplinary and theoretical approaches	<i>"Broader theoretical perspective"</i> (F, C, L); <i>"offered several perspectives"</i> (G, P); <i>"Evaluate... through multiple lenses"</i> (T); <i>"The research topic was further elaborated through discussions, and interdisciplinary aspects were explored from different viewpoints"</i> (E, L)
Critical thinking	Development of analytical and reflexive thinking	<i>"Critical questions... improved the reasoning"</i> (G); <i>"Challenged students' assumptions"</i> (T)
Academic communication (English)	Improved ability to present and discuss research in English	<i>"Discuss their plans... in English"</i> (H); <i>"Greater confidence... especially in English"</i> (F)
Confidence and presentation skills	Increased confidence in presenting and defending research Language anxiety affects participation and engagement	<i>"practice giving professional presentations"</i> (H); <i>"greater confidence as researchers"</i> (F, P) <i>"Students struggled... in English"</i> (G); <i>"Hesitance to speak English"</i> (F)

Each excerpt is identified by the first letter of the educators' country in brackets

Table 5: Added values of the co-supervision process for educators' professional development (Reflection analysis)

Subcategory	Description	Illustrative excerpts
Intercultural awareness	Increased understanding of different academic cultures and systems	<i>"Supervisory expectations differ across countries"</i> (F, P); <i>"Navigate different academic cultures"</i> (T); <i>"compare curricula"</i> (H); <i>"This broadened my understanding of international academic standards"</i> (E)
Reflective practice	Reflection and improvement of supervisory strategies	<i>"Influenced how I plan my meetings"</i> (F); <i>"Took the practice into other supervision cases"</i> (G); <i>has fueled my ongoing search for forms of supervision that are better suited to the diversity of the students</i> (P); <i>"Useful insights into alternative supervisory approaches and practices"</i> (E)
Peer learning and networking	Learning from colleagues and expanding professional networks	<i>"Seen examples of how colleagues... treat students"</i> (H); <i>"Expanded my professional network"</i> (T)

Each excerpt is identified by the first letter of the educators' country in brackets

Table 6: Limitations of the co-supervision process (Questionnaire analysis)

Role	Category	Description	Freq.
Supervisor	Process	Meetings occurred late in thesis process; time constraints; few meetings	7
	Logistics	University regulations; formal limitations; limited freedom	5
	Language	Limited writing help due to language	2
Co-supervisor	Process	Co-supervision started too late; results-focused; scheduling difficulties; online format; reduced interaction	13
	Language	Language barriers for in-depth discussion	3
Pre-service teachers	Process	Meetings occurred late in process; aligning supervisors' feedback and schedules	7
	Language	Difficulty understanding feedback in English	1

Table 7: Interrelation between Korthagen's Onion model for teacher development and supervisor actions included in the Expert coaching dimension

Supervision dimension	Reflection levels	Supervisor actions
Expert coaching	Environment	• Provides advice on the logistics for producing a thesis document
	Behavior	• Assists in formulating a research topic
		• Helps plan and refine the project
		• Introduces the relevant current literature
		• Encourages writing early
	Competency	• Provides specialist/technical expertise
		• Advises on problem framing and solving
		• Advises on critical aspects of research
	Belief	• Assists students to become aware of their own processes in problem solving
	Identity	• Challenges intellectually
		• Encourages the development/evaluation of own ideas
	Mission	• Develop their professional repertoire and judgement as a research practitioner

for the analysis of the proposed co-supervision model implemented in this study.

Ethical considerations

The researchers involved in this study had a dual role as designers, implementers, and evaluators of the proposed model. We acknowledge that this positioning may have introduced a risk of confirmation bias in the interpretation of the findings. To mitigate this risk, several strategies were adopted throughout the study. Data were collected using multiple sources (e.g., questionnaires and written reflection), from closely related participants, allowing for complementary perspectives. Participants' perspectives were prioritized in the reporting of the findings by incorporating direct quotations and evidence from different data sources. Throughout the research process, the team engaged in ongoing reflexive discussions to critically examine assumptions, decisions, and potential sources of bias. While these strategies cannot eliminate researcher bias, they were intended to enhance the credibility, transparency, and trustworthiness of the study. Besides, the majority of the pre-service teachers only answered the questionnaire after they completed their degree, so they did not feel the pressure to evaluate the process positively.

RESULTS

The analysis of the data is organized according to three main sections, interrelated with the three research questions of the study. All the excerpts are identified by the first letter of the educators' country (in brackets).

