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ΙΔΡΥΜΑ ΚΡΑΤΙΚΩΝ ΥΠΟΤΡΟΦΙΩΝ IKY

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CONTENTS

EXECUTIVE SUMMARY

The FERTILE consortium conducted educators' profiling to lay the groundwork for a design methodology for Artful ER projects that cultivate computational thinking in a blended learning context. The scope of this profiling was to explore the experiences of educators originating from the four countries participating in the FERTILE Project.

Since the FERTILE methodology aims to be usable and to embrace the educational needs of educators, we considered it necessary to collect and analyse educators' perspectives on the challenges they have faced, the benefits they see, their needs and suggestions. To this end, the consortium has produced this report, which contains the process and results of the educators profiling study in the four countries participating in the FERTILE Project, Greece, Spain, Checz Republic and Slovakia. We focused on collecting experiences from educators who have already implemented educational robotics activities, focusing on interdisciplinarity, computational thinking, or blended learning.

The research design focused on the question, "How to support educators in designing interdisciplinary activities of ER and Art that promote CT in a blended learning context?". The consortium organised the research in three phases. The 1st phase included identifying the research objectives and the target audience. We opted to adopt purposive sampling; therefore, the 1st phase involved a preliminary survey questionnaire for each country's participants, which allowed us to select the educators that subsequently participated in the educators' profiling study. After that, the 2nd phase included conducting focus groups and interviews to collect data through a fine-grained script based on an anticipatory coding scheme. Lastly, the 3rd phase included the data analysis process and presenting the profiling study's results.

This document concludes by addressing the main research question and reflecting on how the profiling results may inform the development of the FERTILE design methodology.

1. INTRODUCTION

This report constitutes the second milestone (M1.2) set for implementing the first project result: "The FERTILE design Methodology".

The educators' profiling aimed to collect as much information as possible from educators who teach Educational Robotics (ER) or Arts to build a comprehensive understanding of the issues they face and what type of support they need to evolve their teaching practice. In our case, "needs assessment" refers to the difference between educators' current and intended practices according to the FERTILE methodology. The intended practices involve applying contemporary pedagogies when embracing cross-disciplinary learning through integrating ER with Arts in artful ER projects cultivating Computational Thinking (CT) in a blended learning context.

This needs assessment aims to serve as a tool for decision-making in the upcoming project tasks and mainly in the design of the FERTILE methodology (Result 1, Task 3).

As planned in the FERTILE application, four partners (one from each country participating in the FERTILE Project) contributed to this report and its associated research among the five FERTILE consortium partners. These partners were UniWa from Greece, CUP from the Czech Republic, CUB from Slovakia, and URJC from Spain. It is worth mentioning that the research team of UVa, although not initially planned in the FERTILE application, has contributed to the methodological aspects of the field research and acted as an internal evaluator of this report. After the project initiation, the consortium decided to enrich our quality plan by incorporating internal quality control in all the tasks actualised within the FERTILE Project's work. To this end, one member of the UVa research team and one member of the Czech research team acted as internal evaluators. They provided valuable comments and suggestions for improving this report.

In what follows, in the 2nd section, we elaborate on the three phases we have followed in the research design and procedure. We introduce the main research question that has driven our research, define our objectives, and how we identified target audiences. Then we describe how we collected data based on Focus Groups/Interviews. Afterwards, we describe the data analysis we have followed and how the FERTILE coding scheme was shaped. Subsequently, we present the results and their interpretation. In the 3rd section, we draw conclusions from the educators' profiling. The conclusions are twofold. Firstly we address the main research question by elaborating on the results around the issues investigated, and secondly, we reflect on how results may inform the FERTILE design methodology.

2. DESIGN AND PROCEDURE

In this section, we elaborate on the three phases we have followed in the design and procedure of the educators' profiling research. We introduce the main research question that has driven the research, define objectives, and how we identified target audiences. We also describe how we collected data based on Focus Groups/Interviews. Afterwards, we present the data analysis we have followed and how the FERTILE coding scheme was shaped. Subsequently, we present the results and their interpretation.

Conducting an educators' needs assessment is integral to the programmatic planning efforts of the FERTILE Project. As seen in Figure 1, the procedure followed involved three phases.

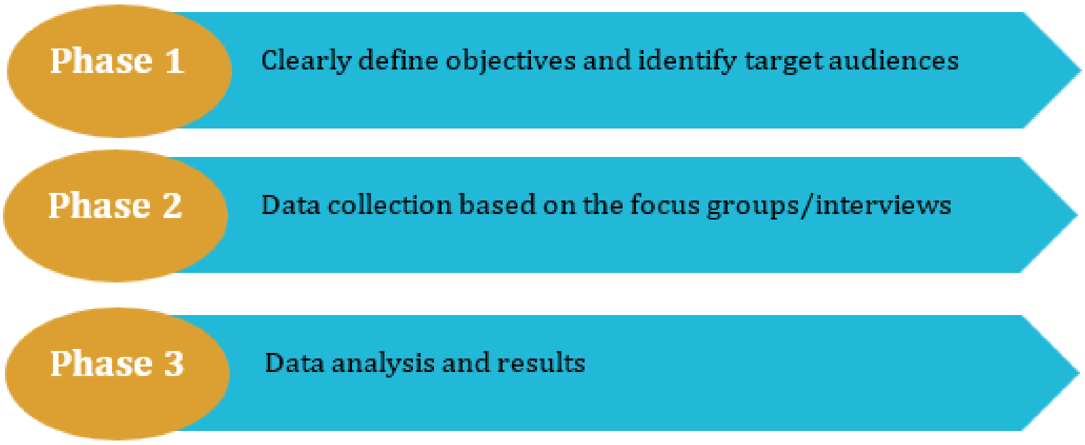

Fig 1.: The procedure for conducting educator profiling

Phase 1: Clearly define objectives and identify target audiences.
Initially, the research design was synthesised by project partners from four countries (UJRC, UNIWA, CU, UB) with the support of Yannis Dimitriadis from UVa. Then we reached educators from various educational levels and disciplines through a preliminary survey. The aim was to explore their teaching experience to form our profiling sample and subsequently organise focus groups and interviews to gain insights into their profile.

Phase 2: Data collection based on the focus groups/interviews.
Then, through focus groups and interviews, we recorded the educators' (a) current ER practice, interdisciplinary design experience, blended learning application, and CT cultivation, (b) reflections on their practice focusing on compelling perspectives and challenges they have faced, as well as (c) readiness related to undertaking the aims of the FERTILE Project.

Phase 3: Data analysis and results.
After collecting, cleaning, and analysing qualitative data, the four partners synthesised and interpreted the findings.

Subsequently, we drew conclusions and produced a comprehensive report. This report will be utilised in the FERTILE Project's next steps concerning the FERTILE design methodology (T1.3).

Below we present in detail the three phases.

2.1 Phase 1: Clearly define objectives and Identify target audiences

Since the FERTILE initiative aims at supporting educators in designing artful ER projects for cultivating CT in a blended learning context, we have set the main **research question**: "How to support educators in designing interdisciplinary activities of ER and Art that promote CT in a blended learning context?". To address such a broad research question through educators' profiling, we collaboratively defined the following main **issues** to drive our research:

- understanding how educators design and implement interdisciplinary projects of ER and Art,
- understanding educators' approaches in designing and implementing blended learning while teaching ER using simulators or Art,
- understanding educators' knowledge and skills in defining and cultivating CT skills.

Moreover, for each issue, we have set the following needs assessment **objectives**:

- to record educators' current state, i.e., knowledge and experience;
- to record the difficulties/challenges that educators face in their educational contexts;
- to record the advantages that educators acknowledge; and
- to record the support that educators need.

Aiming to address these objectives, we opted to form a **purposive sample** (Miles et al., 2014) of educators from all educational levels to synthesise our profiling sample. To this end, we performed a preliminary step that allowed us to determine the participants of this purposive sample. We reached several educators working with ER in their everyday practice in schools (primary and secondary education) or teaching relevant courses in universities and asked them to participate in a preliminary survey. This **survey** (see APPENDIX A) included questions about the context in which they have integrated ER. It investigated the technology they have used (physical robots and simulators), whether they have implemented interdisciplinary projects with ER and arts, and whether they have implemented ER in blended learning contexts.

The **data analysis** of this preliminary survey allowed us to select representative educators for profiling from the three educational levels, primary, secondary and higher education.

In what follows, we present the approach followed by each partner for collecting the data from these preliminary surveys. Also, we elaborate on the rationale of selecting participants for our profiling sample and organising **online focus groups and interviews** to collect insights into the objectives set.

2.1.1 Greece

The UniWA research team collected 45 survey questionnaires from primary, secondary, and higher education educators.

- 90% had more than 13 years of teaching experience.
- 69% had Master's degrees, and 18% held a PhD.
- 74% were ICT educators in primary or secondary education.
- 35% had not attended ER training courses, 13% were certified ER trainers, and the rest attended online seminars for a specific ER technology.
- 45% used a project-based frame to integrate ER.
- 47% taught ER during the COVID-19 pandemic and 60% of those had used ER simulators.

- 33% applied interdisciplinary projects combining ER with Arts and Crafts, 33% with Video Editing, 29 % with Music, and 15 % with Dancing (15%).
- The most used ER technology was Arduino (51%), Lego EV3 (38%), Lego WeDo (33%), Beebot (28%), Lego Spike (17%) Raspberry Pi (13%).

Based on the Greek educators' answers to the preliminary survey questionnaire, 14 educators were selected to participate in the online focus groups or the interviews. The Greek team chose those who positively responded to participate and met at least one of the following criteria: i) teaching experience with ER or ER simulators and ii) teaching experience in designing and applying interdisciplinary activities with robotics and Art. Three Art educators with interdisciplinary teaching experience with ICT were also selected to complement the sample.

Finally, the UniWA research team conducted the following online focus groups and interviews :

- Two focus groups with 5 educators of primary education
- Two focus groups with 7 ICT educators of Secondary education
- One focus group with three Art educators from primary/secondary education
- Two interviews with educators of higher education from departments of preschool education.

2.1.2 Spain

The URJC research team collected 25 survey questionnaires from kindergarten, primary, secondary, higher and non-formal educators. One educator specialising in students with visual disabilities has also answered the questionnaire.

- 84% had more than 13 years of teaching experience.
- 16% held a PhD, and 12% had a Master's degree.
- 48% were ICT or Technology teachers in secondary schools
- 12% had not attended ER courses
- 68% used Project based methodology to introduce ER
- 20% never had blended Arts with ER
- 56% did not teach ER during the COVID-19 pandemic, and only 20% had used simulators.

The most used ER technologies were: Arduino (64%), MicroBit (60%), BeeBot (52%), Mbot (44%), OzoBot (36%), Lego WeDo (36%), Lego EV2 (32%), Edison (32%), Lego Spike (24%), RaspBerry Pi (24%). Other technologies used by some teachers were: Makey-Makey, Escornabot, Goma Brain, Beduino, and Matatalab.

Based on the survey questionnaires, 13 educators were selected to participate in 3 focus groups. The focus groups were organised as follows:

- Focus group 1 (face-to-face): Participants were one Arts educator, one primary educator, and one ICT secondary educator specialising in teaching visually impaired students.
- Focus group 2 (online): Participants were one university professor (preservice primary teachers educator), one kindergarten and primary teacher, one primary teacher, and one technology teacher in secondary education.

- Focus group 3 (online): Participants were two school counsellors, one primary teacher (specialising in teaching students with visual disabilities), one university professor (preservice primary and kindergarten teachers educator), and two technology teachers in secondary education.

2.1.3 The Czech Republic

The CUP research team collected 35 preliminary survey questionnaires (32 valid) from primary, secondary and higher education educators. Those educators mostly had more than five years of experience. There were just three educators with less than three years of experience and two educators in the first year of their practice. 88% of them had Masters degrees. The vast majority (31/32) had teaching experience in secondary education. Some had teaching experience in primary and lower-secondary education.

Half of the Czech educators stated having participated in workshops and webinars organised by the National Institute of Pedagogy (NPI). Such involvement was attributed to the recent curriculum changes in the primary and lower-secondary Czech education system. The educators mostly used robotics education in Computer science (Informatika). Furthermore, in primary and secondary education, they could apply robotics in the context of Maths or Physics subjects. Eight respondents also used educational robotics in some informal courses at their schools.

Most Czech educators declared being acquainted with educational robotics or programmable toys. Popular technologies mentioned were Beebot, Mechatronic Education, FoXee Lab, Arduino, iRobot, Wunderkind, VEX 123, Robotika LEGO® Education SPIKE™ Essential a Prime, Stavebnice VEX 1-2-3, GO, Micro:Bit. There were just two educators who claimed not knowing anything about robotics. It is worth mentioning that one of the Czech educators who participated in the preliminary survey was a certified ER trainer. Also, educators claimed having used other types of technologies with their students, like Mechatronic Education, FoXee Lab, Dobot Magician, Photon, CodeyRocky, Sphero Edu, Matatalab, Fable, and Sam Labs.

Eleven respondents had some experience with simulators during the Covid-19 pandemic, and educators mentioned especially using three types of simulators: Vex code, Geogebra, MakeCode, but individually mentioned Scratch or Ozoblockly. Only nine respondents had made, prepared or moderated activities, including ER and Arts.

The focus groups were organised as follows:

- Two Focus groups with eight educators originating from primary, lower and upper secondary education. It is worth mentioning that among them were two Art teachers (music education, arts education).
- Two interviews with university professors. One taught Computer science in postgraduate courses, and the other taught Computer science in primary teacher education.

2.1.4 Slovakia

The CUB research team collected 29 preliminary survey questionnaires from primary, secondary and higher education educators. The largest group of respondents consisted of educators aged 25 to 40 years old. Also, slightly more than a quarter were 41 to 55 years old. Their teaching experience was balanced. They were mainly either novice educators with teaching experience of up to 5 years or more experienced educators with experience of 13 to 20 years. Most respondents taught at a primary or lower secondary school (62%). The fewest respondents were from higher education (10%). More than half of the respondents had completed a second university degree (Master, Engineering). Moreover, almost 25% had a third degree, i.e., a PhD. More than half of all respondents had a degree in Computer Science, and slightly less than half had a degree in Mathematics.

Based on the data collected from the questionnaires and personal acquaintances in the community dedicated to educational robotics in Slovakia (which is not particularly large), the CUB research team selected and approached 16 educators with whom they conducted online interviews. The educators approached were those who had many years of experience with robotics. Usually, one or at most two respondents were interviewed at a time.

The Slovak team conducted in total:

- Four individual interviews of university professors, each of whom also taught at one or more primary or secondary schools.
- Two individual interviews of two Informatics teachers at high schools.
- One individual interview of an Informatics teacher at a lower secondary school.
- One interview of two Informatics teachers at high schools.
- Three interviews, each of two educators, both of whom taught at a lower secondary and a high school.
- One individual interview of a music educator.

2.2 Phase 2: Data collection based on Focus Groups/Interviews

Considering that qualitative research sampling tends to be more strategic and purposive because it focuses on a case's unique contexts (Miles et al., 2014), the FERTILE consortium asserts that the purposive sampling adopted in our research ensured that our profiling sample included representative educators' profiles. Our sample represents educators' profiles from 4 European countries and all education levels whose practice involves ER or Art.

We planned that the online focus groups and interviews follow a structured script based on the objectives set for our research. To this end, we designed our research following an anticipatory data condensation strategy (Jorrín-Abellán et al., 2021; Stake, 2010; Miles et al., 2014). We defined three ***issues*** that we wanted to explore:

- Teaching experience in interdisciplinary activities with ER and Art,
- Teaching experience with ER simulators, communication technologies & blended learning,
- Teaching experience with ER and Computational Thinking.

For each issue, we triggered educators' feedback on four ***topics*** or areas of interest in which the issue's complexity was reduced:

- their relevant experience,
- the difficulties/challenges they encountered,

- the advantages they perceived,
- the support they required.

In addition, we asked the educators to propose relevant ideas for educational practice for the 2nd and the 3rd issue.

