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The Impact of Using Collaborative Online International Learning during the Design of Maker Educational Practices by Pre-Service Teachers

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Abstract: The main purpose of this study is to measure the effect of COIL when implementing the maker methodological approach in teacher training in relation to motivation and the technology acceptance level. The sample consisted of 44 primary education pre-service teachers from the University of The Basque Country (UPV/EHU). The motivation level was measured using a post survey that included the Reduced Instructional Materials Motivation Survey (RIMMS) and the perception in relation to the acceptance of the technology using items from the Technology Acceptance Model (TAM). Quantitative data were collected at the end of the training to analyse the differences among the two groups, the EHU control group and the EHU-COIL experimental group. Results show that the EHU-COIL experimental group showed higher levels of motivation and technology acceptance in all of the subscales compared to the EHU control group after completion of the experience of being trained on maker education and designing collaboratively sustainable maker educational teaching and learning plans. The differences were particularly significant in the perceived usefulness subscale. In light of these findings, it seems that participation in COIL in teacher training adds value to maker-based educational practices.

Keywords: maker education; collaborative online international learning; pre-service teacher training; motivation; technology acceptance

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Citation: Quintana-Ordorika, A.; Garay-Ruiz, U.; Camino-Esturo, E.; Portillo-Berasaluce, J. The Impact of Using Collaborative Online International Learning during the Design of Maker Educational Practices by Pre-Service Teachers. *Sustainability* **2024**, *16*, 1222. https://doi.org/10.3390/su16031222

Academic Editors: Óscar Gavín-Chocano and Eufrasio Pérez Navío

Received: 22 December 2023
Revised: 25 January 2024
Accepted: 29 January 2024
Published: 31 January 2024

1. Introduction

The maker movement involves tinkering, building and creating innovative artefacts in a collaborative way [1]. Cultivating a maker spirit, fostering continuous development, innovation and creativity, and entrepreneurial awareness are also some of the elements of maker education [2,3]. Collaborative Online International Learning (COIL) is an innovative pedagogical approach that uses online technology to internationalise the curriculum in higher education institutions [4]. By training future educators in the maker pedagogical approach on the one hand, and immersing them in Collaborative Online International Learning programmes on the other, our research seeks to address part of the Sustainable Development Goal of quality education in terms of providing all learners with an education that meets the needs of a 21st century society. Furthermore, through maker education, pre-service teachers are immersed in a web-based learning environment that combines the use of information and communication technologies (ICT) and teaching and learning practices based on the use of technological tools [5], and through a COIL programme, a cost-effective and inclusive approach to international education takes place, i.e., “internationalisation at home” [6]. Therefore, the purpose of our study is to find out whether pre-service teachers’ motivation and acceptance of the maker pedagogical approach increases when they participate in COIL, to test whether participation in such programmes improves outcomes, and thus to consider COIL as an innovative pedagogical approach when included in maker education.

1.1. Collaborative Online International Learning

Collaborative Online International Learning (COIL) is a type of virtual exchange through which students live an internationalisation experience in higher education as part of their studies [7,8]. Virtual exchanges [9] are pedagogically innovative experiences that are becoming popular to internationalise the curriculum at many different levels, whereby students interact and communicate with each other for educational purposes through international mobility through technology rather than physical travel [10].

COIL is an emerging pedagogy [11] that gives instructors and learners the opportunity to co-develop collaborative projects in an online context [12]; this approach serves as a valuable complement to the traditional educational model [7,8], and the approaches are embedded into the formal curriculum [13]. Recently, it has been valued as an interesting way to connect learning on a global scale [14]. Moreover, learning experiences such as COIL address challenges like disparities and travel limitations in global education. These educational encounters contribute to and promote inclusive global learning within the curriculum [15].

COIL is a social and constructivist learning approach where learning is collaborative, social and interactive, and it helps learners to develop digital skills and intercultural competence among other skills [16,17]. Guimarães et al. [18] believe that technology can aid teaching and learning practices through hybrid approaches, fostering the development of global citizenship. Moreover, learners are equipped with skills that help them address the difficulties they face while living and working in present-day societies [19].

The roots of collaborative learning are set in constructivist principles, giving learners a brilliant opportunity to learn together [20]. Students also take responsibility for the learning process and they build their knowledge by being involved in working together.