Potentialities for Pre-service Teachers' Development

Considering the rating attributed to each potential contribution of the co-supervision process to the research conducted (Table 8), according to all participants (supervisors, co-supervisors, and pre-service teachers), this process seems to have contributed mainly to orienting the reading of the current literature, to give methodological expertise, supporting data analysis (results and conclusion), and to provide advice related to the research methodology (critical aspects). Moreover,

it seemed to have contributed also in terms of promoting intellectual challenge and the development and evaluation of original ideas.

These results are in accordance with the analysis of the open-ended question related to the potentialities of this process (Table 3). Indeed, the main potentialities highlighted by the participants, according to their own roles, related to the research project development, pre-service teachers' skills development, and motivation.

Across all perspectives (supervisor, co-supervisor, and pre-service teacher), the co-supervision process provided benefits for pre-service teachers (Table 3), such as:

- Critical reflection: External perspectives helped pre-service teachers to view the research more objectively and identify overlooked aspects
- Skills development: Pre-service teachers highlighted improvements in academic writing, research design, critical analysis, and presentation skills
- Intellectual challenge and support: Pre-service teachers emphasized the opportunity to broaden perspectives on the project, in a supportive way.

The written reflection allowed them to deepen this analysis (Table 4), revealing a strong consensus among educators that this type of co-supervision process significantly enhances pre-service teachers' development as researchers, particularly in terms of methodological rigor, theoretical breadth, and critical thinking. Across responses, pre-service teachers were described as benefiting from exposure to multiple academic perspectives, which contributed to the refinement of research design and the strengthening of analytical reasoning. These findings suggest that the multiplicity of perspectives inherent in co-supervision acts as a mechanism for quality enhancement.

Another prominent aspect concerns the development of academic communication skills, particularly in English. However, the use of English was identified as both a key benefit and a challenge. On the one hand, pre-service teachers

Table 8: Rating of the contribution of the co-supervision process to each aspect considered (Total answers=41; pre-service teachers=13; educators=14) (1=not at all; 6=A lot). Note: each researcher can supervise or co-supervise more than one research project (Questionnaire analysis)

Descriptive statistics	Relevant literature	Research question	Project design	Results and Conclusions	Methodological expertise	Problems' identification	Critical aspects	Intellectual challenge	Original ideas
All Participants									
Median	5	4	4	5	5	4	5	5	5
Min-Max	1-6	1-6	1-6	1-6	1-6	1-6	2-6	2-6	2-6
Educators									
Median	4	4	4	5	5	4	5	5	5
Min-Max	1-6	1-6	1-6	1-6	1-6	1-6	1-6	2-6	2-6
Pre-service teachers									
Median	5	3	5	5	5	5	5	5	5
Min-Max	2-6	1-5	2-6	2-6	2-6	3-6	2-6	3-6	4-6

gained confidence in presenting and discussing their work in an international academic language. On the other hand, language barriers and anxiety were recurrent limitations, sometimes “*affecting participation*” (F) or “*slowing down discussions*” (G).

In addition to methodological gains, all participants highlighted the importance of interdisciplinary and cross-cultural exposure in broadening pre-service teachers' theoretical understanding. Engaging with different research traditions and disciplinary viewpoints encouraged pre-service teachers to “*evaluate scholarly work through multiple lenses*” (T), fostering a more nuanced and reflexive approach to research in general, and to supervision experiences in particular.

As a result, and according to all participants, the co-supervision process contributed to pre-service teachers' socialization into the scientific community. Participants described how pre-service teachers developed an understanding of academic collaboration, dialogue, and feedback processes, ultimately fostering a “*global scholarly identity*” (T) or promoting an “*experience in scientific dialogue*” (G). This seems to illustrate the development of a global researcher identity and academic socialization; in other words, the promotion of the pre-service teachers' scientific identity.

Potentialities for Teacher Educators' Professional Development

The analysis of the questionnaire's open questions also highlighted some potentialities that this process can have for the teachers' educators, such as intellectual enrichment, through the exchange of ideas, diverse perspectives, and international comparisons (teaching approaches, methodologies, evaluation strategies) (10 mentions) and professional opportunities, since the collaboration could open possibilities for joint data collection, comparative studies, or future publications (three mentions).