The questions posed at the online focus groups/interviews are provided in APPENDIX B in two versions, those addressed to groups of educators other than Art (Version 1) and those provided to art educators (Version 2).

Each online focus group was facilitated by one or two researchers who introduced the session, asked questions, and encouraged participation by all group members. The discussions were video-recorded for subsequent word-to-word transcription.

2.3 Phase 3: Data analysis and results

2.3.1 Data Analysis

We followed a deductive coding scheme to address the main research question, "How to support educators in designing interdisciplinary activities of ER and Art that promote CT in a blended learning context?" (Willing, 2013). This scheme followed an analysis framework that evolved around the issues identified in the anticipatory data condensation process set during our research design (see section 2.2). We organised the coding process into four phases.

In the first phase, the Greek researchers performed a preliminary content analysis and generated an initial coding scheme to organise the data analysis process among partners. This coding scheme classified educators' feedback into preliminary categories.

Subsequently, in the second phase, the rest of the partners considered this scheme for their datasets. They proposed extra categories or modifications to existing ones to synthesise the main FERTILE categories. It is worth mentioning that each partner used two researchers to negotiate the content analysis of their country's dataset and inter-partner negotiation occurred systematically to achieve the consortium consensus. Also, several online meetings took place during July and August of 2022 among the partners to develop a shared understanding of the process.

The Greek researchers considered the categories identified in the second phase towards a refined coding scheme in the third phase. This coding scheme adopted the shared categories identified in the second phase as Codes II. These Codes II were further classified in overarching Codes I. Finally, the Codes I that shared similar characteristics formed Themes. An example of the interrelation between educators' responses with categories/Codes II, Codes I, and Themes is illustrated in Figure 2.

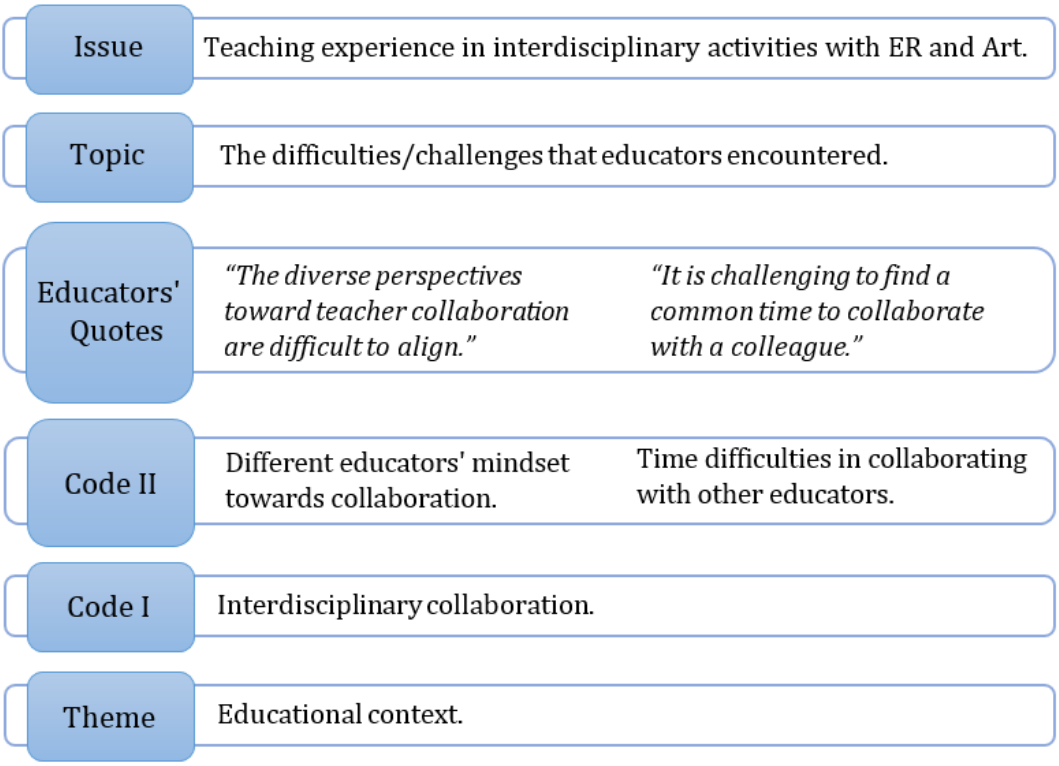

Fig. 2: An example of the FERTILE coding scheme

In the fourth phase, the rest of the partners considered the refined coding scheme, and inter-partner negotiation resulted in the final coding scheme. Afterwards, all partners applied the final coding scheme to their datasets and performed a frequency analysis of the content analysis results (Neuendorf, 2019).

An overarching issue emerged during the coding scheme's refinement. We considered it useful for the FERTILE Project's continuation to present distinctively this issue involving ER technologies that educators utilise in their practice. Thus, a fourth issue was added to the three issues initially set (see Section 2.2). Consequently, we adopted an anticipatory data condensation strategy for the data analysis of our datasets that was organised into three levels. The first level included four issues which in the second level were further analysed in specific topics (T). These topics in the third level were addressed by informative questions (IQ) that subtly defined the line to follow to establish conclusions around the issues. Figure 3 illustrates the final analysis framework for the educators' profiling.

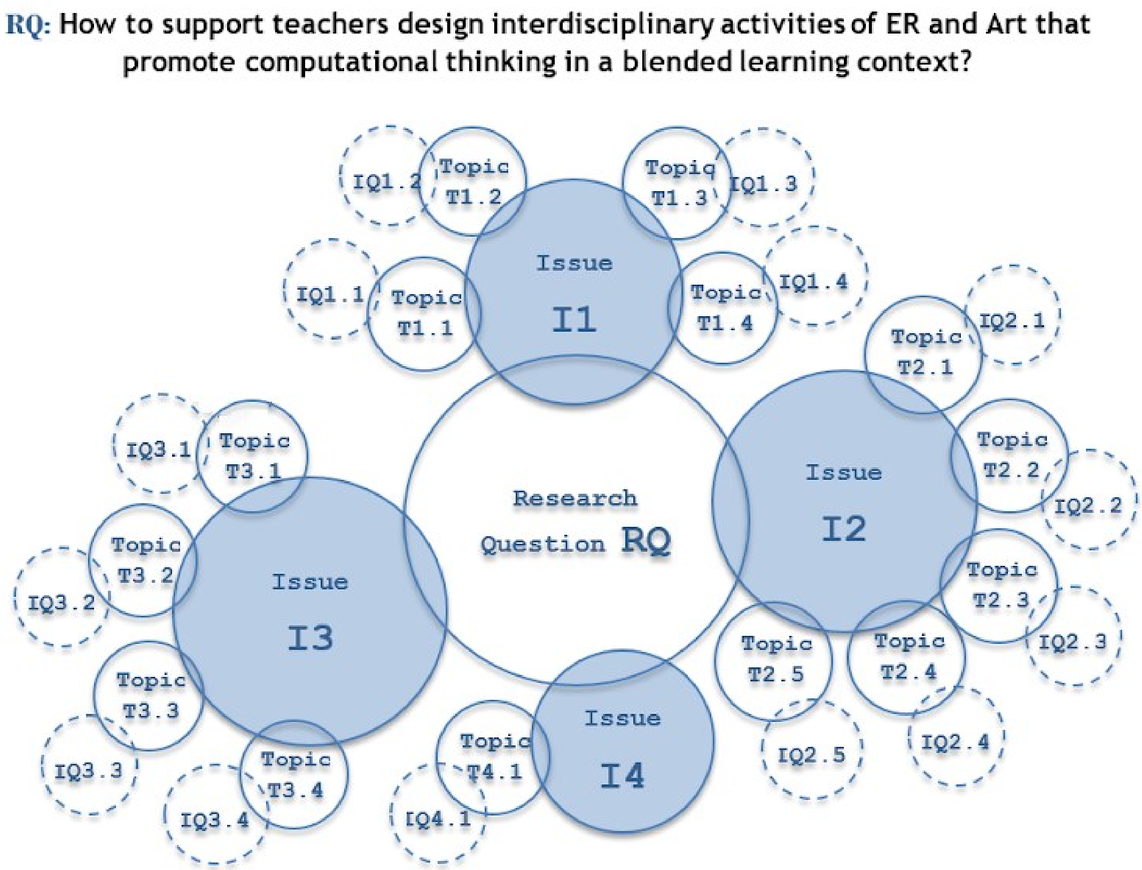

Fig. 3. Visual representation of the anticipated data condensation strategy for educators profiling.

Issue 1. What experience do educators have in designing interdisciplinary activities of ER and Art?

T1.1 The Design Ideas

IQ1.1 How have educators designed interdisciplinary activities combining ER with Arts?

T1.2 The Difficulties/Challenges

IQ1.2 What challenges do educators face when designing interdisciplinary activities combining ER with Art?

T1.3 The Benefits/Implications

IQ1.3 What are the implications of organising interdisciplinary activities combining ER with Art?

T1.4 The support required

IQ1.4 What type of support do educators require to design interdisciplinary activities combining ER with Art?

Issue 2. What experience do educators have with ER simulators and ICT for blended learning?

T2.1 The Design Ideas

IQ2.1 How have educators designed ER activities utilising ER simulators and ICT for blended learning?

T2.2 The Challenges

IQ2.2 What challenges do educators face when utilising ER simulators and ICT for blended learning?

T2.3 The implications

IQ2.3 What are the implications of utilising ER simulators and ICT for blended learning?

T2.4 The mindset

IQ2.4 How can educators' mindset shift towards integrating ER simulators and ICT for blended learning?

T2.5 The support required

IQ2.5 What type of support do educators require to utilise ER simulators and ICT for blended learning?

Issue 3. What experience do educators have with ER and Computational Thinking?

T3.1 The Design Ideas

IQ3.1 How have educators designed ER activities to promote students' Computational Thinking?

T3.2 The Challenges

IQ3.2 What challenges do educators face when designing ER activities to promote students' Computational Thinking?

T3.3 The implications

IQ3.3 What are the implications of utilising ER to promote students' Computational Thinking?

T3.4 The support required

IQ3.4 What type of support do educators require to utilise ER to promote students' Computational Thinking?

Issue 4. What experience do educators have with ER technologies?

T4.1 The Technologies

IQ4.1 What ER technologies do educators utilise in their practice?

2.3.2 Results and Interpretation

Results are presented in Tables x.A and Tables x.B, where x=1-14.

Specifically, **Tables x.A**, i.e., Table 1.A up to Table 14.A provide the educators' responses per country and educational level, focusing on Themes (column 'Theme') and Codes I (column 'Code I'). Moreover, **Tables x.A** include the number of educators' responses per country (Greece, Slovakia, Czech Republic, and Spain) from primary education (column P), secondary education (column S), higher education (column H), and Art educators (column A).

Additionally, the column '%' presents the frequency of educators' responses **per country** as follows:

- for Table x.A, frequency (%)=sum of responses classified as Code I/N* 100
- for Table x.B, frequency (%)=sum of responses classified as Code II/N* 100

where N=sum of total responses of the country

When conducting the focus group discussions, each educator (participant) could have given more than one response to each question, so we decided that "N" should correspond to the number of responses rather than the number of educators (participants).

Then, focusing on the most popular Codes I per country, the **Tables x.B** present their associated Codes II and some quotes. For example, Table 1.B shows the Codes II of the codes having the highest frequency per country, as shown in Table 1.A. Finally, **Tables x.B** include indicative quotes for each value of Code II of Table x.B.

Below we present the results for each issue and its informative questions. We also interpret the results appearing in Tables x.A, and x.B following the procedure:

Step 1: Initially, we comment on the Code(s) I of Table x.A noted as the most popular ones by meeting two criteria (the corresponding rows are marked in colour). They either had the highest frequency per country, or they had frequencies of 25% and above per country. We have chosen to note those codes achieving a quarter of responses due to the variety of responses given to each question.

Step 2: Then, we comment on Codes II included in Table x.B, corresponding to the Codes I noted in Step 1.

Step 3: Finally, if deemed noteworthy, we indicate the quotes included in Table x.B, corresponding to the Codes II noted in Step 2.

Issue 1. What experience do educators have in designing interdisciplinary activities of ER and Art?

T1.1 The design ideas

IQ1.1 How have educators designed interdisciplinary activities combining ER with Arts?

The analysis of the educators' responses about their experiences or ideas on interdisciplinary activities of ER and Art, identified three different themes (see Table 1.A, column 'Theme'):

- 'Arts and Crafts',

- 'Literature',
- 'Performing Arts'.

These themes were further analysed in three levels of detail reflected in Codes I and Codes II (see Table 1.B, columns 'Code I', 'Code II'). Also, educators' quotes are provided in Table 1.B (see Table 1.B, column 'Quotes').

For example, regarding the first theme, i.e., ER with 'Arts and Crafts', the educators' responses are classified into five Codes I (see Table 1.A, column 'Code I'). These codes are: 'Program robot to perform Art', 'Program robot to create Art', 'Program robot to respond to artful triggers', 'Create Artful robots and program them for a general task', and 'Create Artful robots and program them to perform Art'. In particular, the most frequently reported are:

- "Program Robot to create Art" for activities involving programming robots to create an artefact/piece of Art. For instance, robots use a pencil or a marker to draw on paper.
- "Program Robot to perform Art" for activities involving programming robots to perform Art. For instance, robots may be the characters in a play; they may create Music or dance on specific steps.
- "Create Artful Robots" for activities involving constructing robots with artistic materials, such as painting or dressing them in costumes designed by the students.

Then, in Table 1.B, we focus on the Codes I of Table 1.A having the higher frequencies, and we present the corresponding Codes II (column 'Code II'). For example, the Code I: 'Program Robot to create Art' is further organised into two categories 'Robot having a pencil to draw' and 'Painting: Robot draws based on an Art style (e.g., Cubism, Renaissance)'. Accordingly, Table 1.B. complements Codes II results with indicative educators' quotes.

Below we present the results. The results indicate that educators' design ideas on interdisciplinary activities (GR: 28.0%, CZ: 26.7%, SP: 35.0%) mainly involved ideas on 'Arts & Crafts' (see Table 1.A, 'Theme') and especially on 'programming robots to perform art' (see Table 1.A, 'Code I'). In more detail, 'drawing and constructing playgrounds with ER on a specific role' was the dominant idea (see Table 1.B - Code I: "Program robot to perform Art").

Many Slovak educators' responses (33.3%) mentioned programming robots to create Art (see Table 1.A) and specifically to produce Music (see Table 1.B - Code II: 'Playing Music using robots'). Also, many Spanish educators' responses (25.0%) shared the same idea (see Table 1.A). Furthermore, 25% of Spanish and 20% of Czech educators suggested creating artful robots to perform Art (see Table 1.A). Namely, programming robots to dance (see Table1. B, Code II: 'Dancing robots') and for theatre (see Table 1.B, Code II: 'Theatre: Constructing and decorating robots for a play').

We note that educators designed interdisciplinary activities combining ER with Arts mainly by *programming and constructing robots to produce an artistic artefact*. For evidence, see Table 1.A, Code I: 'Program robot to perform art', and 'Create Artful robots to perform Art'. From the corresponding quotes of the Codes I as mentioned above, we deem that the stimulus for these interdisciplinary activities usually involved addressing an artistic challenge (see Table 1.B "We made a moving puppet…" (SP), and "The chicks dance" (SP).

Table 1.A. Two-level coding (Themes, Code I) of educators' responses on how they designed interdisciplinary activities combining ER with Arts (IQ1.1).

Theme	Code I	Greece (N=25)					Slovakia (N=30)					The Czech Republic (N=15)					Spain (N=20)				
		P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%
Interdisciplinary activities of ER with Arts & Crafts	Program robot to perform Art	2	4		1	28.0		2			6.7	1	2	1		26.7	4	1	0	2	35.0
	Program robot to create Art	1	2	1		16.0	3	1			13.3	1	1	1		20.0					
	Program robot to respond to artful triggers	2		1		12.0		1			3.3										
	Create Artful robots and program them for a general task				1	4.0	1	3	1		16.7										
	Create Artful robots and program them to perform Art				1	4.0	1				3.3										
Interdisciplinary activities of ER with Literature	Create Artful robots	3		1		16.0					0.0			1		6.7	3				15.0
Interdisciplinary activities of ER with Performing Arts (Music, dance, theater)	Create Artful robots to perform Art		2		1	12.0	1		1		6.7	1		2		20.0	3		2		25.0
	Program robot to create Art		2			8.0	4	6			33.3		1		1	13.3	4	1			25.0
	Program robot to perform Art							4		1	16.7			2		13.3					

(*) The highlighted rows are further analysed in Table 1.B

Table 1.B. Three-level coding (Themes, Code I, Code II, Quotes) of educators' most frequent responses on IQ1.1.