The effectiveness of COIL has been widely researched in higher education institutions. Focusing on faculty educators, research shows that educators' self-interest was associated with COIL programmes [21]. In the case of students, several other factors were measured in relation to COIL programmes; the motivation of students was measured both before and after their involvement in COIL, and it was concluded that learners had a higher level of motivation before and after the COIL course [22]. Skagen et al. [23] concluded that learners gained a better understanding and conceptualisation of course content after participating in COIL. Regarding the internationalisation factor, an increase in openness towards aspects related to learning about other cultures, traditions, customs, etc., and academic efficacy was also increased when students were involved in the internationalization programme [24]. The collaborative creation of knowledge, the independent control of the learning process and the increased use of technology are also promoted by this collaborative approach [25].

1.2. Maker Education

Maker education, brings together "maker" and "education"; maker literacy is linked to the ability that enables the crafting of objects aligned with learners' interests. It engages learners in the construction of objects with physical, digital or a blend of both tools [26]. The theory of Papert's constructionism is at the roots of the maker pedagogical approach [1,27]. Papert in [28], developed the constructionist framework where he stated that the learners engage with content knowledge while creating the artefact, and that learning happens when constructing a physical or digital artefact. Following this idea, maker teaching and learning approaches promote the development of artefact design and creation and consequently a deeper knowledge acquisition is achieved and collaborative teamwork is promoted [29]. As a result, the topics to be learned are more relevant to the learners [30], active problem-solving skills are fostered [31–33] and the learners assume an interactive role in both the teaching and learning process [34,35]. There is also a change in the predominant roles of teacher and learner, placing the learner at the core of the plan, while the teacher assumes the roles of guide and facilitator [36]. Maker teaching and learning practices are usually carried out in makerspaces, that are global and technological learning spaces [37], where collaboration and innovative teaching and learning practices are used to ideate and create artifacts [38]. Regarding curricular aspects, when teaching and learning practices align with making, they can have a transformative effect on educational practices [39].

Dougherty [40] also mentioned that among the biggest challenges and at the same time the biggest opportunities that maker education could bring to the educational field is transformation. Several authors have mentioned that, in order to change from traditional teaching practices into maker centred teaching and learning practices, and to suitably integrate maker activities in the curriculum, suitable professional development is needed [41], both to support pre-service and in-service teachers [42].

This study was conducted in the context of incorporating both the maker pedagogical approach and COIL into pre-service teacher training in primary education. Pre-service teachers had to design teaching and learning plans based on the theme of a specific Sustainable Development Goal (SDG). Educators are considered to be powerful agents of change if they train future generations with sufficient knowledge and competencies to address the SDGs [43]. Universally embraced by all UN member states in 2015 under the 2030 Agenda for Sustainable Development, the 17 Sustainable Development Goals are a global initiative calling for collective efforts to eradicate poverty, safeguard the planet and enhance the lives and well-being and opportunities of everyone, everywhere. A 15-year plan has been put in place to achieve these goals. Despite the improvements and progress that have been made to achieve these goals, there is still much work to be done, as indicated by the UN's statement urging for a decade of ambitious action to achieve the goals by 2030 [44]. Quality education is the fourth of these goals and is considered a multidimensional concept, ranging from the existence of an educational infrastructure based on adequate tools and spaces, to the level of teacher training and the individual learning outcomes of students [45]. COIL is an online pedagogy aimed at all students rather than a specific minority [46]; it may be an option to reduce the carbon footprint.

However, there is still a need to know how the combined implementation of these two innovative approaches is perceived by pre-service teachers in terms of motivation and technology acceptance, and therefore the absence of concrete evidence regarding this matter not only validates the need for this study, but also makes it pertinent, due to the fact that the results obtained may open new ways to consider ways of introducing two innovative approaches in higher education institutions, specifically in teacher education institutions.

2. Research Questions

The state of the art described in the previous sections illustrates some of the research that has been performed to date in relation to Collaborative Online International Learning and maker education in formal education contexts. In this paper, we aim to examine the motivation and technology acceptance levels of primary education, training teachers towards the maker pedagogical approach after participating in a 5-week apprentice maker training project aimed at collaboratively designing maker-based teaching and learning plans in teams. The main aim is to compare the results of motivation and technology acceptance between those who collaborated with international peers in a Collaborative Online International Learning experience (EHU-COIL experimental group) and those who had the experience with peers from the Faculty of Education (EHU control group).

For this purpose, we have developed the following research questions.

RQ1. Does the motivation towards maker education increase when participating in COIL in terms of attention, relevance, confidence and satisfaction?

RQ2. Does the technology acceptance of maker education regarding the usefulness, ease of use, enjoyment, attitude towards its use and intention to use increase when participating in COIL?