The analysis of the written reflection revealed that participation in the co-supervision process across countries also had significant implications for supervisors' professional development (Table 5). A central finding is the increased

awareness of diverse academic cultures and supervisory practices. Participants reported gaining insights into how expectations, communication styles, and pedagogical approaches vary across countries, contributing to a more nuanced understanding of supervision. For instance, one participant highlighted a deeper awareness of “*how supervisory expectations differ across countries*” (F), whereas another emphasized the development of intercultural communication skills and the ability to “*navigate different academic cultures*” (T). This exposure prompted critical reflection on participants' own supervisory practices.

The process also facilitated peer learning and professional networking. Interaction with international colleagues allowed participants to exchange practices, compare curricula, and benchmark their work against other institutional contexts. These exchanges were seen as valuable for maintaining high academic standards and fostering innovation in teacher training and supervision.

Limitations of the Developed Model and Suggestions for Its Improvement

Considering the limitations of this process, all participants emphasized constraints related to the process (in particular, time constraints) and language barriers, making it harder to fully absorb and act on feedback (Table 6).

These limitations were also highlighted in the written reflections by all participant educators. Indeed, aligning expectations and responsibilities among supervisors proved complex, requiring negotiation and, at times, professional diplomacy. Intercultural communication, while enriching, also introduced a degree of caution that could limit spontaneity in discussions. In addition, as noted by the German team, the presence of multiple supervisors could generate some confusion or pressure for pre-service teachers, particularly when faced with differing or seemingly conflicting guidance. In some cases, pre-service teachers perceived co-supervision as an evaluative rather than supportive process, highlighting the importance of clearly communicating its formative purpose.

Considering the suggestions for improving this process, all participants suggested that the process should start earlier (at the beginning of the research design), and some suggested helping to structure the interaction with pre-service teachers, like providing written feedback alongside the oral feedback, to facilitate communication, and the use of shared digital workspaces for exchanging documents and helping to prepare the sessions (Table 9).

Moreover, in the written reflections, some educators suggested the need to establish clear supervisory agreements to define roles and expectations, and the possibility of creating opportunities for informal interaction, such as initial “get-to-know” sessions, was suggested as a way to reduce pre-service teachers' anxiety and foster a more supportive environment.

Taken together, the findings highlight a central tension within this type of co-supervision process. On the one hand, the diversity of perspectives generates substantial epistemic and pedagogical benefits, enhancing both pre-service teachers' learning and supervisor development. On the other hand, this same diversity introduces challenges related to coordination, communication, and alignment. Despite these limitations, the overall evidence suggests that the benefits of co-supervision outweigh its challenges, particularly when supported by clear structures and effective communication strategies. The process can therefore be understood as a potentially impactful educational practice that, when well-organized, promotes both academic excellence and internationalization in higher education.

DISCUSSION

The findings suggest that, despite practical and communication barriers that limited the continuity and depth of the process, all participants (supervisor, co-supervisor, and pre-service teachers) perceived co-supervision as an enriching experience, since it provided benefits for both pre-service teachers and supervisors.

What are the Main Implications for Pre-service Teachers' Development?

For pre-service teachers, the main contribution of the co-supervision process appeared to be related to the development of research behavior, research competencies, academic confidence, and emerging professional identity.

Indeed, the co-supervision process was particularly relevant in supporting pre-service teachers' engagement with their research projects. This support included fostering critical reflection, helping pre-service teachers refine their research focus, suggesting relevant literature, and encouraging the development of academic skills such as academic writing, critical analysis, and presentation skills. These findings are consistent with recent work on academic supervision, which emphasizes that thesis supervision is not only a technical process of guiding a written product, but also a pedagogical space in which pre-service teachers develop autonomy,

Table 9: Suggestions for the co-supervision process (questionnaire analysis)

Role	Category	Subcategory	Freq.
Supervisor	Process	Start earlier; pre-meeting preparation	8
	Interaction	Stronger exchange; personal connection	1
Co-supervisor	Process	Start earlier; shared digital workspace	6
	Interaction	More structured; face-to-face or hybrid meetings; written feedback	7
Pre-service teachers	Process	Earlier inclusion, more frequent meetings	2

judgment, critical thinking, and independence as researchers (Zackariasson and Magnusson, 2024).

A particularly distinctive aspect of the process was the opportunity for master's students, as pre-service teachers, to present their research and preliminary findings in English to an international expert. This created a low-risk but intellectually demanding context in which pre-service teachers could explain, defend, and rethink their research. Recent literature on virtual exchange and internationalization in teacher education similarly highlights the value of international encounters for developing intercultural, linguistic, digital-pedagogical, and professional competences among pre-service teachers (Ingrisch-Rupp and Symeonidis, 2025; Brück-Hübner et al., 2024).