Theme	Code I	Code II	Greece (N=25)					Slovakia (N=30)					The Czech Republic (N=15)					Spain (N=20)					Quotes
			P	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**	
Interdisciplinary activities of ER with Arts & Crafts	Program robot to perform Art	Drawing and constructing a playground with ER on a specific role	2	4		1	28.0		2			6.7	1	2	1		26.7	4	1	0	2	35.0	*"...the students used recyclable materials to create a bench and a lake, and programmed the robot as a windmill." (GR)* *"...they constructed a village. One of the village houses was Mondrian's, and another one was Picasso's. Then they programmed the Arduino to move" (SP)*
Interdisciplinary activities of ER with Performing Arts (music, dance, theatre)	Create Artful robots to perform Art	Dancing robots		2			8.0	1		1		6.7	1		2		20.0	2		1		15,0	*"... chicks dance. They programmed 8 ozobots to do a coordinated dance. From the movement of the kids, the music that was made, what they danced, the costume design and all that stuff." (SP)*
		Theatre: Constructing and decorating robots for a play				1	4.0					0.0						1	1			10,0	*"We made a moving puppet..." (SP)*
	Program robot to create Art	Playing Music using robots		2			8.0	4	6			33.3		1		1.0	13.3	4	1			25,0	*"... playing music by programming Microbit" (CZ)* *"...a robot represented Freddie Mercury interpreting a song." (SP)*

T1.2 The Difficulties/Challenges

IQ1.2 What challenges do educators face when designing interdisciplinary activities combining ER with Art?

The analysis of the educators' responses about the challenges they faced when designing interdisciplinary activities of ER and Art, identified five different themes (see Table 2.A, column 'Theme'):

- Design Issues,
- Students Issues,
- Technical Issues,
- Curriculum Issues, and
- Educational context.

These themes were further analysed in two levels of detail reflected in Codes I and Codes II (see Table 2.B, columns 'Code I', 'Code II'). Also, educators' quotes are provided in Table 2.B (see Table 2.B, columns 'Code I', 'Code II', 'Quotes').

As shown in Table 2.A, educators' most prominent challenge when designing interdisciplinary activities combining ER with Art was collaborating with educators of different disciplines (GR:22.4%, SK:27.3%, SP:28.9%). In particular, educators encountered practical difficulties during their collaboration with other colleagues. These difficulties involved (i) educators not sharing common working hours with colleagues (see Table 2.B, Code II: 'Collaboration not facilitated among art educators-primary educators-ICT educators'), (ii) educators' unwillingness to collaborate (see Table 2.B, Code II: 'Lack of collaboration among educators'), and educators not sharing the same perceptions on how they should collaborate (see Table 2.B, Code II: 'Different educators' mindset towards collaboration').

We noted two difficulties encountered mainly by the Czech educators. The first one (23.1%) involved designing interdisciplinary activities that combine ICT and Arts as it was difficult for educators to understand the objective of each subject (see Table 2.B). The second one (23.1%) involved the educational context, specifically the school management (see Table 2.A). The Spanish educators also frequently reported the latter difficulty (26.3%). Specifically, the educators reported having to teach (i) in more than one school, (ii) in limited time, (iii) in many different classrooms, which often had many students, and (iv) with a limited budget for purchasing technology (see Table 2.B).

Therefore, the results indicate that the biggest challenge that the educators had to overcome was *collaborating with peers from different disciplines*. See evidence in Table 2.A, Code I: "Management of ICT and Art" and Table 2.B, Code II: "Educators need to understand the objectives of each subject". Also, see Table 2.a Code I: "Interdisciplinary Collaboration and Table 2.B Code II: Collaboration not facilitated among Art educators-primary educators-ICT educators.

Table 2.A. Two-level coding of educators' responses on the challenges they faced when designing interdisciplinary activities combining ER with Arts (IQ1.2)

Theme	Code I	Greece (N=49)					Slovakia (N=66)					The Czech Republic (N=13)					Spain (N=38)				
		P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%
Design Issues	Management of ICT and Art			3		6.1	1	1		1	4.5	2	1			23.1					
	Management of various needs of students	1				2.0	3				4.5						1	2			7.9
	Choose appropriate technologies					0.0			1		1.5	1				7.7					
	Appropriate Material		1			2.0	1	3			6.1										
Student Issues	Focus	1		1		4.1					0.0						1				2.6
	Students' poor ICT and Programming Skills		2			4.1	1	2	3		9.1						1	2			7.9
	Engagement				3	6.1		1	1		3.0	1				7.7					
Technical Issues	Appropriate Robotic technologies availability		1	1		4.1	1	4			7.6						1	3	1		13.2
	Robotic components' malfunction					0.0	1	2			4.5										
	ICT malfunction					0.0		1			1.5	1				7.7					
Curricu lum Issues	Time limitation	3	5	1		18.4	2	4	2		12.1						1	1			5.3
	Lack of Interdisciplinarity		2			4.1	3	1	1		7.6										
	School management					0.0					0.0	1				7.7					
Educational context	School management	1	4		3	16.3	3	2		1	9.1	1	1	1		23.1	3	5	1	1	26.3
	ER and interdisciplinarity added value		3			6.1					0.0						1				2.6
	Interdisciplinary collaboration	1	7	1	2	22.4	6	10	2		27.3	1				7.7		6	3	2	28.9
	Educator training		1		1	4.1				1	1.5	2				15.4	1	1			5.3

Table 2.B. Three-level coding (Themes, Code I, Code II, Quotes) of educators' most frequent responses on IQ1.2

Theme	Code I	Code II	Greece (N=49)					Slovakia (N=66)					The Czech Republic (N=13)					Spain (N=38)					Quotes
			P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	
Design Issues	Management of ICT and Art	Balance art and programming.			1		2.0				1	1.5					0.0					0.0	*"Integrating informatics' concept with Artistic ones is challenging." (GR)*
		ICT educators do not have expertise in other subjects, e.g., music.					0.0	1				1.5					0.0					0.0	*"... missing a peer who is acquainted with music or art, you have limited ideas on how to integrate art" (CZ)*
		Educators need to understand the objectives of each subject.			2		4.1		1			1.5	2	1			23.1					0.0	*"I need colleagues' expertise on other subjects" (SK)*
Educational context	School management	Oversized classes. Educator in more than one school. Educator teaching in many classes.	1	1			4.1					0.0					0.0		2		1	7.9	*"When my class is full with around 30 students, I cannot teach some of them Scratch..." (SP)*
		Actual classroom time.	1				2.0	2	1		1	6.1					0.0	2	2			10.5	*"The teaching time is not 45 minutes. It can be 40 or 35 depending on the school schedule." (GR)*
		Limited financial resources for technologies/materials.		3		3	12.2	1	1			3.0	1	1	1		23.1	1	1	1		7.9	*"Robotic supplies are tricky. It is not like telling your boss, " well, buy me robots"." (SP)*
	Interdisciplinary collaboration	Collaboration is not facilitated among art-primary-ICT educators.					0.0					0.0					0.0		4	1	1	15.8	*"... teach in 3 or 4 schools, so I cannot contact other educators when it suits me." (GR)*
		Different educators' mindsets toward collaboration.	1		1		4.1	1	3	1		7.6					0.0		2	2	1	13.2	*" Other educators' attitude is peculiar. Usually, they do not respond to my suggestions for collaboration." (SP)*
		Lack of collaboration among educators	1	5			12.2	4	6	1		16.7	1				7.7					0.0	*"...the problem of finding a computer science educator for the first grade." (CZ)*
		ER is focused more on competitions than interdisciplinary collaboration		2		2	8.2					0.0					0.0					0.0	*" Some competitions are very demanding...They stick in following robotic competitions' prerequisites. " (GR)*
		Time difficulties in collaborating with other educators.					0.0	1	1			3.0					0.0					0.0	*"... we are always busy at school, and it is hard to find someone willing to work with you... we do not keep up ... Older colleagues are not up to it at all." (SK)*

T1.3 The Benefits/Implications

IQ1.3 What are the implications of organising interdisciplinary activities combining AR with Art?

The analysis of the educators' responses about the implications of organising interdisciplinary activities of ER and Art, identified four different themes (see Table 3.A, column 'Theme'):

- Student Engagement,
- Student Learning,
- Student Skills, and
- Educator practice.

These themes were further analysed in two levels of detail reflected in Codes I and Codes II (see Table 3.B, columns 'Code I', 'Code II'). Also, educators' quotes are provided in Table 3.B (see Table 3.B, columns 'Code I', 'Code II', 'Quotes').

As seen in Table 3.A, the responses of the Slovak and Spanish educators (SL:24.6%, SP:31.0%) highlighted as most beneficial the interdisciplinarity of ER with Art regarding cognitive issues (see Table 3.A) and specifically on students' motivation and interest (see Table 3.B, Code I: 'Cognitive'). Also, the Greek and the Czech educators (GR:12.5%, CZ:11.8%) shared the same perception, although not as often (see Table 3.A Code I: 'Cognitive'). The responses of the Greek educators also highlighted the promotion of students' emotional engagement (12.5%) (see Table 3.A Code I: 'Emotional') through CT, as well as that CT engages students in authentic learning (12.5%) (see Table 3.A Code I: 'Authentic Learning').

The Czech educators' responses brought to the fore that interdisciplinarity promotes meaningful learning (23.5%) and students' effective teaching (23.5%) (see Table 3.A). Also, the Greek (9.4%), Slovak (8.8%), and Spanish (6.9%) educators' responses highlighted the benefits of effective teaching. They focused specifically on ER and Art promoting interdisciplinarity (see Table 3.B, Code II: 'ER acts as a link between many subjects', 'Art enriches any subject') and inclusion (see Table 3.B, Code II: 'helps educators to create inclusive activities').

Therefore, the main implications of organising interdisciplinary activities of educational robotics and Art were (i) *facilitating students' engagement with a cognitive objective*, (ii) *reinforcing meaningful and authentic learning*, and (iii) *promoting ER and Art as pillars of interdisciplinarity and inclusion*.

Table 3.A. Two-level coding of educators' responses on the benefits of organising interdisciplinary activities combining ER with Arts (IQ1.3).

Theme	Code I	Greece (N=32)					Slovakia (N=57)					The Czech Republic (N=17)					Spain (N=29)				
		P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%
Student engagement	Cognitive	2	2			12.5	3	10		1	24.6			2		11.8	3	5		1	31.0
	Behavioural	1		1		6.3	1	2			5.3						1	1			6,9
	Emotional		4			12.5					0.0										0,0
Student Learning	Meaningful learning	1				3.1	1	3	1		8.8	1	1	2		23.5	1	1		1	10.3
	Experiential learning	1		1		6.3	1	1	1		5.3						1	1			6.9
	Authentic learning	1	3			12.5	4	4	1	2	19.3		2			11.8					0.0
	Collaborative learning		3			9.4	2	2	1		8.8		1			5.9	3	1			13.8
	Inquiry-based learning			1		3.1			1		1.8										0.0
	Feedback provision					0.0		1			1.8										0.0
Student Skills	Problem-solving				1	3.1	2				3.5		1			5.9					0.0
	Creative thinking		1		1	6.3	2	2			7.0			2	1	17.6					0.0
	Collaboration		3			9.4					0.0						3	1			13.8
	Sensory					0.0		1		1	3.5										0.0
Educator practice	Assessment		2			6.3					0.0					0.0					0.0
	Collaboration					0.0	1				1.8					0.0	1	2			10.3
	Effective teaching (educator knowledge strategies and conduct)		1		2	9.4	2	1	2		8.8	1	2	1		23.5		2			6.9

Table 3.B. Three-level coding (Themes, Code I, Code II, Quotes) of educators' most frequent responses on IQ1.3.

Theme	Code I	Code II	Greece (N=32)					Slovakia (N=57)					The Czech Republic (N=17)					Spain (N=29)					Quotes
			P	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**	
Student engagement	Cognitive	Increases student motivation					0.0	1	6			12.3					0.0					0.0	*"... to motivate students' interest" (GR)*
		Increases students' interest	2	2			12.5	1	3		1	8.8			2		11.8	2	2		1	17.2	*"... they were interested in relating the program to the Microbit and then observed how this affects the control light..." (SK)*
		Increases girls' interest					0.0	1	1			3.5					0.0	1	3			13.8	*"... girls were more interested than boys." (SP)*
Student Learning	Meaningful learning	Constructing and programming for a meaningful purpose	1				3.1	1	3	1		8.8	1	1	2		23.5	1	1		1	10.3	*"I consider advantageous the fact that we are not just coding without any particular meaning." (GR)*
	Authentic learning	Connecting digital and real worlds					0.0	1	2			5.3					0.0					0.0	*"It is also great when the digital world breaks into the real world " (SK)*
		Students create authentic, not only abstract artefacts					0.0	2	1			5.3					0.0					0.0	*"But the important thing is that it has some sort of end product because that does not occur much in school"(SK)*
		Promotes authentic learning	1	3			12.5	1	1	1	1	7.0		2			11.8					0.0	*"Knowledge is directly linked to life, and whatever we learn, we can apply it to other areas." (GR)*
		Practical use of the knowledge learned in music theory					0.0				1	1.8					0.0					0.0	*"When I teach music theory with the piano, for example, when I teach the length of a note, I may teach it in combination with some robot's technique. Or, the robot may be used to play a melody for the students to write it down." (SK)*

Theme	Code I	Code II	Greece (N=32)					Slovakia (N=57)					The Czech Republic (N=17)					Spain (N=29)					Quotes
Educator practice	Effective teaching (educator knowledge. Strategies, and conduct)	ER acts as a link between many subjects		1			3.1	1	1	1		5.3			1		5.9					0.0	*"Robotics can act as a core around various activities with different objectives, to link several subjects." (GR)*
		Art enriches any subject				2	6.3					0.0	1	2			17.6					0.0	*"Art helps you conceptualize new ideas, and it helps the students a lot."(GR)*
		Easier to combine ER with Arts than other subjects					0.0	1				1.8					0.0					0.0	*"If I'm looking for a connection, maybe it's more in the artistic field than in other subjects" (SK)*
		Helps educators to create inclusive activities (e.g. for visually impaired students)					0.0			1		1.8					0.0		2			6.9	*"Robotics enable us to create accessible activities. For example, Scratch enabled me to create a story that students interact with the computer using the keyboard rather than the visual puppet. " (SP)*

T1.4 The support required

IQ1.4 What type of support do educators require to design interdisciplinary activities combining ER with Art?

The analysis of the educators' responses on the type of support they need when organising activities combining activities of ER and Art, identified four different themes (see Table 4.A, column 'Theme'):

- Curriculum Issues,
- Educational context,
- Learning Content, and
- Design Issues

These themes were further analysed in two levels of detail reflected in Codes I and Codes II (see Table 4.B, columns 'Code I', 'Code II'). Also, educators' quotes are provided in Table 4.B (see Table 4.B, columns 'Code I', 'Code II', 'Quotes').

We note that Greek educators focused more on issues related to *interdisciplinary collaboration* (34.2%). The same issues were also noted in Slovakia (11.8%), the Czech Republic (15.8%) and Spain (13%) (see Table 4.A). Specifically, the educators mentioned the need to (i) cultivate collaboration among educators through a collaboration framework, (ii) share students' information such as interests and knowledge level, and (iii) exchange ideas through forums (see Table 3.B).

In Slovakia (31.4%) and the Czech Republic (31.6%), the *need for a repository* has been mentioned most often (see Table 4.A). Specifically, educators required exemplar activities, lesson plans, graded activities' collection (levels), and a repository for sharing activities among educators (see Table 4.B).