3. Materials and Method

3.1. Participants

The participants were 44 pre-service teachers of primary education, studying the subject of Information and Communication Technologies in the second year of their trilingual (Basque, Spanish and English) degree at the Faculty of Education of the University of the Basque Country (UPV/EHU), randomly divided into a control group (n = 23) called the EHU control group, and an experimental group (n = 21) called the EHU-COIL experimental group.

The 44 participants were students in the second year of the Information and Communication Technologies (ICT) course, which is the total number of students enrolled in the trilingual (Basque, Spanish and English) Primary Education teacher training course. They were the individuals who received extensive training in both the theoretical and practical aspects of the maker pedagogical approach, and who designed the teaching and learning plans. They decided to answer the questionnaire anonymously after completing the five-week training programme at the end of the spring semester 2023. On the last day of the course, the participants were given a QR code and had the option to decide whether or not to provide a response.

As part of the study, a five-week training around the maker pedagogical approach was created for pre-service teachers. Both the EHU control group and the EHU-COIL experimental group received the same training. The EHU-COIL experimental group worked with partners from the University of Zlin (Czech Republic) and had some asynchronous and synchronous sessions, while the EHU control group had all sessions synchronously with faculty partners. The main objective of the project was to design a maker-based sustainable teaching and learning plan for primary school students. They had to design several hands-on, sustainability-related, maker-based activities combined with appropriate and balanced use of ICT for pedagogical purposes around the chosen Sustainable Development Goal.

The project lasted 5 weeks and was planned according to and adapting the virtual exchange planning sequence proposed by De Wit et al. [47]. The first week consisted of a formal introduction to the project. This first phase consisted of a warm-up and familiarisation with the project; several tasks such as icebreakers were performed to get to know the team members, different tools such as the learning hub were introduced and the schedule was presented. The final goal of the project was explained, the working teams were formed, and the pre-service teachers were trained on the theoretical foundations of maker education and also introduced to the SDG goals. They actively participated in several tasks based on readings and discussions related to maker education. They were also immersed in how maker-based activities could be appropriately designed for primary school children, and pre-service teachers had the opportunity to discuss all their views on this innovative methodological approach with their peers. The main aim of this phase was to develop ideas and brainstorm on how to start designing the project.

The second week was dedicated to collaborating and co-creating the teaching and learning plans. The aim of this phase was to prepare and design a project that would include some activities based on the sustainable maker pedagogical approach. The pre-service teachers were given basic guidelines on the key elements that a project should cover, including the curriculum elements suggested by Van den Akker [48]. Elements included were general information (topic, class, number of pupils), objectives, organisation and materials, as well as information on how to design the project, a detailed description and timing of the different activities and, finally, an explanation on how the project would be assessed. In terms of maker education, some of the technological resources categorised by different purposes were presented, as well as tools and gadgets to tinker and create, and the participants received an explanation of the key 4Cs presented by Dr. Suresh Chiruguru, & Chiruguru, S. [49] such as creativity, communication, collaboration and critical thinking and how to incorporate sustainability for educational purposes.

The following two weeks were used to create and develop the teaching and learning plans. Aspects related to the format and structure in which they had to develop their project were discussed. The pre-service teachers were also provided with a template for developing the task, in which they could find the possible steps of the maker pedagogical approach and some of the technological tools and applications they could use to design the tasks. These two weeks were also used to receive feedback from the teachers and to clarify any doubts.

The last week was dedicated to presenting the projects and receiving feedback not only from the trainers but also from their peers. All projects were uploaded to a virtual wall and synchronously each group presented their proposal, adding information on how they would implement it in the future and highlighting possible ways of sharing it. The training teachers gave feedback on the proposed project according to a rubric. After the final session, the students received a link and a QR code and decided whether or not to answer the questionnaire.

3.2. Instruments

Pre-service teachers (n = 44) completed the online survey which contained the RIMMS and TAM items at the end of the course, in week 5. In the following, a more detailed description of the items of the questionnaire is provided.

3.3. RIMMS: Reduced Instructional Materials Motivation Survey

The Reduced Instructional Materials Motivation Survey developed by Loorbach et al. [50] Is a self-report questionnaire consisting of 12 items, utilizing a six-point Likert scale where respondents indicate their agreement on a scale from 1 (strongly disagree) to 6 (strongly agree). It is a short version of the IMMS, which encompasses the four factors of the ARCS model of motivational design created by John Keller. The ARCS model, widely employed in the educational domain, has been used to assess the effects of instructional materials [51–54]. It consists of four subscales: attention, relevance, confidence and satisfaction that can be used and scored independently, as presented by Keller [53]. In accordance with the chosen ARCS model [55], achieving motivation requires an appropriate balance between all four categories.