The findings also indicate that co-supervision may contribute to deeper dimensions of pre-service teachers' development. Drawing on Korthagen's Onion Model (2004; 2014), the process clearly supported development at the level of competencies, but it also showed potential to influence pre-service teachers' beliefs and professional identity. By intellectually challenging pre-service teachers and exposing them to alternative ways of thinking, the co-supervisor helped them reflect not only on the quality of their research, but also on their emerging identity as researchers and future teachers.

This interpretation is supported by recent work using the Onion Model, which argues that teacher professional learning involves interactions between environment, behavior, competencies, beliefs, identity, and mission rather than isolated skill acquisition (Li, 2024). Besides, this emphasis on critical reflection, acting at the more superficial reflection levels, like research behavior and competency dimensions, would be expected, since critical thinking implies a “researcher absent” process (Brew, 2001; Pearson and Brew, 2002), and that is exactly the lens of the foreign supervisor, who could act as an external specialist, assuming what Jackson (2001) named as a “Gentle Socratic Inquiry,” in which the supervisor assumes a position of co-operative inquiry and accepts that there is no right answer.

However, the potential for acting also at the identity level – an essential and deeper reflection level for the pre-service teacher professional – through intellectual challenge, promoting openness to new visions and perspectives on their own work,

and for evaluating it, is an important aspect to be considered when thinking about the type of supervision model we want. Indeed, and considering Korthagen's Onion Model (2004, 2014), while all participants reported gains at the levels of skills competencies, the extent to which deeper levels – beliefs, identity, and mission – were activated varied., i.e., its transformative potential, particularly regarding deeper levels of the participants development, such as beliefs, professional identity, and sense of mission of the future teachers, is contingent on specific circumstances. Hence, the findings suggest that co-supervision has the potential to support this deeper development, particularly by challenging pre-service teachers' assumptions and exposing them to alternative ways of thinking, but such a transformation is not automatic (Körkkö et al., 2016).

In summary, the co-supervision process can support both research competence and professional identity formation. However, its strongest effects were observed at the level of research skills, critical reflection, academic communication, and openness to external perspectives, whereas its deeper transformative potential depends on the quality, continuity, and intensity of the interaction.

What are the Main Implications for Teacher Educators' Professional Development?

The findings also show that co-supervision has important implications for teacher educators' professional development. Although the process was mainly designed to support pre-service teachers, it also became a meaningful professional learning opportunity for supervisors and co-supervisors.

At the supervisor level, co-supervision encouraged the exchange of ideas, research perspectives, teaching approaches, and evaluation strategies. The interaction with a colleague from another country created opportunities for professional dialogue and reflection on supervision practices. This is relevant because recent research argues that supervision itself is a form of professional practice that supervisors continue to learn through experience, peer interaction, institutional contexts, and exposure to different supervisory models (Jacobsen et al., 2024).

One of the most relevant implications is the potential contribution of co-supervision to the development of international communities of practice among teacher educators. Through shared supervision, participants were able to compare academic expectations, discuss research approaches, and reflect on different educational traditions. This type of interaction can broaden teacher educators' perspectives and promote more internationally informed approaches to teacher education. Recent studies on teacher educators' communities of practice show that collegial, supportive spaces can foster professional learning through critical reflection and can influence teacher educators' identity, pedagogy, and well-being (Leahy et al., 2025).

The process also opened possibilities for future collaboration, including joint data collection, comparative studies, and

co-authored publications. These outcomes suggest that co-supervision can act as a starting point for more sustained academic partnerships. All these added values highlighted the major potential of the co-supervision process for promoting collaborative work across different countries, thus positioning itself as a process capable of contributing to the development of a sustainable international framework for the professional development of teachers and teacher educators' careers (Boix Mansilla and Schleicher, 2022)

To What Degree Could the Proposed Model be Applicable, and Under Which Circumstances, Across All Countries?

Overall, this co-supervision process emerges as a potentially impactful practice that strengthens both pre-service teacher research competence and supervisor professional learning, but its success depends heavily on organizational structure, clarity of roles, and support for intercultural communication. The core tension identified is its high epistemic value (diversity of practices, research rigor, and internationalization) versus its high coordination complexity (time constraints, communication difficulties, and alignment expectations).