The Spanish educators' responses (39.1%) highly indicated that support is needed in school *management issues* (see Table 4.A). For example, they asked (i) for technical experts to assist them and (ii) to have a flexible school timetable (see Table 4.B).

Table 4.A. Two-level coding of educators' responses on the type of support they need when organising activities combining ER with Arts (IQ1.4).

Theme	**Code I**	**Greece (N=38)**					**Slovakia (N=51)**					**The Czech Republic (N=19)**					**Spain (N=23)**				
		P	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**
Curriculum Issues	Time allocation	1	5			15.8	2	2		1	9.8					0.0	2	2			17.4
	Exemplar matches the Curriculum					0.0	1				2.0					0.0					0.0
Educational context	School management	3	4		1	21.1	1	4	2	2	17.6			1		5.3	6	3			39.1
	Interdisciplinary collaboration	4	7	1	1	34.2	2	4			11.8		2	1		15.8	1	1	1		13.0
	Educator training	1	2	1		10.5	3	1	1		9.8	1	3			21.1	3	1			17.4
	Educator workload				2	5.3		1	1		3.9					0.0					0.0
Learning Content	Teaching Materials					0.0		2			3.9		1	0		5.3		2			8.7
	Repository	2	3			13.2	4	11	1		31.4		3	3		31.6					0.0
Design Issues	Methodology					0.0		4	1		9.8					0.0		1			4.3

Table 4.B. Three-level coding (Themes, Code I, Code II, Quotes) of educators' most frequent responses on IQ1.4.

Theme	Code I	Code II	Greece (N=38)					Slovakia (N=51)					The Czech Republic (N=19)					Spain (N=23)					Quotes
			P	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**	
Educational context	School management	Financial support	3	2			13.2	1	2	1	1	9.8					0.0	2	2			17.4	*"The support needed is mainly financial ..." (GR)*
		Less bureaucracy					0.0			1		2.0			1		5.3					0.0	*"...eliminate any bureaucracy, because, for example, when I want to do the team project, I don't know how to pay for the students' purchases" (SK)*
		Two educators teaching the same subject (2 educators for 1 class)					0.0		1			2.0					0.0					0.0	*"...a class where there is a physicist, a chemist and a computer scientist at the same time or at least two teachers who teach one subject."* (SK)
		Sufficient time allocation					0.0		1			2.0					0.0					0.0	*"In the time allotted for it, so it's unfeasible" (SK)*
		Need of technical experts					0.0				1	2.0					0.0	2				8.7	*"... an expert in educational robotics or electronics topics." (SP)*
		School organization (flexible schedule)		2		1	7.9					0.0					0.0	2	1			13.0	*"... to have the school administration's support regarding the school's timetable." (GR)*
	Interdisciplinary collaboration	Cultivate collaboration among educators (art-primary-ICT educators)	3	7		1	28.9	2	4			11.8		2	1		15.8	1	1	1		13.0	*"You need to somehow get in touch with those specialists in that other subject." (SK)*
		Educators sharing students' profile information (e.g., interests and knowledge level)	1				2.6					0.0					0.0					0.0	*"To know the knowledge level of all your students, you need to share information with your colleagues." (GR)*
		Forum for exchanging ideas			1		2.6					0.0					0.0					0.0	*"... participate in a community to exchange ideas." (GR)*
	Educator training	Need for educator training: Seminars	1	2			7.9	2	1	1		7.8	1	3			21.1	3	1			17.4	*"... summer schools for educators. To get training and share practice." (CZ)*
		Conferences			1		2.6	1				2.0					0.0					0.0	*"Participating in conferences always helps." (GR)*

Theme	Code I	Code II	Greece (N=38)					Slovakia (N=51)					The Czech Republic (N=19)					Spain (N=23)					Quotes
			P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	
Learning Content	Repository	Need for exemplar activities	1	2			7.9	2	5	1		15.7		1	1		10.5					0.0	*"Having access to exemplar activities helps."(SK)*
		Lesson plans					0.0		2			3.9					0.0					0.0	*"It would be nice to have lesson plans and worksheets" (SK)*
		Graded activities collection (levels)					0.0	1	3			7.8					0.0					0.0	*"... some kind of collection divided into levels, e.g., for beginners, intermediate... " (SK)*
		Repository for sharing activities among educators	1	1			5.3	1	1			3.9		1	1		10.5					0.0	*"... to leave a documentation of what he has done during the year so that someone else can see it." (GR)*
		Examples of good practice					0.0					0.0		1	1		10.5					0.0	*"... suitable activities with specific instructions for a beginner or someone with little experience."*

Issue 2 What experience do educators have with ER simulators and ICT for blended learning?

T2.1 The Design Ideas

IQ2.1 How have educators designed ER activities utilising ER simulators and ICT for blended learning?

Many educators focused on the technologies they employed in online teaching. The analysis of the educators' responses on technologies used in online classes identified three different themes (see Table 5.A, column 'Theme'):

- Asynchronous Technologies,
- Synchronous Technologies, and
- Online Learning Implementation

The "Online Learning Implementation" theme is further analysed in two levels of detail reflected in Codes I and Codes II (see Table 5.B, columns 'Code I', 'Code II'). Also, educators' quotes are provided in Table 5.B (see Table 5.B, columns 'Code I', 'Code II', 'Quotes'). The themes "Asynchronous Technologies" and "Synchronous Technologies" are not presented in more detail (specific technologies) because this is beyond the scope of this study.

The Slovak and Spanish educators focused more on what technologies they used in combination with ER simulators rather than on implementing the relevant educational activities (see Table 5.A, Themes: 'Asynchronous technologies', 'Synchronous technologies'). Specifically, the Greek, Spanish and Slovak educators who used asynchronous and synchronous communication technologies (GR 23.8%, SK 64.0%, SP 44.4%) leaned towards asynchronous communication. In comparison, the Czech educators leaned more towards synchronous communication (41.7%) (see Table 5.A).

Indeed, as far as the implementation of asynchronous online learning is concerned, mainly the Greek educators provided some insights (26.2%) (see Table 5.A, Theme 'Online Learning Implementation' & Table 5.B, Code I: 'Asynchronously ER/ART: Study'). They reported working asynchronously on ER activities related to studying a robot function and teaching software. Also, they worked asynchronously on Art activities related to studying art history, using repositories for online art activities. Notably, they implemented asynchronous individual activities instead of collaborative ones (see Table 5.B, Code I:'Asynchronous ER/ART: Study'). In addition, in online synchronous classes, educators were demonstrating (Table 5.A, Code I: 'Synchronously ER/ART: Demonstration') (CZ 25.0%, GR 19.0%) either art creations (see Table 5.B, Code II: 'Real-time art demonstration') or the function of robotic constructions in real-time (see Table 5.B, Code II: 'Synchronous communication for showing robots').

Moreover, regarding online learning design, two main suggestions emerged from the educators' responses according to their experience:

1. in online synchronous classes, educators were demonstrating either art creations (Table 5.A, Code I: 'Synchronously ER/ART: Demonstration') or the function of robotic constructions in real-time (see Table 5.B, Code II: 'Synchronous communication for showing robots'),
2. in online asynchronous classes, educators enhanced students' home study (Table 5.A, Code I: 'Asynchronously ER/ART: Study') .

Table 5.A. Two-level coding of educators' responses on how they designed ER activities utilising ER simulators and ICT in a blended learning context. (IQ2.1).

Theme	Code I	Greece (N=42)					Slovakia (N=25)					The Czech Republic (N=12)					Spain (N=9)				
		P	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**
Asynchronous technologies	blog /email / padlet/Teams Class/Moodle / Google Classroom/ EduPage/Wiki/LAMS/Replit	3	3	3	1	23.8	5	6	4	1	64.0		1			8.3	1	2	1		44.4
Synchronous technologies	Teams / Zoom / Webex / WhatsApp / Micro: bit classroom / Google Meet / Classter / Among Us	1	1	3	3	19.0	2	5	1	1	36.0	1	3	1		41.7	2		1		33.3
Online Learning Implementation	Synchronously ER/ART: Demonstration	2	1	2	3	19.0					0.0		1	2		25.0					0.0
	Asynchronously ER/ART: Study	1	2		8	26.2					0.0	1	1			16.7					0.0
	Synchronously/Asynchronously ER: Programming, programming unplugged	2	1	2		11.9					0.0			1		8.3	1	1			22.2

Table 5.B. Three-level coding (Themes, Code I, Code II, Quotes) of educators' most frequent responses on IQ2.1.

Theme	Code I	Code II	Greece (N=42)					Slovakia (N=25)					The Czech Republic (N=12)					Spain (N=9)					Quotes
			P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	
Online Learning Implementation	Synchronously ER/ART Demonstration	Real-time art demonstration				2	4.8					0.0		1	1		16.7					0.0	*"The students presented their dancing robots. Some turned on their webcam and showed their robots in real-time. Others had prepared a movie and shared it." (CZ)*
		Synchronous communication for showing robots	2	1	2		11.9					0.0			1		8.3					0.0	*"Since we had worked f2f with Arduino, in the online context, we used Tinkercad to show robots as it fully supports Arduino." (CZ)*
		Educator uses a second camera				1	2.4					0.0					0.0					0.0	*I used two cameras. One to share instructions with students and the other to show what I was drawing. (GR)*
	Asynchronously ER/ART Study	Study the robot function asynchronously		1			2.4					0.0					0.0					0.0	*"...take home the robot to familiarize herself and present how it works. (GR)*
		Online for the history of Art		1		2	7.1					0.0					0.0					0.0	*"I presented online some theoretical stuff about the history of art and enriched them with quizzes." (GR)*
		Creating instructional Art videos (tutorials)				1	2.4					0.0					0.0					0.0	*"... made YouTube videos like "How to make a pencil box" as tutorials which we uploaded on Clusters. (GR)*
		Utilize a repository for Arts activities				2	4.8					0.0					0.0					0.0	*"... presented videos about artists' works... a lot were available in the e-learning repository." (GR)*
		Online is better for individual activities (lower primary)	1			1	4.8					0.0					0.0					0.0	*"... distance learning to actualize activities performed by students individually (GR)*
		Online for teaching software (photoshop, premiere)				2	4.8					0.0	1	1			16.7					0.0	*"...I found a suitable game called LogicBox. It is similar to what we did in Lego, where you build a robot and program it to follow a route, classic line followers, as we do in class. Its advantage is that it is not programmed in the form of a programming language, but connected using logic circuits." However, I could not force anyone to buy a game for 500. (CZ)*

T2.2 The Challenges

IQ2.2 What challenges do educators face when utilising ER simulators and ICT for blended learning?

The analysis of the educators' responses about the challenges they faced when utilising ER simulators for blended learning implications of organising interdisciplinary activities of ER and Art, identified four different themes (see Table 6.A, column 'Theme'):

- Technical Issues,
- Design Issues,
- Student Issues, and
- No Issues

These themes were further analysed in two levels of detail reflected in Codes I and Codes II (see Table 6.B, columns 'Code I', 'Code II'). Also, educators' quotes are provided in Table 6.B (see Table 6.B, columns 'Code I', 'Code II', 'Quotes').

The difficulties encountered by educators in the four countries were distributed across technical, design and student issues (see Table 6.A, column "Theme").

The most prominent challenge for the Greek and Spanish educators was students' *engagement in blended learning activities with ER simulators* (GR:23.7%, SP:41.7%) (see Table 6.A, Theme: 'Students Issues'). Specifically, the educators reported difficulties in engaging students regarding both synchronous (SP:16.7%) and asynchronous sessions (GR:7.9%) (see Table 6.B). Moreover, they reported that it was more challenging to promote engagement in lower primary (GR:2.6%, SP:8.3%) than in middle and upper-primary education (GR:2.6%) (see Table 6.B). Finally, the educators reported limited students' participation (GR:5.3%, CZ:13.8%, SP:16.7%) (see Table 6.B). However, it is worth considering that even when students' participation in online classes was achieved, students were not actively engaged (GR:5.3%) (see Table 6.B).

The Slovak educators' responses (23.1%) emphasised the challenge of the *availability of appropriate robotic technologies* (see Table 6.A Code I: 'Appropriate Robotics technologies (simulators) availability'). Remarkably, they reported that students using simulators resulted in missing the use of physical robots' sensors (10.3%) (see Table 6. B Code II: 'Simulators missing sensors') and other additional components (2.6%) (see Table 6. B Code II: 'Simulators missing additional components'). Also, they claimed that in a face-to-face teaching context, there were not enough robots to distribute to students to study at home (10.3%) (see Table 6.B Code II" 'Not enough robotic kits to distribute to the students').

The Czech educators' responses (27.6%) raised the issue of designing blended learning with simulators (see Table 6.A Code I: "Online Modality"). As seen in Table 6.B, the educators highlighted the following problematic issues: i) *communication management* (10.3%), ii) the *lack of non-verbal communication* (6.9%), iii) the *lack of collaboration* (6.9%) and (iii) that online teaching may be *difficult in terms of time* (3.4%). As a result, educators expressed concerns about various design and technical issues, bringing to the fore the challenge of engaging students using simulators.

Table 6.A Two-level coding of educators' responses on the challenges they faced when utilising ER simulators for blended learning (IQ2.2).

Theme	Code I	Greece (N=38)					Slovakia (N=39)					The Czech Republic (N=29)					Spain (N=12)				
		P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%
Technical Issues	Appropriate Robotics technologies (simulators) availability			3		7.9	2	7			23.1		1			3.4					0.0
	Appropriate ICT technologies availability	3				7.9	2	3	2	1	20.5	2	3	1		20.7	1	1			16.7
	ICT malfunction	1			1	5.3		4	1		12.8	1	4	1		20.7					0.0
Design Issues	Online modality	5				13.2	3	1	1	1	15.4	3	3	1	1	27.6					0.0
	ER simulators			1		2.6	1		1		5.1			1		3.4					0.0
	Accommodate different student profiles				1	2.6	1	1	1		7.7					0.0	1				8.3
	School management	1				2.6	1				2.6		1			3.4					0.0
	Digital Material		2		1	7.9		1			2.6					0.0					0.0
Student Issues	Engagement	5	2		2	23.7		1	2		7.7	1	2	1	1	17.2	3	2			41.7
	Adaptability		1	1		5.3					0.0			1		3.4					0.0
	Ability to follow instructions		1			2.6					0.0					0.0					0.0
	Family interventions	2	2			10.5	1				2.6					0.0	1	3			33.3
No Issues	No difficulties	1	2			7.9					0.0					0.0					0.0

Table 6.B Three-level coding (Themes, Code I, Code II, Quotes) of educators' most frequent responses on IQ2.2.

Themes	Code I	Code II	Greece (N=38)					Slovakia (N=39)					The Czech Republic (N=29)					Spain (N=12)					Quotes
			P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	
Technical Issues	Appropriate Robotics technologies (simulators) availability	Simulators missing sensors			1		2.6	1	3			10.3		1			3.4					0	*"... ER simulators cannot simulate many robotic sensors " (SK)*
		Simulators missing additional components			1		2.6		1			2.6										0	*"As it was not possible to implement in that simulator, I looked for other simulators supporting adequate components." (SK)*
		Not enough robotic kits to distribute to the students			1		2.6	1	3			10.3										0	*"We did not have enough construction kits to provide to the students for them to take home." (SK)*
Design Issues	Online modality	Communication management in a synchronous session (lower primary)	3				7.9					0	2		1		10.3					0	*"... did not participate because he was too embarrassed to speak. My difficulty was more in managing the online class than the activity itself." (GR)*
		Lack of nonverbal communication					0	2			1	7.7	1	1			6.9					0	*"I did not know if they understood my instructions. The non-verbal communication was absent, and therefore, I did not know how they were doing." (SK)*
		Time limitation/challenging					0	1	1	1		7.7		1			3.4					0	*"...students performed slower. I did not address as many topics as in a normal f2f class" (SK)*
		Lack of collaboration	2				5.3					0		1		1	6.9					0	*"... there is no teamwork ." (GR)*

Themes	Code I	Code II	Greece (N=38)					Slovakia (N=39)					The Czech Republic (N=29)					Spain (N=12)					Quotes
			P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	
Student Issues	Engagement	Lack of engagement in synchronous sessions					0	1	2			7.7						1	1			16.7	*They did not participate because they did not know how to navigate designated links or forgot instructions. (GR)*
		Lack of engagement in asynchronous sessions	1	2			7.9					0		1			3.4					0	*"... when we are working on tinkering, assembling, playing, building, and all that, we may use ER simulators. (SP)*
		Promoting students' engagement in a synchronous session (lower primary)	1				2.6					0						1				8.3	*"Students were not as independent as required. I had to share my screen for instructions and respond to their queries simultaneously." (SP)*
		No engagement difficulties for students of middle and upper primary school (age 8-11)	1				2.6					0										0	*"... with the grown-ups, 4th, 5th, 6th grade, we were fine." (GR)*
		Limited students participation	2				5.3					0	1	1	1	1	13.8	1	1			16.7	*"Unfortunately, students participated scarcely." (GR)*
		Students could not participate interactively in online classes				2	5.3					0										0	*"The kids were not participating. They were just watching." (GR)*
No Issues	No difficulties	Not important difficulties	1	2			7.9					0										0	*I expected to have difficulties. Nevertheless, being honest, I did not have any special ones (GR)*

T2.3 The implications

IQ2.3 What are the implications of utilising ER simulators and ICT for blended learning?