The subscales of the questionnaire assess the following dimensions:

- Attention includes the following items: A3 Quality of the sessions; A6 Suitability of the arrangement of assignments; A10 Variety of assignments, illustrations, etc.
- Relevance includes the following items: R1 Content and materials are related to previous knowledge; R6 Content is worthy, purposeful, and advantageous; R9 Usefulness.
- Confidence includes the following items: C5 Confidence to learn the content; C7 Confidence level to succeed in an assessment or evaluation; C9 Good organization of the tasks.
- Satisfaction includes the following items: S2 Willingness to know more about it; S3 Enjoyment level of having taken part in the project; S6 Feeling pleasure to have taken part in well-designed tasks.

3.4. TAM: Technology Acceptance Model

In this study, we employed the Technology Acceptance Model (TAM) to assess the level of acceptance of the maker methodological approach [56]. TAM consists of five constructs, usefulness (PU), ease of use (PEU), enjoyment level (PEN), attitude towards its use (ACU) and intention to use it (IU). TAM has been extensively utilized in the field of education as a reliable model for assessing various learning technologies [57].

In the model of Davis in Llorente-Cejudo et al. [58], key variables such as perceived usefulness (PU) and perceived ease of use (PEU) are identified as the most crucial variables. Consequently, these variables are connected to the attitude towards its use (ACU), the enjoyment and, ultimately, the intention to use it (IU). To maintain coherence throughout the survey, a 6-point Likert scale was employed, ranging from 1 “completely disagree” to 6 “completely agree”.

In the following, each of the five constructs of TAM is presented as well as the items included:

- Perceived usefulness (PU1 Learning improvement; PU2 Eases the general understanding of certain concepts; PU3 Usefulness; PU4 Enhancement of the learning);
- Perceived ease of use (PEU1 Easy to use; PEU2 Learning and dealing with it has not been a problem; PEU3 Learning and dealing are clear and understandable);
- Perceived enjoyment (PEN1 Using it is enjoyable; PEN2 I enjoy using it; PEN3 It allows learning by doing);
- Attitude towards use (ACU1 Learning is more interesting; ACU2 It is a good idea to use it in class);
- Intention to Use (IU1 Use it in the future; IU2 Use it to learn new topics).

This resulted in a 26-item survey.

3.5. Design and Data Analysis

The intervention design scheme consisted of two independent samples, experimental and control, with post-test only [59], attempting to compare two different groups and the resulting means of the intervention or independent variable:

Control group (A) O2

Experimental group (B) X O2

X represents the COIL activity, as the independent variable chosen as the object of study, while the dependent variable corresponds to the effect of the measures to be taken on motivation and acceptance of the model. O2 corresponds to the observation of the post-test measured at the end of the COIL in both groups (A and B).

The subsequent analysis of the differences between the experimental and control groups was carried out by means of a contrast of means (*t*-test) with which the measurements of both RIMMS and TAM instruments were observed in both groups. The variables analysed were the subscales as well as the global calculation of motivation (RIMMS) and model acceptance (TAM). The contrast of means was carried out with a significance level of 0.05 and the effect size (Cohen's d) was calculated, as well as the correlations between the two groups (r) in each of the subscales.

Finally, a cluster analysis was carried out in order to reduce the information from both instrumental measures to a single variable, placing each participant in a particular cluster. This analysis allowed us to explore the associations and structures observed in the sample data. In the analysis, the hierarchical classification method was used, introducing a combination of the categories Attention, Relevance, Confidence and Satisfaction from the RIMMS instrument, as well as the categories PU, PEU, PEN, ACU and IU from the TAM instrument. The clustering method used was the Ward linkage method and the squared Euclidean distance was used to measure the interval. To obtain the number of clusters, the elbow method was used with subsequent visualisation of the dendrogram, choosing a final solution of four clusters. This analysis made it possible to classify the sample cases into homogeneous groups according to the different scores assigned to each category, which resulted in a new ordinal variable with four clusters or hierarchical groups from the lowest to the highest score on the perception of the satisfaction and acceptance categories used in the instrument. Thus, the cases grouped in the first cluster (C1) have lower values of motivation and acceptance, and as we move up the cluster hierarchy (C2, C3 and C4), the cases correspond to higher levels of motivation and acceptance of the maker pedagogical approach used in the training activity.