The findings suggest that the co-supervision model has strong potential for wider application across countries, particularly in the context of international teacher education. Its value lies in its capacity to promote research quality, internationalization, intercultural dialogue, and professional collaboration. However, its applicability is not automatic and depends on several important conditions.

The model appears especially applicable when there is a clear structure supporting the process. This includes well-defined roles for the supervisor and co-supervisor, shared expectations regarding the purpose of the interaction, and clear communication with pre-service teachers about what the co-supervisor can contribute. Recent research on collaborative and cohort-based supervision similarly shows that supervision models beyond the traditional one-to-one format can promote engagement, collaborative scholarship, reduced isolation, and academic identity formation, but only when they are supported by thoughtful design, structured facilitation, role clarity, and institutional readiness (Byrne et al., 2026).

Time and coordination are also central conditions for applicability. The findings revealed a tension between the high epistemic value of co-supervision and its high coordination complexity. On the one hand, the model offers important benefits, including exposure to diverse academic perspectives, increased research rigor, and internationalization. On the other hand, it requires careful coordination across calendars, languages, institutional expectations, and supervisory cultures.

Intercultural communication is another key condition. Since the model involves supervisors and pre-service teachers from different national and academic contexts, participants need support in managing linguistic, cultural, and disciplinary differences. The use of English as a shared academic language can be beneficial, but it may also create challenges, especially

for pre-service teachers who are less confident in presenting and discussing their research in English. The model is therefore more likely to succeed when communication is intentionally supported and when the interaction takes place in a respectful, dialogic, and low-pressure environment.

Across all countries represented, participants consistently reported similar benefits, including enhanced methodological rigor, broader theoretical understanding and promotion of critical thinking. These convergences suggest that the model addresses core dimensions of researcher and teacher development that are not context-specific and emphasize the notion of supervision as a dialogic and socially constructed process, rather than a unidirectional transmission of knowledge.

However, the co-supervision process can actually be considered applicable across countries to a significant degree, but only under certain conditions. These include organizational support, role clarity, time allocation, intercultural sensitivity, linguistic support, technological infrastructure, and shared commitment among supervisors, co-supervisors, and pre-service teachers. Its transformative potential depends not simply on the presence of an international co-supervisor, but on the quality and structure of the collaborative process.

CONCLUSION

Overall, the co-supervision process emerges as a potentially impactful practice. It strengthens pre-service teachers' research development, supports the professional learning of teacher educators, and creates opportunities for international collaboration in teacher education. Its main value lies in the combination of research support, critical reflection, intercultural exchange, and professional dialogue.

At the same time, the findings reveal a central tension: The model has high epistemic value but also high coordination complexity. It can enrich research quality, broaden perspectives, and foster internationalization, but it requires time, communication, institutional support, and clear alignment of expectations.

Thus, co-supervision should be understood not simply as an additional supervisory arrangement, but as a structured pedagogical and professional development model. When carefully designed, it has the potential to support pre-service teachers' development as researchers and future teachers, while also contributing to the creation of sustainable international communities of practice among teacher educators.

Recommendations for the Refinement of the Model for Co-supervision

To strengthen the potentialities of the model for co-supervision proposed, so that co-supervision can move beyond the development of isolated skills to support the formation of reflective, research-informed, and globally oriented education professionals, the following recommendations should be considered:

- Pedagogical design matters: Co-supervision should be intentionally structured to include multiple stages (design, analysis, and presentation) and opportunities for reflection
- Support intercultural and linguistic competence: Language support and intercultural preparation are essential to ensure meaningful participation
- Enhance coordination mechanisms: Clear agreements, shared materials, and regular communication can reduce ambiguity and improve alignment.

As a final suggestion, as a way to empower the co-supervision as a process capable of supporting the promoting of collaborative work across different countries, and to contribute to the development of a community of practice between teachers' educators across Europe, it would be important to create an online platform, supported by the European Union, where teachers, teachers' educators and pre-service teachers, working on similar topics, could find one another and discuss their problems and achievements in a safe and friendly environment.