The analysis of the educators' responses about the implications of utilising ER simulators and ICT for blended learning implications, identified three different themes (see Table 7.A, column 'Theme'):

- ➢ Student engagement,
- ➢ Educator Practice, and
- ➢ No Implications

These themes were further analysed in two levels of detail reflected in Codes I and Codes II (see Table 7.B, columns 'Code I', 'Code II'). Also, educators' quotes are provided in Table 7.B (see Table 7.B, columns 'Code I', 'Code II', 'Quotes').

We noted a notable percentage of Greek (53.5%), Czech (58.3%), and Spanish (100%) educators' responses who deemed having no benefits from utilising ER for online learning. However, several responses supported the potential of ER simulators for blended learning.

An interesting finding about a positive effect of using ER simulators was implementing *effective teaching practices* (GR 26.7%, SK 58.8%, CZ 25%) (see Table 7.A). In particular, (see Table 7.B) the responses included several perspectives of effective teaching:

(i) provide educators with the flexibility to teach from another region (SK 10%) (see Table 7.B, Code II: 'Flexible educator - can teach from another city'),

(ii)) save educators' time (see Table 2.B, Code II 'Synchronous sessions more efficient than f2f') ,

(iii) allow a learning activity's recording (see Table 2.B, Code II 'Online recording of student activity'),

(iv) facilitate educators to see students' work (see Table 2.B, Code II 'Educator sees all students' projects at once'),

(v) resolve the lack of physical robots (see Table 2.B, Code II 'Use of simulators when there is a lack of physical robots'),

(vi) substitute ER f2f practice (see Table 2.B, Code II 'No need to skip ER'),

(vii) facilitate educators to carry out activities that are not easily feasible in real life (see Table 2.B, Code II: 'Activities that are not feasible in real life'), and

(viii) increase educators' digital competences (see Table 2.B, Code II 'Increase teacher's digital competence').

Table 7. A. Two-level coding of educators' responses on the implications of utilising ER simulators and ICT for blended learning (IQ2.3).

Theme	Code I	Greece (N=15)					Slovakia (N=17)					The Czech Republic (N=12)					Spain (N=5)				
		P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%
Student learning	Collaborative learning					0.0		4			23.5					0.0					0.0
Student Engagement	Behavioural	2			1	20.0	1				5.9		1			8.3					0.0
Educator Practice	Mindset				1	6.7	1				5.9			1		8.3					0.0
	Collaboration					0.0			1		5.9					0.0					0.0
	Effective teaching (educators' knowledge, strategies and conduct)	2	1			26.7	1	6	3		58.8		2	1		25.0					0.0
No Implications	No benefits from online learning	3	5			53.3					0.0	4	2	1		58.3	3	1	1		100

Table 7.B. Three-level coding (Themes, Code I, Code II, Quotes) of educators' most frequent responses on IQ2.3.

Themes	Code I	Code II	Greece (N=15)					Slovakia (N=17)					The Czech Republic (N=12)					Spain (N=5)					Quotes
			P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	
Educator practice	Effective teaching (educator knowledge, strategies, and conduct)	Flexible educator - can teach from another city					0.0			1		10.0					0.0					0.0	*"... I could travel to my husband's family back east and teach from there." (SK)*
		Online recording of student activity		1			6.3					0.0					0.0					0.0	*"... the platform records students' activity" (GR)*
		Use of simulators when there is a lack of physical robots					0.0		2			20.0					0.0					0.0	*"... as we cannot afford to buy robots, we use ER simulators in tablets" (CZ)*
		Activities that are not feasible in real life					0.0		1	1		20.0					0.0					0.0	*"e.g. Mars exploration - you cannot realistically build a Mars rover in a classroom" (SK)*
		No need to skip ER					0.0		1			10.0					0.0					0.0	*"The school has to deal with whether it can lend robots to students to take home during distance learning and whether to teach robotics at all. This is not the case with software stuff. A simulator will certainly help in this case." (SK)*
		Educator sees all students' projects at once					0.0	1				10.0					0.0					0.0	*"... that I am taking advantage of being able to see all students' projects. And I can also send it out to everybody..." (SK)*
		Synchronous sessions are more efficient than f2f	2				12.5		2	1		30.0					0.0					0.0	*"... although I prefer face-to-face interaction, I acknowledge that online sessions save me some class time." (GR)*
		Increase teacher`s digital competence					0.0					0.0		2	1		30.0					0.0	*"..so the schools moved forward. Otherwise, it would still be pencil and paper." (CZ)*
No Implications	No benefits	No benefits from online learning	1	5			37.5					0.0	2	2			40.0	3	1	1		100	*"In primary education, the pandemic's aftermath is that online is not the solution" (SP)* *"... I do not think that robotics can be done remotely. When you practice STEM, you simply miss the "M" of Mechanics." (GR)*

T2.4 The mindset

IQ2.4 How can educators' mindset shift towards integrating ER simulators and ICT for blended learning?

The analysis of the educators' responses on how can educators' mindset shift towards integrating ER simulators and ICT for blended learning, identified four different themes (see Table 8.A, column 'Theme'):

- Learning Content,
- Collaboration,
- Technology utilisation, and
- Educational Practice

These themes were further analysed in two levels of detail reflected in Codes I and Codes II (see Table 8.B, columns 'Code I', 'Code II'). Also, educators' quotes are provided in Table 8.B (see Table 8.B, columns 'Code I', 'Code II', 'Quotes').

During the focus groups and interview sessions, the educators came up with proposals to change the educators' mindset toward integrating ER simulators and ICT for blended learning. They mainly focused on teaching strategies, meaning ideas related to *online learning* (SK:66.7%), *complementary online activities for students* (SP:37.5%, GR:20%), and *flipped classroom* (GR:40%, SK:33.3%) (see Table 8.A).

The responses of Czech educators (37.5%) highlight the potential of using simulators instead of physical robots (see Table 8.A, Theme: 'Technology utilisation').

Regarding online learning, the educators stated that online sessions could alternate some face-to-face courses. They also stated that online courses might be an adequate alternative when students do not have the opportunity to participate in face-to-face sessions, such as in case of illness (see Table 8.B, Code I: 'Online Learning').

Regarding complementary online activities, the educators proposed (i) having students work asynchronously with simulators as homework (see Table 8.A, Code I 'Complementary Online activities for students' and Table 8.B Code II: 'Work asynchronously with simulators as homework') (CZ:25%, GR:15%) and (ii) providing extra asynchronous activities for those interested (see Table 8.B, Code II: 'Complementary Online activities for students' and Table 8.B, Code II: 'Provide extra asynchronous activities for those interested') (CZ:12.5%).
The educators proposed two cases for implementing a flipped classroom to extend the face-to-face lessons. The first case involved online asynchronous activities (GR 10%, SK 33.3%). The second case involved activities where the programming is done at home, and then the implementation in the physical robot is done in the classroom (GR 30%)(See Table 8.B, Code I: 'Flipped classroom').

Thus, we observed that teachers pursue the potential offered by the simulators by proposing mainly ideas related to extending the physical classroom with online activities.

Table 8.A Two-level coding of educators' responses on how can educators' mindset shift towards integrating ER simulators and ICT for blended learning (IQ2.4).

Theme	**Code I**	**Greece (N=20)**					**Slovakia (N=3)**					**The Czech Republic (N=8)**					**Spain (N=0)**				
		P	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**
Learning Content	Online content delivery	1	1	1		15.0					0.0		2			25.0					0.0
Collaboration	Educational community collaboration	2				10.0					0.0					0.0					0.0
Technology utilisation	ER simulators instead of physical robots	1	2			15.0					0.0	1	1	1		37.5					0.0
Teaching strategies	Online learning					0.0		1		1	66.7					0.0					0.0
	Complementary Online activities for students	3		1		20.0					0.0		3			37.5					0.0
	Flipped classroom	3	5			40.0			1		33.3					0.0					0.0

Table 8.B Three-level coding (Themes, Code I, Code II, Quotes) of educators' most frequent responses on IQ2.3.

Theme	Code I	Code II	Greece (N=20)					Slovakia (N=3)					The Czech Republic (N=8)					Spain (N=0)					Quotes
			P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	
Learning Content	Online content delivery	Means of content delivery (blog, eclass, email)	1	1	1		15.0		2			25.0					0.0					0	*"Since time is limited, I used eclass." (GR)*
Technology utilisation	ER simulators instead of physical robots	Simulators are low budget devices (microbit, edison)	1				5.0					0.0	1	1	1		37.5					0	*"...economic benefit. I do not need to buy robotic kits" (CZ)*
		Simulators where physical robots are not provided		2			10.0					0.0					0.0					0	*"... we do not have the hardware, so we turn to simulators." (GR)*
Teaching Strategies	Online learning	To alternate online and F2F lessons					0.0		1			33.3					0.0					0	*"I can imagine, in principle, alternating online and f2f" (SK)*
		Online classes for ill students					0.0				1	33.3					0.0					0	*"Normally, they would not come to class because they were slightly ill. But, they can connect online from home." (SK)*
	Complementary Online activities for students	Work asynchronously with simulators as homework	2		1		15.0					0.0		2			25.0					0	*"... working on it at home and then coming back and being better prepared." (GR)*
		Provide extra asynchronous activities for those interested	1				5.0					0.0		1			12.5					0	*"... give them some optional tasks on easy subjects as homework" (GR)*
	Flipped classroom	Extent the f2f lessons with online asynchronous activities, e.g. theory to be done online and practice to be done f2	2				10.0			1		33.3					0.0					0	*"... give them homework on the weekend to work on the basic IT concepts, and then discuss during the lesson at school." (GR)*
		A flipped classroom by doing the programming at home and the implementation in the physical robot in the classroom.	1	5			30.0					0.0					0.0					0	*"... do some preparation at home, e.g., code for the problem you have set for them, and in school, they can download and run it." (GR)*

T2.5 The support required

IQ2.5 What type of support do educators require to utilise ER simulators and ICT for blended learning?

The analysis of the educators' responses on the type of support educators need when integrating ER simulators and ICT for blended learning, identified four different themes (see Table 9.A, column 'Theme'):

- ➢ Educational context,
- ➢ Technical Issues
- ➢ Design Issues, and
- ➢ Learning Content

These themes were further analysed in two levels of detail reflected in Codes I and Codes II (see Table 9.B, columns 'Code I', 'Code II'). Also, educators' quotes are provided in Table 9.B (see Table 9.B, columns 'Code I', 'Code II', 'Quotes').

Most Czech and Greek educators' responses asked for support related to the educational context. The educational context included *school management* (see Table 9.A)(CZ:33.3%, GR:47.6%) requiring financial support for technologies (see Table 9.B) (CZ:22.2%, GR:28.6%, SK:8.9%), and more hours available for ER lessons (SK:6.7%, GR:4.8%) (see Table 9.A). Also, regarding *educator training* (CZ:33.3%, GR:19%), they highlighted the need for training through seminars (CZ:22.2%, GR:14.3%) (see Table 9.B).

Moreover, the Spanish educators' responses included two unique requests concerning **methodology** (see Table 9.A)**.** Some Slovak (8. 9%) and Greek (9.5%) educators also made the same requests. Moreover, the Spanish educators expressed the need for a design methodology for using simulators in a blended learning context (see Table 9.B). Finally, Slovak educators (22.2%) asked for support in terms of the *availability of appropriate robotic technologies* (see Table 9.A, Codes I)**,** and in particular, required the provision of sufficient Internet connection (4.4%) as well as free access to learning platforms/software (17.8%) (see Table 9.B).

Therefore, we observed that educators asked for several means of support. Still, most responses concerned the *financial support* of technologies and the need to *train educators* to design lessons using ER simulators in a blended learning context.

Table 9.A Two-level coding of educators' responses on the type of support they require when utilising ER simulators and ICT for blended learning (IQ2.5).

Theme	Code I	Greece (N=21)					Slovakia (N=45)					The Czech Republic (N=9)					Spain (N=2)				
		P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%
Educational Context	School management	3	4	2	1	47.6	2	3		2	15.6	2		1		33.3					0.0
	Educator training		2	2		19.0	3	2	1	2	17.8	1	2			33.3					0.0
Design Issues	ER simulators					0.0		3	1		8.9										0.0
	Materials					0.0	2	4	1	1	17.8										0.0
	Methodology	2				9.5		4			8.9						2				100.0
Technical Issues	Appropriate Robotics technologies availability			1	1	9.5		1	1		4.4										0.0
	Appropriate ICT technologies availability			1		4.8	2	5	2	1	22.2		1			11.1					0.0
Learning Content	Repository		2			9.5		1		1	4.4		2			22.2					0

Table 9.B. Three-level coding (Themes, Code I, Code II, Quotes) of educators' most frequent responses on IQ2.5

Theme	Code I	Code II	Greece (N=21)					Slovakia (N=45)					The Czech Republic (N=9)					Spain (N=2)					Quotes
			P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	
Educational context	School management	Financial support for technologies	3	3			28.6	1	2		1	8.9	1		1		22.2					0.0	*"... not enough robots for the kids to practice. We keep asking the school management..." GR)*
		Hybrid Classrooms			1		4.8					0.0					0.0					0.0	*"...have cameras...form hybrid spaces, be able to move around and interact. "(GR)*
		Assistants for older teachers to organise online teaching			1		4.8					0.0					0.0					0.0	*"... someone to assist teachers. Someone who knows how to use the tools and assist them." (GR)*
		Need for technical experts				1	4.8					0.0	1				11.1					0.0	*"...the support we had in quarantine from an IT colleague. I was communicating on Viber to ask her what to do.... That was really helpful." (GR)*
		More time/hours		1			4.8	1	1		1	6.7					0.0					0.0	*"...in the time allotted, it's basically unfeasible" (SK)*
	Teacher training	Need for teacher training: Seminars		2	1		14.3				1	2.2	1	1			22.2					0.0	*"I constantly need training..." (GR)*
		Need for teacher training					0.0	3	2	1		13.3					0.0					0.0	*"... some webinars in addition to the materials" (SK)*
		Redesigning the courses to include the new tools/methods			1		4.8				1	2.2		1			11.1					0.0	*" ...update and reformulate courses."(GR)*
Design Issues	Methodology	Need for a design methodology	2				9.5		2			4.4					0.0	2				100,0	*A methodology that prioritizes developing projects over the actual subject topics." (SP)*
		Methodology expert					0.0		1			2.2					0.0					0.0	*"... an expert to consult directly regarding an appropriate design methodology" (SK)*
Technical Issues	Appropriate ICT technologies availability	Sufficient internet connection					0.0		1	1		4.4					0.0					0.0	*"... there were 3 of us working online, so the network was overloaded" (SK)*
		Free access to learning platforms/software			1		4.8	2	4	1	1	17.8		1			11.1					0.0	*"... provide free software. To have access to several ER simulators."(GR)*

Issue 3. What experience do educators have with ER and Computational Thinking?