The reliability analysis (Table 1) showed good results for all subscales, with Cronbach's Alpha levels ranging from 0.642 to 0.923, with the overall RIMMS (Alpha = 0.885) and TAM (0.901) being particularly reliable. On the other hand, the normality analysis (Shapiro–Wilk Test) showed normal distributions of the overall instrument scores in both the EHU control group and the EHU-COIL experimental group.

Table 1. Reliability analysis of RIMMS and TAM.

	Cronbach's Alpha NTotal (EHU-COIL/EHU)	N of Items	Shapiro–Wilk Test Sig NTotal (EHU-COIL/EHU)
Attention	0.820 (0.847/0.795)	3	0.016 (0.086/0.262)
Relevance	0.647 (0.642/0.701)	3	0.191 (0.071/0.096)
Confidence	0.761 (0.776/0.722)	3	0.216 (0.558/0.609)
Satisfaction	0.875 (0.923/0.839)	3	0.139 (0.042/0.268)
RIMMS	0.885 (0.915/0.853)	12	0.235 (0.354/0.488)
PU	0.829 (0.819/0.792)	4	0.043 (0.315/0.459)
PEU	0.796 (0.852/0.764)	3	0.072 (0.695/0.012)
PEN	0.849 (0.774/0.881)	3	0.034 (0.720/0.122)
ACU	0.730 (0.732/0.717)	2	0.003 (0.012/0.038)
IU	0.732 (0.653/0.790)	2	0.004 (0.033/0.217)
TAM	0.901 (0.887/0.809)	14	0.006 (0.246/0.060)

4. Results

A first general approximation of the data obtained using the two instruments gives us an overview of the differences between the EHU control group and the EHU-COIL experimental group. In this sense, it can be seen that all subscales of both instruments increase their mean scores towards the group that has experienced COIL. The overall mean of RIMMS motivation in the EHU-COIL experimental group (4.19) is higher than in the EHU control group (3.99) with a difference of 0.2 satisfaction points. In the area of acceptance of the TAM model, there are also differences in all the subscales, as well as in the overall calculation of acceptance, with a higher average score in the EHU-COIL experimental group (4.80) that has carried out the experience, compared to the average (4.44) of the control group. These two groups have registered a difference of 0.36 points in the acceptance of the model, in favour of the group that had the COIL experience (Table 2).

Table 2. Statistical comparison of instruments between EHU control and EHU/COIL experimental groups.

	EHU (Control)	EHU-COIL (Experi.)	Total	EHU-COIL/ EHU	Independent Samples Test			
	Mean (Std.Dev)	Mean (Std.Dev)	Mean (Std.Dev)	Mean Differ.	t	Sig.	d	r
Attention	3.86 (0.75)	3.95 (0.86)	3.90 (0.80)	+0.09	0.398	0.692	0.120	0.061
Relevance	4.38 (0.70)	4.57 (0.56)	4.47 (0.60)	+0.19	1.064	0.294	0.321	0.162
Confidence	4.12 (0.78)	4.49 (0.68)	4.29 (0.75)	+0.37	1.711	0.094	0.516	0.255
Satisfaction	3.60 (1.15)	3.75 (0.95)	3.67 (1.06)	+0.15	0.511	0.612	0.154	0.079
RIMMS	3.99 (0.68)	4.19 (0.64)	4.08 (0.62)	+0.20	1.093	0.281	0.330	0.166
PU	4.50 (0.83)	5.12 (0.54)	4.79 (0.76)	+0.62	2.895	0.006 **	0.874	0.408 **
PEU	4.23 (0.91)	4.40 (0.74)	4.31 (0.82)	+0.17	0.656	0.515	0.198	0.101
PEN	4.07 (1.11)	4.37 (0.80)	4.21 (0.97)	+0.30	0.994	0.326	0.300	0.152
ACU	4.91 (0.79)	5.19 (0.62)	5.04 (0.72)	+0.28	1.283	0.207	0.387	0.194
IU	4.50 (1.01)	4.93 (0.69)	4.71 (0.89)	+0.43	1.623	0.112	0.490	0.243
TAM	4.44 (0.72)	4.80 (0.53)	4.61 (0.65)	+0.36	1.981	0.054	0.598	0.275