Limitations

One limitation of this study concerns the relatively small number of participants involved, including both supervisors and pre-service teachers. The number of pre-service teachers available in the various countries also limited the trials. Although the data collected provided valuable insights into the co-supervision experiences examined, the limited sample size restricts the diversity of perspectives and experiences represented in the study. Consequently, the findings should be interpreted with caution, as they may not fully capture the variability that could emerge in larger or more heterogeneous groups. Besides, overall, the degree of involvement of the co-supervisor differed across the diverse supervisions. These differences could have influenced the participants' experiences differently, and it would be interesting to address them in the analysis. However, it was impossible, given the data collection tools used, to record these differences in a way that would allow them to be used in the analysis. In a future study, it would be interesting to develop a data collection tool that is sensitive to these differences.

Moreover, the validation of the co-supervision model was limited by the lifetime of the project and had to be done in the framework of the already existing national models. As a result, the number and duration of the co-supervision processes investigated, as well as the participating countries and individuals, reflect relatively specific contexts. The findings indicate that the depth and effectiveness of implementation vary depending on contextual and structural conditions, suggesting that different institutional settings, cultural environments, or participant profiles might have led to somewhat different conclusions.

Finally, and precisely because of the constraints of each contextual and structural condition, it was only possible to implement the meetings between the supervisor/co-supervisor and pre-service teachers very late in the process; data collection had already started, contrary to what was envisaged in the

proposed model. However, we believe that this constraint, although it constitutes a limitation in terms of the piloting of the proposed model, ultimately lends greater weight to the results obtained, since even though the co-supervision process did not encompass the initial phases of the research, involving only the analysis and conclusions phase, it proved to have a range of potential benefits for the professional development of future teachers and teacher educators.

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APPENDIX

Appendix 1: Co-supervision Questionnaire

Metadata: (for all participants)

- What was your role: supervisor/co-supervisor/student
- First and last name (In case of student: Initials of your first and last name together):
- Your country: (Croatia, Estonia, Finland, Germany, Hungary, Latvia, Portugal, Turkey)

Co-supervision process

- Brief description of the co-supervision process implemented: (for all participants)
- Date(s) of the meeting(s) (if applicable): (only for supervisor)
- Evidence of the meeting(s): (only for supervisor)

PowerPoint (or other presentation slides)/photograph/voice recording/video recording/other: (only for supervisor)

Co-supervision reflection (for all participants)

Please rate each item on a scale of 1–6, where 1= Not at all, 6= A lot

1. In your opinion, the co-supervision process contributed to:	1	2	3	4	5	6	Not applicable
1.1. Read the relevant current literature							
1.2. Compose the research question							
1.3. Design the project and refine the methods used							
1.4. Evaluate the results and draw conclusions							

Please rate each item on a scale of 1 - 6, where 1 = Not useful at all, 6 = Very much useful

2. In your opinion, the added value of learning about other perspectives on ... was	1	2	3	4	5	6	Not applicable
2.1. Providing methodological and technical expertise							
2.2. Advising on identifying and solving problems							
2.3. Advising on critical aspects of research							
2.4. In terms of intellectual challenge							
2.5. Encouraging the development and evaluation of original ideas							

2. In your opinion, what were the added values of the implemented co-supervision process? (in two or three sentences)
3. In your opinion, what were the limitations of the implemented co-supervision process? (in two or three sentences)
4. If you have any suggestions to improve the co-supervision process, please write it here:

Appendix 2: Guidelines for a written Reflection about the Co-supervision Process (for Supervisors and Co-supervisors)

1. How would you describe your overall experience with the co-supervision process? If you had to sum up this experience in one sentence, what would it be?
2. Considering its potential for the student's development as a researcher,
 - a. How did the diversity of perspectives (disciplinary, methodological, cultural, or institutional) contribute to the student's academic development?
 - b. At what points was co-supervision particularly beneficial to the progress of the student's work?
 - c. Do you think it was beneficial for students to become more familiar with different academic cultures? In what way?
 - d. What difficulties did you encounter with students as a result of co-supervision?
3. Considering your role as a supervisor or co-supervisor,
 - a. How did the diversity of perspectives (disciplinary, methodological, cultural, or institutional) contribute to your professional development?
 - b. To what extent did interaction with supervisors from other countries influence your supervisory practice?
 - c. Do you think this experience changed your view of supervising master's theses? Why?
 - d. What were the main challenges in coordinating with other supervisors?
4. Review of the co-supervision process as a whole
 - a. What specific challenges arose when working with supervisors or students from other countries?
 - b. Do you think the international dimension added scientific and pedagogical value to the process? To what extent?
 - c. What recommendations would you make to improve future international co-supervision processes?
 - d. If you could redesign this process, what would you keep and what would you change?