T3.1 The Design ideas

IQ3.1 How have educators designed ER activities to promote students' Computational Thinking?

The analysis of the educators' responses about their experience or ideas when designing ER activities to promote students' Computational Thinking, identified seven different themes (see Table 10.A, column 'Theme'):

- CT Data representation promotion,
- CT Algorithmic Thinking promotion,
- CT Decomposition promotion,
- CT Abstraction promotion,
- CT Pattern Recognition promotion,
- CT Conceptualization, and
- No experience

These themes were further analysed in two levels of detail reflected in Codes I and Codes II (see Table 10.B, columns 'Code I', 'Code II'). Also, educators' quotes are provided in Table 10.B (see Table 10.B, columns 'Code I', 'Code II', 'Quotes').

Computational thinking seems to be approached initially as problem-solving and/or algorithmic thinking eliminating the various dimensions of abstraction, decomposition, evaluation, etc. Therefore, we observed that educators perceive computational thinking as a problem-solving process and associate it directly with programming as a way of cultivating algorithmic thinking. Many primary and secondary teachers referred to Computational Thinking mainly as a problem-solving process (see Table 10.B). Although they described activities that were used to cultivate the various dimensions of Computational Thinking, except for Algorithmic Thinking (see Table 10.B), most did not refer to terms such as Abstraction, Decomposition, Evaluation, etc. The researchers were the ones who often had to associate the activities with the corresponding concepts.

When explaining in detail the activities they designed, two important points for analysis emerged: most frequently, the educators design CT activities either to promote CT Conceptualisation or Algorithmic Thinking (see Table 10.A).

Regarding CT Conceptualization the responses (see Table 10.B) mainly focused on the *problem-solving dimension of CT* (SP:41.7%, CZ:31.8%, GR:26.7%, SK:8.9%). Most educators mentioned that they designed "Problem-solving activities with ER" (SP:33.3%, CZ:22.7%, GR:13.3%. SK:8.9%) (see Table 10.B, Code II: 'Problem-solving activities with ER').

The Slovak, Spanish and Czech educators reported designing activities related to Algorithmic Thinking promotion (see Table 10.B) focusing on its main component, "*Input/ Output Data*" (SK 42.2%, SP 33.3%, CZ 22.7%, GR: 13.3%). These activities addressed general algorithmic concepts such as ordered steps (SK: 6.7%), or more specific programming concepts such as sequences (SK: 13.3%), conditions (SK: 8.9%) and variables (SK: 6.7 %, CZ:13.6%) (see Table 10.B).

Some educators (GR:13.3%, SK:2.2%, CZ:4.5%) stated having no CT experience (see Table 10.A, Theme: 'No CT experience'). In this line, a finding not included in the FERTILE coding scheme is worth mentioning. This finding involved the underlying researchers' observation that educators, even those with an ICT background) had several misconceptions about CT.

Table 10.A. Two-level coding of educators' responses on how they designed ER activities to promote students' Computational Thinking (IQ3.1).

Theme	**Code I**	**Greece (N=30)**					**Slovakia (N=45)**					**The Czech Republic (N=22)**					**Spain (N=12)**				
		P	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**
CT Data representation promotion	Datastore					0.0		2			4.4					0.0					0.0
	Data process	1		2		10.0		2			4.4			1		4.5			1	1	16.7
CT Algorithmic Thinking promotion	Input / Output data	4				13.3	5	14			42.2	2	2	1		22.7	3	1			33.3
	Algorithmic construct (sequence, selection, and iteration)					0.0	2		1		6.7					0.0	1				8.3
	Debugging and Optimisation	1				3.3	1	1	1		6.7					0.0					0.0
CT Decomposition promotion	Analysis				1	3.3	4		2		13.3					0.0					0.0
CT Abstraction promotion	Control Abstraction	1				3.3					0.0					0.0					0.0
CT Pattern Recognition promotion	Geometric figures as patterns	1		2		10.0		5			11.1		1		2	13.6					0.0
	Colours as patterns			1		3.3					0.0			1		4.5					0.0
CT Conceptualization	Problem-solving	2	4	2		26.7	1	2	1		8.9	2	2	2	1	31.8	2	2		1	41.7
	CT concepts		2	2		13.3					0.0		2	2		18.2					0.0
No CT experience		1	2		1	13.3				1	2.2	1				4.5					0.0

Table 10.B. Three-level coding (Themes, Code I, Code II, Quotes) of educators' most frequent responses on IQ3.1

Themes	Code I	Code II	Greece (N=30)					Slovakia (N=45)					The Czech Republic (N=22)					Spain (N=12)					Quotes
			P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	
CT Algorithmic Thinking promotion	Input / Output data	Variables					0.0	1	2			6,7		2	1		13.6					0.0	*"...with the younger pupils, what would be hard to explain, for example, the variable, they might understand easier with robotics" (SK)*
		Play unplugged code game (Cody Roby)	1				3.3					0.0	1		1		9.1					0.0	*"... I had used CobyRoby, the one made with cards, basically for algorithmic thinking." (GR)*
		Activities creating ordered steps (sequencing)					0.0	1	2			6,7	1				4.5					0.0	*" Students have to realize that they cannot program the robot how they want... they need to think about consequences of each step (CZ)*
		Activities creating ordered steps	2				6.7		1			2,2					0.0	1	1			16.7	*"... how they make a paper boat and ... how to select coloured clothes for a washing machine." (GR)*
		Conditions (with sensors)					0.0	1	3			8,9					0.0					0.0	*"Now remember the garage task, where we basically trained a conditional command" (SK)*
		Loops					0.0	1	2			6,7					0.0					0.0	*"quite nice use of repetition - cycle, it was quite nice there" (SK)*
		Play music sound sensors, notes, sequences	1				3.3	1	4		1	13,3					0.0	1				8.3	*"... if we consider music, there are repetitions that make sense to code them" (SK)*
CT Conceptualization	Problem-solving	Authentic problem-solving activities without ER		2	1		10.0					0.0		1		1	9.1				1	8.3	*"For example, we have the problem: I want to get up and go to my school. What steps do I need to take to go to my school?" (GR)*
		The problem-solving process (CT) to be used in the creation of artwork		1			3.3					0.0					0.0					0.0	*"... the point is for students to develop problem-solving skills ... to move on to synthesizing the solutions of the sub-problems. (GR)*
		Problem-solving activities with ER	2	1	1		13.3	1	2	1		8.9	2	1	2		22.7	2	2			33.3	*"... consider alternative solutions and then either with the simulation from the beebot or with the real beebot... " (GR)*

3.2 The Challenges

IQ3.2 What challenges do educators face when designing ER activities to promote students' Computational Thinking?

The analysis of the educators' responses about the challenges they faced when designing ER activities to promote students' Computational Thinking identified six different themes (see Table 11.A, column 'Theme'):

- Design Issues,
- CT,
- Educational context,
- Curriculum Issues,
- Student Issues, and
- Technical Issues

These themes were further analysed in two levels of detail reflected in Codes I and Codes II (see Table 11.B, columns 'Code I', 'Code II'). Also, educators' quotes are provided in Table 11.B (see Table 11.B, columns 'Code I', 'Code II', 'Quotes').

Table 11 shows that most educators' responses were distributed on challenges around designing, educational context, and student issues.

Regarding design issues, many Greek educators' responses (30.8%) (see Table 11.A, Code I "*Effort*") indicated that additional workload (see Table 11.B, Code II "Teacher effort in designing the activities") is required to design and prepare ER activities aiming to foster computational thinking. The Czech educators' responses (26.7%) also highlighted a design issue, such as adapting the course to different profiles of students (see Table 11.A, Code I: 'Accommodate different student profiles') and specifically their cognitive level (see Table 11.B, Code II "Students' different level on CT").

The Slovak educators' responses focused more on students' issues, especially in the subject of *programming skills* (21.6%) (see Table 11.A), claiming mainly (8.1%) that students are often involved with concepts that they find hard to understand (see Table 11.B, Code II: 'Complex concepts - students cannot understand'). Furthermore, they highlighted issues related to student *engagement* (21.6%) (see Table 11.A), as students often lose interest due to, e.g., factors affecting the operation of robots (13.5%) (see Table 11.B, Code II "Demotivation because of factors influencing robots working").

Finally, many Spanish educators' responses (33.3%) and those of other countries (GR:23.1%, SK:13.5%, CZ:13.3%) converged on *school management* issues (see Table 11.A, Code I: 'School management'). In this context, the Spanish educators' responses highlighted again the financial problem of purchasing robotics technology (see Table 11.B, Code II "No money to buy robotic material"). For the same issue, other educators mentioned that there was insufficient time to carry out such activities (see Table 11.B, Code II: "Classroom time") .

Therefore, we observe that Computational Thinking's promotion through ER activities entailed three significant challenges regarding (i) *designing and conducting ER activities* (workload and time required for designing and conducting lessons), (ii) *students' lacking programming skills*, and (iii) *financial issues* around acquiring and maintaining robotic technologies.

Table 11.A Two-level coding of educators’ responses on the challenges they faced when they designed ER activities to promote students’ CT (IQ3.2).

Theme	Code I	Greece (N=13)					Slovakia (N=37)					The Czech Republic (N=15)					Spain (N=12)				
		P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%
Design Issues	Accommodate different student profiles		1			7.7					0.0	1	2	1		26.7					0.0
	Effort	1	1	2		30.8		2	3		13.5			1		6.7		1		1	16.7
	Choose appropriate technologies			1		7.7					0.0		1			6.7					0.0
	Digital Materials					0.0	1	3			10.8			1		6.7	1	1			16.7
CT	CT Conceptualization		1	1		15.4		4	1		13.5	1		2		20.0			2		16.7
Educational context	School management		2	1		23.1	1	3	1		13.5		2			13.3	2	2			33.3
Curriculum Issues	Limitations					0.0					0.0					0.0	1			1	16.7
Student Issues	Programming Skills					0.0	2	5	1		21.6					0.0					0.0
	Engagement					0.0	4	4			21.6					0.0					0.0
	Ability to follow instructions		2			15.4	2				5.4		1			6.7					0.0
Technical Issues	Robot malfunction					0.0					0.0	1	1			13.3					0.0

Table 11.B. Three-level coding (Themes, Code I, Code II, Quotes) of educators' most frequent responses on IQ3.2

Theme	Code I	Code II	Greece (N=13)					Slovakia (N=37)					The Czech Republic (N=15)					Spain (N=12)					Quotes
			P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	
Design Issues	Accommodate different student profiles	Students' different levels on CT		1			7.7					0.0	1	2	1		26.7					0.0	*"Many students are discouraged from being involved considering that IT requires high skills. Having bad academic results, perhaps they underestimate themselves and assume that they cannot handle it" (CZ)*
	Effort	Time-consuming for teachers (preparation, maintenance)					0.0		1	2		8.1					0.0					0.0	*"...the second factor is the lack of time - when you do robotics, it takes far more time" (SK)*
		Teacher effort in designing the activities	1	1	2		30.8		1	1		5.4			1		6.7		1		1	16.7	*"It takes quite some time to design an activity. To structure an introduction, the worksheets, if any, to do group formation and the division of roles." (GR)*
Educational context	School management	Classroom time		2	1		23.1	1	3			10.8		2			13,3					0.0	*"... I feel that I do not have enough time in my classes for my students. (GR)*
		No money to buy robotic materials					0.0			1		2.7					0.0	2	2			33.3	*"...they continue to introduce new subjects like robotics without providing the appropriate economic resources to buy the material needed!" (SP)*
Student Issues	Programming skills	Students without experience with programming					0.0			1		2.7					0.0					0.0	*"An impending issue involves students' lack of experience in programming." (SP)*
		How to run a program					0.0		1			2					0.0					0.0	*"Some did not realize what instructions meant about that something will start..." (SK)*
		Sequence of steps					0.0		1			2.7					0.0					0.0	*"... they could not arrange the sequence of steps, as one step following the other" (SK)*
		Conditions					0.0		1			2.7					0.0					0.0	*"... they could not understand what a branch is. To consider what happens in a condition when the answer is yes and when the answer is no, was a problem for them." (SK)*

Theme	Code I	Code II	Greece (N=13)					Slovakia (N=37)					The Czech Republic (N=15)					Spain (N=12)					Quotes
			P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	
Student Issues	Programming Skills	Difficult to find a problem (construction? Programming? Robotic kit?)					0.0		1			2.7					0.0					0.0	*"...it was hard to find the fault, because the fault could have been in the program, or the wiring, or to a component that stopped working" (SK)*
		Complex concepts - students cannot understand					0.0	2	1			8.1					0.0					0.0	*"... the student may not quite know algorithmization.... the student thinks he knows how to program, but he only knows how to modify some existing code! "(SK)*
	Engagement	Lack of attitude to improve their solution					0.0	1	1			5.4					0.0					0.0	*Some students are annoyed when their construction does not work and then give up. (SK)*
		Demotivation because of factors influencing robots' working					0.0	2	3			13.5					0.0					0.0	*"...when programming is adequate, but the robot doesn't do what it's supposed to do, it often discourage those clever pupils" (SK)*
		Problem with self-confidence among girls instead of boys					0.0	1				2.7					0.0					0.0	*"Girls do not usually have confidence while boys are more persistent than girls. However, many girls are sometimes smarter..." (SK)*

T3.3 The implications

IQ3.3 What are the implications of utilising ER to promote students' Computational Thinking?

The analysis of the educators' responses about the implications of utilising ER activities to promote students' Computational Thinking, identified three different themes (see Table 12.A, column 'Theme'):

- Student engagement,
- Student Learning, and
- Student Skills

These themes were further analysed in two levels of detail reflected in Codes I and Codes II (see Table 12.B, columns 'Code I', 'Code II'). Also, educators' quotes are provided in Table 12.B (see Table 11.B, columns 'Code I', 'Code II', 'Quotes').

Most of the educators' responses (GR:41.2%, CZ:28.6%, SK:8.5%, SP:25%) tended toward the promotion of **Computational Thinking** skills through ER activities. They claimed that it is particularly important regarding students' skills (see Table 12.A, Theme: 'Student Skills') acknowledging that CT is (i) *a fundamental skill* and (ii) *a lifelong problem solving skill* (see Table 12.B, Code II:CT is a fundamental skill' and 'CT is a lifelong problem-solving skill' respectively).

Many Spanish educators' responses acknowledged the contribution of ER activities to students' *cognitive* (SP:25%) and *emotional engagement* (SP:25%) (see Table 12.A). They claimed that ER activities facilitated the educators to distinguish the less engaged and the high-performing students (see Table 12.B Code II: 'Separates the less engaged from the high-performing students'). Also, some claimed that their students' positive attitudes increased (see Table 12.B Code II: 'Increases students' positive attitude (entertainment)'). Greek, Slovak, and Czech educators' responses (GR:11.8%, SK: 12.1%, CZ:10.7%) also acknowledged the added value of student emotional engagement (see Table 12.A) but to a lesser extent than in Spain.

Finally, many Slovak educators' responses (23.4%) mentioned the added value of the *feedback* provided to the students (see Table 12.A Code I: 'Feedback provision') and in particular (see Table 12.B) the possibility of self and peer assessment (see Table 12.B Code II: 'CT Evaluation through self and peer assessment') (10.6%), as well as direct feedback (see Table 12.B, Code II: 'Immediate, visible output') (12.8%).

We observed that educators highlighted the relevance of CT skills, which may be cultivated through ER. Additionally, the ER activities *provided feedback* and enhanced their students' *emotional and cognitive engagement*.

Table 12.A. Two level coding of educators' responses on the implications of utilising ER to promote students' CT (IQ3.3).

Theme	Code I	Greece (N=25)					Slovakia (N=30)					The Czech Republic (N=15)					Spain (N=20)				
		P	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**	**P**	**S**	**H**	**A**	**%**
Student Engagement	Cognitive			1		5.9	1	1	1		6.4					0.0	2				25
	Behavioral	1				5.9					0.0		2		1	10.7				1	12.5
	Emotional	1		1		11.8		5	1		12.8	2			3	17.9	1			1	25
Student Learning	Authentic learning			1		5.9		6	2		17.0	1	1			7.1					0.0
	Playful learning					0.0	1	2	1		8.5		2	1	1	14.3					0.0
	Experiential learning					0.0		2	1		6.4					0.0					0.0
	Collaborative learning	1				5.9	1	3	1		10.6					0.0					0.0
	Feedback provision	1				5.9	2	6	3		23.4			3	1	14.3					0.0
Student Skills	CT	2	2	2	1	41.2	1	2	1		8.5	1	2	3	2	28.6	1		1		25.0
	Abstraction			1		5.9		1			2.1		1			3.6				1	12.5
	Cognitive			2		11.8	1	1			4.3		1			3.6					0.0

Table 12.B. Three-level coding (Themes, Code I, Code II, Quotes) of educators' most frequent responses on IQ3.3

Theme	Code I	Code II	Greece (N=17)					Slovakia (N=47)					The Czech Republic (N=28)					Spain (N=8)					Quotes
			P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	
Student engagement	Cognitive	Increases girls' interest			1		5.9	1				2.1					0.0					0.0	*"...girls are intrigued by creative activities and devote much time working that a boy would not normally do." (GR)*
		Separates the less engaged from the high-performing students					0.0			1		2.1					0.0	2				25.0	*"... allows evaluating students. Those being less engaged from those being persistent and highly performing." (SK)*
		Easier to understand the easier informatics concepts, e.g. variables					0.0		1			2.1					0.0					0.0	*"...with the younger pupils, what would be hard to explain, for example, the variable, they might understand easier with robotics" (SK)*
	Emotional	Promotes Expressing feelings			1		5.9		1			2.1	1			1	7.1					0.0	*"To express emotions. So that is where art comes in" (GR)*
		Increases students' positive attitude (entertainment)	1				5.9		4	1		10.6	1			2	10.7	1			1	25.0	*"... they like it very much. Because it is straightforward. They just did something and see it." (SP)*
Student Learning	Feedback provision	CT Evaluation through self and peer assessment	1				5.9	1	2	2		10.6					0.0					0.0	*"... they were able to compare who had made the better choice of the two." (GR)*
		Immediate, visible output					0.0	1	4	1		12.8					0.0					0.0	*"...the benefit is that they have visible output and get immediate feedback. "(SK)*
		Promote interdisciplinarity					0.0					0.0			1		3.6					0.0	*"The development of CT consists in the fact that it is not limited to the field of IT, but is an interdisciplinary issue that intersects with a larger number of areas. (CZ)*
		Promote creativity					0.0					0.0			2	1	10.7					0.0	*"including such activities in the 8th or 9th grade would be an excellent motivational element to whip up their imagination and creativity. And even more, they are already in such a phase of thinking that it could also push them further concerning other subjects (CZ)*

Theme	Code I	Code II	Greece (N=17)					Slovakia (N=47)					The Czech Republic (N=28)					Spain (N=8)					Quotes
			P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	
Student Skills	CT	CT is innate in various art forms				1	5.9					0.0				1	3.6					0.0	*"In the visual arts, whatever you try to do, you need to calculate your movements. So you definitely use computational thinking. (GR)*
		Promotes algorithmic thinking					0.0	1	1			4.3					0.0					0.0	*"I think that it develops logical thinking"(SK)*
		CT is a fundamental skill for active citizenship			1		5.9					0.0					0.0					0.0	*"Computational thinking makes you an active citizen" (GR)*
		CT is a fundamental skill		1	1		11.8		1	1		4.3			1		3.6	1				12.5	*"Whatever you study, you need CT skills. If you do not have them, let's say you won't be able to compete with others."(GR)*
		CT is a lifelong problem-solving skill	2	1			17.6					0.0	1	2	2	1	21.4			1		12.5	*"...Computational thinking is integral to our everyday practice. During our life, we are called to deal with problems. (GR)*

T3.4 The support required

IQ3.4 What type of support do educators require to utilise ER to promote students' Computational Thinking?

The analysis of the educators' responses about the type of support they require when designing ER activities to promote students' Computational Thinking, identified six different themes (see Table 13.A, column 'Theme'):

- Curriculum Issues
- Educational context
- Learning Content
- Design Issues
- Technical Issues
- No Need for support

These themes were further analysed in two levels of detail reflected in Codes I and Codes II (see Table 13.B, columns 'Code I', 'Code II'). Also, educators' quotes are provided in Table 13.B (see Table 13.B, columns 'Code I', 'Code II', 'Quotes').

The educators' responses in this issue (GR 25.0%, SK 25.0%, CZ 27.8%) reinforced the overall requirement for a ***repository*.** Specifically, they asked for (i) exemplar activities (see Table 13.B, Code II: 'Need for exemplar activities'), and (ii) a community platform for sharing ideas and designing collaboratively (see Table 13.B, Code II: 'Community platform for content & human resources - for sharing projects and finding co-designers').

According to the Spanish educators' responses, they need a supportive *school management* (21.4%) (see Table 13.B, Code II 'Makers' club') and appropriate *learning material* (21.4%) (see Table 13.A) specifically for Art teachers (see Table 13.B, Code II: "Materials for Art teachers").

Table 13.A. Two-level coding of educators' responses on the type of support they require to utilise ER toward promoting students' Computational Thinking (IQ3.4)

Theme	Code I	Greece (N=17)					Slovakia (N=16)					The Czech Republic (N=12)					Spain (N=15)				
		P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%
Curriculum Issues	Time allocation	1				3.1	1			1	5.0				1	5.6		2			14.3
	Interdisciplinary support	1				3.1					0.0	1				5.6			1	1	14.3
	Subject-based curriculum					0.0					0.0					0.0				1	7.1
Educational context	School management			1	2	9.4		1	1		5.0	1	1	1		16.7	1	1		1	21.4
	Interdisciplinary collaboration	1	1	2		12.5					0.0		2			11.1				1	7.1
	educator training	1	1			6.3	1	3	1		12.5			1	1	11.1					0.0
	educator community	2	2	2		18.8					0.0					0.0					0.0
Learning Content	Materials					0.0	3	1	1	1	15.0					0.0	2			1	21.4
	Repository	1	5	1	1	25.0	2	5	3		25.0		3	1	1	27.8					0.0
Design Issues	Methodology	1	4			15.6	1	6	2		22.5		1	2	1	22.2	1	1			14.3
	Materials					0.0	1	4			12.5					0.0					0.0
Technical Issues	Appropriate Robotics technologies availability					0.0	1				2.5					0.0					0.0
No Support	No need for support		2			6.3					0.0					0.0					0.0

Table 13.B. Three-level coding (Themes, Code I, Code II, Quotes) of educators' most frequent responses on IQ3.4

Theme	Code I	Code II	Greece (N=32)					Slovakia (N=40)					The Czech Republic (N=18)					Spain (N=14)					Quotes
			P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	
Educational context	School management	Create makers' clubs			1		3.1					0,0					0.0	1	1		1	21.4	*"In a makers club, you do not have the anxiety of wasting educative time. It may be more fun…". (GR)*
		Arts teachers to attend educational robotics in class				2	6.3					0,0	1	1	1		16.7					0,0	*"…I want to get acquainted with robotics, to see some action in a classroom." (GR)*
		Financial support					0.0		1	1		5.0					0.0					0.0	*"…finance and material provision certainly" (SK)*
Learning Content	Materials	Materials for Art teachers					0.0	1				2.5					0.0	2			1	21.4	*"…materials not only for informatics but also for art" (SK)*
		Video Tutorials					0.0	2	1	1	1	12.5					0.0					0.0	*"… maybe video tutorials would be helpful" (SK)*
		Textbooks, materials for students - to work independently					0.0		1			2.5					0.0					0.0	*"Such basic, simple teaching material, I would call it worksheets." (SK)*
	Repository	Need for exemplar activities	1	5	1	1	25.0	2	2	1		12.5		1		1	11.1					0.0	*"… have recommended activities that do not just provide a flow of tasks but elaborate on their objectives for both CT and Art." (GR)*
		Community platform for content & human resources - for sharing projects and finding co-designers					0.0		3	2		12.5		2	1		16,7					0.0	*" …some kind of electronic platform, some kind of website, not to use a written form, but videos of best practice…" (CZ)*
Design Issues	Methodology	Short useable methodology					0.0		2	1		7.5					0.0					0.0	*"…a short methodology for 15 min is realistic." (SK)*
		Less formalism		3			9.4			1		2.5			1	1	11.1					0,0	*"…scenarios should be well written, and they need to be simple to achieve an adequate enactment." (GR)*
		Need for a design methodology	1	1			6.3	1	4			12.5		1	1		11.1	1	1			14,3	*"…a framework that structures my practice, because right now it is a little bit up in the air. " (GR)*
No support	No need for support			2			6.3					0.0					0.0					0.0	*"We do not need any special help." (GR)*

Issue 4. What experience do educators have with ER technologies?

T4.1 The Technologies

IQ4.1 What ER technologies do educators utilise in their practice?

The analysis of the educators' responses about the type of support they require when designing ER activities to promote students' Computational Thinking, identified three different themes (see Table 14, column 'Theme'):

- Robotics kits,
- ER simulator technologies, and
- Programming environment.

These themes are further analysed in detail in Codes I (see Table 14.A.1, Table 14.A.2, Table 14.A.3 'Code I'). Since the responses refer to particular technologies, they are quite specific, thus not requiring further analysis. Thus, Table 14.B with Codes II and educators' quotes are not provided for this question.

There were various responses regarding the use of ER technologies in educators' practice. Educators mentioned **21 different robotics kits**, **12 ER simulators** and **7 programming environments** (see Tables 14. A.1, 14. A.2, 14. A.3). Although the response rates were uniformly distributed, it is worth noting that regarding robotics kits the Lego Mindstorms was mentioned by educators of all four countries (SK:15%, GR:9.4%, SP:6.7%, CZ:5.6%). Most responses about ER simulators mentioned Makecode for Micro:bit (SK:20%, GR:12 %, CZ:5.6 %) and Tinkercad (SK:7.5%, GR:6.3%, CZ:5.6%). Both ER simulators can also be used by physical robots. Lastly, the Scratch programming environment emerged as the most used programming environment (SP:20%, CZ:5.6%, SK:5%, GR:3%).

Table 14.A.1 Two-level coding of educators' responses on the technologies educators utilise in their practice (IQ 4) focusing on Robotics Kits

Theme	Code I	Greece (N=32)					Slovakia (N=40)					The Czech Republic (N=18)					Spain (N=14)				
		P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%
Robotics Kits	Arduino					0,0		2	1		7.5					0.0	1				6.7
	Artsy			1		3.1					0.0					0.0					0.0
	Beebot			1		3.1					0.0	1				5.6	1				6.7
	Bluebot			1		3.1					0.0			2		11.1	1				6.7
	Cubetto					0.0					0.0					0.0	1				6.7
	E-textiles (Arduino Lillypad, Flora)					0.0					0.0					0.0		1			6.7
	Edison		1			3.1					0.0					0.0					0.0
	Escornabot					0.0					0.0					0.0	1				6.7
	Kitronik + microbit					0.0			1		2.5					0.0					0.0
	Lego (not specified)					0.0	1	1	1		7.5					0.0					0.0
	Lego Mindstorms	1	2			9.4	1	4	1		15.0			1		5.6				1	6.7
	Lego Spike					0.0		1			2.5					0.0					0.0
	Makey-makey			1		3.1					0.0					0.0	1				6.7
	Microbit					0.0	3	5			20.0					0.0					0.0
	Neuron					0.0					0.0					0.0					0.0
	No MCU					0.0					0.0					0,0					0.0
	Ozobot					0.0	1	1			5.0		3	1		22.2	1				6.7
	Ring:bit Car					0.0		1			2.5					0.0					0.0
	Thymio		1			3.1					0.0					0.0					0.0
	Unplugged					0.0					0.0					0.0		1			6.7
	WeDo	1	2			9.4	1				2.5					0.0					0.0

Table 14.A.2 Two-level coding of educators' responses on the technologies educators utilise in their practice (IQ 4) focusing on ER simulators technologies

Theme	Code I	Greece (N=32)					Slovakia (N=40)					The Czech Republic (N=18)					Spain (N=14)				
		P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%
ER simulators technologies	Terrapinlogo-beebot	3				9.4					0.0	2				11.1					0.0
	Genially-beebot	1				3.1					0.0	2				11.1					0.0
	Makecode for microbit	1	3			12.5	2	4	2		20.0		1			5.6					0.0
	Miranda					0.0					0.0					0.0					0.0
	OpenRoberta		3	1		12.5	1				2.5					0.0					0.0
	Virtual Robotics Toolkit		2			6.3					0.0					0.0					0.0
	Tinkercad		1	1		6.3	1	1	1		7.5		1			5.6					0.0
	TRIK studio		1			3.1					0.0					0.0					0.0
	Delivery of physical robots			1		3.1					0.0			1		5.6					0.0
	Roboblockly		1			3.1					0.0					0.0	1				6.7
	VexCode					0.0					0.0			1		5.6					0.0
	WeBots					0.0					0.0		1			5.6					0.0

Table 14.A.3 Two-level coding of educators' responses on the technologies educators utilise in their practice (IQ 4) focusing on the Programming Environment

Theme	Code I	Greece (N=32)					Slovakia (N=40)					The Czech Republic (N=18)					Spain (N=14)				
		P	S	H	A	%	P	S	H	A	%	P	S	H	A	%	P	S	H	A	%
Programming environment	w3schools	1				3.1					0.0					0.0					0.0
	doodles	1				3.1					0.0					0.0					0.0
	scratch	1				3.1	1	1			5.0		1			5.6	3				20.0
	python					0,0		1			2.5					0.0		2			13.3
	edublock	1				3.1					0.0					0.0					0.0
	code.org	1				3.1					0.0					0.0		1			6.7
	Minecraft	1				3.1					0.0					0.0		1			6.7

3. CONCLUSIONS

The conclusions included in this section are twofold. Firstly we address the main research question by elaborating on the results around the issues investigated, and secondly, we reflect on how results may inform the FERTILE design methodology.

3.1 Research Question: "How to support educators in designing interdisciplinary activities of ER and Art that promote CT in a blended learning context?"
We address the main research question through the issues set in the research design (see section 2.2).

Issue 1. *What experience do educators have in designing interdisciplinary activities of ER and Art?*
Regarding the educators' experience of designing interdisciplinary activities of ER and Art, we noted diverse responses per country. However, despite this emerging diversity, we distinguished some common experiences in the four topics investigated.

The *educators' ideas* for designing interdisciplinary activities that combine ER with Arts highlighted the potential of generating an artistic output through programming and constructing robots (see Table 1.A, Codes I: 'Create Artful robots and program them for a general task' and 'Create Artful robots and program them to perform Art'). They also exploited the potential of designing an environment where the robot operates (see Table 1.A, Codes I: Program robot to perform Art, 'Program robot to create Art', 'Program robot to respond to artful triggers'). The typical art forms proposed for interdisciplinary activities were Arts & Crafts, Music, Dance, and Theatre.

The *difficulties/challenges* that educators faced when designing interdisciplinary activities combining ER with Art that also prevented artful ER projects from being carried out, concerned the design process, the students' involvement, technical malfunctions, and rigidity of the curriculum or the educational context (see Table 2.A, Column: 'Themes'). The most important problem mentioned, related to the educational context, was the collaboration among educators of different subjects (see Table 2.A, Code I: 'Interdisciplinary Collaboration'). This challenge also turned into a design issue (see Table 2.B, Code I: 'Management of ICT and Art'), since ICT educators were unfamiliar with the subject of Art and, respectively art educators were unfamiliar with robotics when designing activities.

The perceived *benefits/implications* of organising interdisciplinary activities combining ER with Art were considered significant in terms of student engagement at a cognitive level (see Table 3.A, Code I: 'Cognitive'). These activities motivated and increased the students' interest since, through Art, they were involved in meaningful robotic activities. Another important benefit involved these activities revealing the potential of a) ER to be a cornerstone for cross-curricular activities and b) Art to enrich any subject with which it is combined (see Table 3.B, Code II: 'ER acts as a link between many subjects' and 'Art enriches any subject' respectively).

Finally, the *support* that educators required to design interdisciplinary activities combining ER with Art was mainly the provision and sharing of educational material (exemplars) from a repository (see Table 4.A, Code I: 'Repository'). In addition, they needed a framework for collaborating with educators from other disciplines to exchange ideas and information (see Table 4.B, Code II: 'Cultivate collaboration among educators'). Consequently, in the context of school management (see Table 4.A, Code I: School management'), they asked for a flexible program to have opportunities to work with other educators. Finally, as a follow-up to the financial difficulties they mentioned as a problem, they would like financial support for the purchase of technology (see Table 4.B, Code II: 'Financial Support').

Issue 2. ***What experience do educators have with ER simulators and ICT for blended learning?***

The educators' ideas for **designing ER activities utilising ER simulators and ICT for blended learning,** three main suggestions emerged from the educators' responses according to their experience:

1. Online synchronous classes mainly for demonstration purposes (see Table 5.A, Code I 'Synchronously ER/ART: Demonstration') either art creations (see Table 5.B, Code II: ''Synchronously ER/ART: Demonstration') or the operation of robotic constructions, in real time (see Table 5.B, Code II: 'Synchronous communication for showing robots'),
2. Online asynchronous classes for providing appropriate materials to reinforce students' home study (Table 5.A, Code I: 'Asynchronously ER/ART: Study'),
3. Programming of robots both synchronously and asynchronously (Table 5.A, Code I 'Synchronously/Asynchronously ER: Programming, programming unplugged').

Educators' responses focused on the technologies used in combination with simulators for synchronous and asynchronous activities, rather than on the design and implementation of such activities. This is evident from their responses which focused more on technologies (see Table 5.A, Themes: 'Asynchronous technologies, Synchronous technologies and Online Learning Implementation). Educators' responses refered to the design of online courses. In particular, The *difficulties* that educators faced when utilising ER simulators and mainly ICT for online learning in the four countries were distributed across technical, design and student issues (see Table 6.A, Column: 'Themes'). The most prominent challenge faced was related to students' engagement in online learning activities regarding synchronous and asynchronous sessions (see Table 6.A, Code I: 'Engagement'). Another issue that has also emerged was the availability of appropriate robotic technologies for online courses_(see Table 6.A, Code I: 'Appropriate Robotic Technologies'). Finally, the issue of communication and time management in online synchronous courses with simulators has been raised (see Table 6.A, Code I: 'Online Modality').

The perceived *benefits/implications* of utilising ER simulators and ICT for blended learning focused on effective teaching practice (see Table 6.A, Code I: 'Effective teaching') which was consistent with teachers' suggestions on how to change the educator mindset towards integrating ER simulators and ICT for blended learning. The majority of the proposals to change the educators' mindset toward integrating ER simulators and ICT for blended learning, included the design and organisation of teaching practice as follows: (i) to alternate online and f2f lessons (see Table 8.B, Code II: 'To alternate online and f2f lessons'), (ii) to use ER simulators instead of physical robots when needed, e.g., in cases of students' absence or when robotic kits are not available (see Table 8.B, Code I: 'ER simulators instead of physical robots'), (iii) to use simulators for extending f2f lesson or for homework (see Table 8.B, Code II: 'Work asynchronously with sumulators as homework'), (v) to provide extra asynchronous activities for those interested (see Table 8.B, Code II: 'Provide extra asynchronous activities for those interested'), and (vi) to implement flipped classroom (see Table 8.B, Code I: 'Flipped classroom').

Lastly, the *support* that educators required to utilise ER simulators and ICT for blended learning involved a design methodology (see Table 9.B, Code II: 'Need for a design methodology'), more teaching time (see Table 9.B, Code II: 'More time/hours') and educator training (see Table 9.B, Code II: 'Need for teacher training: Seminars') through seminars. They had also asked for financial support for software and robotic technologies (see Table 9.B, Code II: 'Financial support for technologies').

To summarise, as far as the experience of the educators in designing ER activities by utilising ER simulators and ICT for blended learning is concerned, they focused more on the issue of the technologies used. Their practice scarcely included designing blended learning courses with ER simulators. This practice may be attributed to the challenge of achieving students' engagement in online sessions and the need for support through seminars and a design methodology.

Issue 3: ***What experience do educators have with ER and Computational Thinking?***

The educators' ideas for designing ER activities to promote computational thinking focused on the problem-solving process involved. In most cases, educators haven't referred to the variety of computational thinking skills, mainly focusing on i) the design of activities to promote Algorithmic Thinking (see Table 10.A, Theme: 'CT Algorithmic Thinking Promotion') and ii) Problem solving activities that cultivate CT (see Table 10.A, Code I: 'Problem Solving') .

The *challenges* that the educators faced when designing ER activities to promote students' CT, included the time and effort required (see Table 11.A, Code I: 'Effort') and student-related parameters such as students' programming skills and engagement (see Table 11.A, Code I: 'Programming Skills', 'Engagement'). Moreover, they mentioned difficulties related to the school's management, such as the class teaching time needed and the budget constraints for purchasing the required robotic equipment (see Table 11.B, Code I: 'School management').

The perceived *benefits/implications* of utilising ER to promote students' CT, highlighted CT's added value as fundamental and lifelong skills (see Table 12.B, Code I: 'CT'). Moreover, the educators mentioned that the combination of ER and CT promotes students' engagement at both cognitive and emotional levels (see Table 12.A, Theme: 'Engagement'). In addition, this combination positively impacted students' learning by providing on-time feedback (either by the ER simulators or by peers) (see Table 12.B, Code I: 'Feedback provision').

The *support* the educators required to utilise ER toward promoting students' CT skills was associated with design issues, learning content and educational context (see Table 13.A, Themes: 'design issues', 'learning content', 'educational context'). In particular, they needed both to share ideas and material (see Table 13.B, Code I: 'materials') as well as a repository of exemplar material related to the curriculum (see Table 13.B, Code I: repository). In terms of design, they pointed out the need for a design methodology (see Table 13.B, Code I: 'Methodology').

Issue 4: ***What experience do educators have with ER technologies?***

The educators mentioned a variety of robotic kits, ER simulators and programming environments for ER activities. The robotic kit that was highly mentioned by educators of the four countries was Lego Mindstorms whilst Makecode for Micro:bit and Tinkercad were the most popular ER simulators. It is quite interesting that the most frequently used ER simulators were those that simulate and program physical robots. Lastly, Scratch programming environment emerged as the most used programming environment, which may also program physical robots (see Table 14.A.1, Theme: 'robotic kits').

4.2 How results may inform the FERTILE design methodology

All the above findings will form the basis for the design of the FERTILE methodology. In particular, (i) the steps of the artful ER projects design process, (ii) the way of interweaving ER and Art in artful ER projects, (ii) the sharing of activities between f2f and online in a blended learning mode, as well as (iv) the support provided for cultivating various CT skills.

The educators' profiling illustrated their experience of (i) designing interdisciplinary activities with ER and Art, (ii) designing blended learning using ICT and ER simulators, and (iii) cultivating CT. In particular, regarding these three pillars, they provided ideas, reflected on the benefits, expressed their concerns, and outlined the support they need for integrating artful ER projects into their educational practice.

Below we make a first attempt to distinguish aspects of the educators' profiling that may inform the FERTILE design methodology. In general, educators seemed to recognise the value of CT as a fundamental skill. Approaching CT through problem-solving, they adopted a problem-solving approach in designing Artful robotic projects. However, most educators, even ICT educators, seemed to match CT with algorithmic thinking ignoring other skills like abstraction, decomposition, evaluation, etc. The FERTILE methodology must also cope with this, cultivating all the popular CT skills. They also asked for guidance, although the level of guidance differed since some asked for step-by-step support while others asked for the core idea of an artful robotic project.

Regarding *blended learning,* we intend to exploit the ideas proposed by the educators who participated in our profiling. They suggested several effective teaching strategies for enriching face-to-face teaching, asynchronous communication for studying, and synchronous communication for demonstrating art/robotic constructions and learning material. Although the educators expressed concerns about student engagement during online learning sessions, there were indications about the potential of artful ER activities cultivating CT to promote student engagement in a blended learning context. Especially, study material and programming seem appropriate for asynchronous learning highlighting the potential of ER simulators.

Still, although the educators were highly sceptical about the added value of online learning in everyday educational practice, they favour utilising ER simulators when physical robots are unavailable. Such a recommendation is essential given that the financial support to purchase robotic technologies emerged as an important aspect. In fact, we noted that the most frequently used simulators could also be used with physical robots in the classroom. This conclusion is critical towards proposing adequate simulators for particular educational contexts.

The educators also acknowledged the need for additional effort to design artful ER activities in blended learning, and therefore they asked for a repository of exemplar projects. Finally, they underlined the importance of collaboration among teachers and, hence mentioned the need for a community platform to share ideas and design collaboratively. A main issue emerging from these needs is the context of interaction and a common 'language' making this interaction meaningful for co-designing Artful robotic projects. The FERTILE consortium concludes that it is crucial to cater to these needs in the FERTILE design process and adequately integrate them into the FERTILE community platform.

The effort needed for this report was enormous. It involved collecting data from questionnaires and then through focus groups and interviews in the four countries, involving educators from various fields (ICT & Arts) and levels of education (primary, secondary and higher). Furthermore, analysing all these data uniformly so that results combine and compare educators' experiences from the four countries was quite demanding and time-consuming. This effort reflects the partners' effective collaboration and commitment to a quality result useful for the next steps of the FERTILE Project. This report, along with the literature review, are the main pillars for the tasks that follow: the FERTILE design methodology and the FERTILE community platform.

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APPENDIX

Appendix A: Preliminary Survey Questionnaire

Introduction

The following questionnaire aims to explore the profile of educators practising Educational Robotics in their everyday educational practice and the implications caused by the pandemic. It has been developed in the context of FERTILE Project (Artful Educational Robotics to promote Computational Thinking in a Blended Learning context), Erasmus+ KA2 - Partnership for Higher Education, KA 2021-1-EL01-KA220-HED-00002336.1.

You need about 10 minutes to complete it.

Thanks for your time and support!

Section I. Background Information

What is your age?

- under 25
- 25-40
- 41 -55
- more than 55

How long have you been working as a teacher/professor?

- This is my first year
- 1-5
- 6-12
- 13-20
- more than 20

At which educational level do you currently teach?

- Higher Education
- Secondary Level
- Primary Level
- Non-formal education

What is the highest level of formal education that you have completed?

- Bachelor Degree
- Master Degree
- PhD Degree

Your main background is in..

- Informatics
- Mathematics
- Physics

- Technology
- Primary Education
- Other (please explain):

Have you attended ER training courses ? If "yes" please explain (seminars, teacher training along with dates-duration, mode -f2f, online, blended-learning)

Section II. Teaching experience with ER technologies

In which context have you applied ER?

- Projects (primary education)
- Projects (secondary education)
- University course for ER
- Non-formal education
- Other (please explain):

In which subjects have you applied ER? (check more than one if necessary)

- Informatics / Information & Communication Technology (ICT)
- Maths
- Physics
- Art
- Technology
- Robotics
- Other (please explain):

What kind of ER technology have you used with your students? To what extent? *

	Low	Moderate	High
Beebot			
Ozobot			
WeDo			
Spike			
EV3			
Thymio			
Edison			
Microbit			
Arduino			

Raspberry PI			
Mbot			
None			
Other (please explain)			

Have you applied interdisciplinary projects combining ER with various types of arts like… (select from the list)? To what extent?

	None	Low	Moderate	High
Music				
Dancing				
Theatre				
Video and Arts(e.g animation)				
Literature				
Art and Crafts (eg. painting)				
Other (please explain)				

Have you designed interdisciplinary projects with ER and various types of Art like… (select from the list)? To what extent?

	None	Low	Moderate	High
Music				
Dancing				
Theatre				
Video and Arts(e.g animation)				
Literature				
Art and Crafts (eg. painting)				
Other (please explain)				

Which ER simulators have you used and in what mode?

	F2F	Blended	Online
GearsBot			
Open Roberta			
Webots			
Vex code			
Miranda Software			
Kibotics			
Tactode programming system			
Geogebra			
USARSim			
Thymio Suite			
Simspark			
Gazebo			
MakeCode			
None			

Section III. Practices adopted during the lockdown due to COVID-19 with ER

Have you applied ER activities during the lockdown due to COVID-19?

- Yes
- No

Please briefly describe the context

……

If 'Yes', have you used ER simulators?

- Yes
- No

SECTION IV. Professional development needs

Thinking of your own professional development needs, please select relevant subjects from the list below.

	None	Low	Moderate	High

Training in ER kits				
Training in ER simulators				
Training in ER pedagogical approaches				
Training in learning design with ER				

Do you wish to participate in a focus group or interview at the next stage of the FERTILE Project concerning educators profiling that use ER in their educational practice? If so, please note below your name and email

………………………………………………………………………………………….

APPENDIX B

1 - Focus Discussion Groups Questions- Version 1

1 - Teaching experience in interdisciplinary activities with ER and Art

1.1 Have you organised interdisciplinary activities combining Educational Robotics with Arts? Please describe them in detail. If not, why? (experience)

1.2 If yes, what were the main difficulties you faced in designing and implementing such interdisciplinary activities?

1.3 If yes, which are the main benefits of these interdisciplinary activities?

1.4 What type of support do you need to design or implement such interdisciplinary activities?

2 - Teaching experience with ER simulators, communication technologies & blended learning

2.1 Have you organised online ER activities? Which technologies have you employed and what for? Please describe it in detail. If not, why? (experience)

- ER simulators,
- communication/collaboration tools

2.2 What were the main difficulties you faced in designing and implementing online ER activities (during the lockdown)?

2.3 What are the main benefits of these online ER activities?

2.4 How does this experience may enrich your everyday educational practice with ER? What could be done online, and what would better remain in the classroom? (idea generation)

2.5 What type of support do you need to blend f2f activities with online ER activities?

3. Teaching experience with ER and Computational Thinking

3.1 Have you organised ER activities to promote CT skills? Please describe in detail, i.e., which skills have you tried to cultivate and how. If not, why? (experience)

3.2 What were the main difficulties that you faced in cultivating CT skills?

3.3 Which, in your opinion, are the main benefits of these activities?

3.4 How do you think that ER and ART can be combined to cultivate CT skills?

3.5 What support do you need to promote CT in designing or implementing ER for interdisciplinary activities?

2 - Focus Discussion Groups Questionnaire -Version 2

1 - Teaching experience in interdisciplinary activities with ER and Art

1.1 Which other subjects have you planned interdisciplinary activities with?

1.2 Have you organised interdisciplinary activities combining Art and Educational Robotics? Describe them in detail. If not, why?

1.3 What do you consider being the main difficulties in designing/implementing them?

1.4 What do you consider to be the main advantages of these interdisciplinary activities4

1.5 What type of support do you need to design or implement such interdisciplinary activities?

2 - Teaching experience with digital technologies and distance learning.

2.1 Have you organised online activities? Which technologies have you employed and what for? Please describe it in detail. If not, why? (experience)

- Web2.0
- communication/collaboration tools

2.2 What were the main difficulties you faced in designing and implementing online activities (during the lockdown)?

2.3 What are the main benefits of these online activities?

2.4 How does this experience may enrich your everyday educational practice with ER? What could be done online, and what would better remain in the classroom? (idea generation)

2.5 What type of support do you need to blend f2f activities with online ER activities?

3. Teaching experience with ER and Computational Thinking

3.1 What do you know about Computational Thinking? (, pattern recognition, abstraction, generalisation, algorithmic thinking, etc.)

3.2 Have you organised activities that you believe promote Computational Thinking skills?

3.3 Do you consider that CT can be combined with the teaching of art lessons? If so, in what way? (ideas)

3.4 How do you think that ER and ART can be combined to cultivate CT skills?

3.5 What support do you believe you need to promote CT in designing or implementing ER for interdisciplinary activities?