** $p < 0.01$.

However, although in all the subscales and the global computations of the RIMMS and the TAM positive differences have been obtained towards the EHU-COIL group, these differences do not present significant results ($p < 0.05$), except in the PU or Perceived Usefulness subscale (sig. = 0.006), where significant differences are registered between both groups with regard to the perception of the usefulness of the model, with an increase of 0.62 points in favour of the group that had the COIL experience. In this subscale, it can be considered that the activity carried out had a high effect (Cohen's d > 0.8) on the group and that it determines 16.64% of the variability of the sample in this subscale (r^2). Likewise, we can state that 80.8% of the EHU-COIL group are above the mean of the EHU control group, with a 73.1% probability that a randomly selected participant from the experimental group has a higher score than a participant from the control group.

Another noteworthy aspect is that the overall result of the model acceptance (TAM) is situated at a p-value (0.54) that warns of the differences between the means of the two groups (+0.36), as well as a medium effect size (Cohen's d > 0.5) of the intervention on the participants, although with a low intensity of correlation (r = 0.275). Other subscales with a medium effect size would be Confidence (d = 0.516) within motivation, and IU or Intention to Use (d = 0.490) within the model acceptance instrument.

The analysis of the sample through the hierarchical cluster analysis (Table 3) identifies a number of differences in the distribution of motivation (RIMMS) and model acceptance (TAM). The hierarchical cluster analysis, constructed on the basis of the unique four-cluster solution obtained from the dendrogram, establishes a number of clusters.

Table 3. Cluster statistics in the RIMMS and TAM instruments, according to total, control and experimental groups.

		Total Mean			**EHU (Control) Mean**			**EHU- COIL (Experi.) Mean**		
	n	**RIMMS**	**TAM**	**%**	**RIMMS**	**TAM**	**%**	**RIMMS**	**TAM**	**%**
C1	6	3.47	3.30	13.64	3.55	3.29	83.33	3.08	3.40	16.67
C2	11	3.41	4.70	25.00	3.42	4.60	54.55	3.40	4.83	45.45
C3	17	4.34	4.63	38.64	4.30	4.70	47.06	4.38	4.58	52.94
C4	10	4.75	5.26	22.73	4.75	5.15	40.00	4.75	5.34	60.00

- Cluster 1 (C1) contains 13.64% of the sample and has the lowest average level of motivation (3.55) and acceptance (3.29). All cases have very low levels, as they are a very unmotivated group with very low acceptance of the instrument. In this group, 83.33% is represented by students from the EHU control group, while only 16.67% of the students belong to the EHU-COIL experimental group.
- Cluster 2 (C2) represents 25% of the sample, being a demotivated group in average terms (3.41), although it presents high levels of acceptance of the model (4.70). This cluster contains 54.55% of the control group, while the experimental group contributes 45.45% of its components.
- Cluster 3 (C3) constitutes 38.64% of the participants and shows high average levels of motivation (4.34) and acceptance (4.63). In this cluster, the control group contributes 47.06% and the experimental group accounts for 52.94%.
- Cluster 4 (C4), on the other hand, accounts for 22.73% of the sample and corresponds to the group with the highest average motivation (4.75) and very high average acceptance (5.26) among all study participants. This cluster also represents 40% of the control group and 60% of the experimental group.

In general terms, we can see that this cluster analysis has allowed us to dissect the sample into a group of participants who have low motivation (38.64%), who belong to clusters C1 and C2 and are below the mean value (3.5) of the RIMMS instrument scale (1–6), and another group of participants (61.37%) who have high motivation (above 3.5), who belong to clusters C3 and C4. In contrast, there is a lower proportion of participants who have low acceptance of the model (13.64%). This percentage of participants, who are positioned in C1, is below average levels, below 3.5 on the TAM instrument scale, while, on the contrary, the majority of the sample (86.36%) considers that the maker–COIL intervention has been highly positive in terms of acceptance of the intervention model. This sector of the sample is located in clusters C2, C3 and C4. Therefore, in C2, there is a group of participants (25%) who remain somewhat ambiguous about how the intervention has been perceived with a low motivation, but a positive acceptance of the model.

In the aspect of individual belonging to the control group or to the experimental group, the proportions found show that the EHU control group has a higher percentage of presence in the lower clusters of motivation and acceptance, with a decrease in the percentages as the gradation of the clusters increases. Thus, in cluster C1, the EHU control group has a presence of 83.33%, while in cluster C4 its proportional presence decreases to 40%. In the experimental group EHU-COIL, on the other hand, the presence of these participants increases as we move up the cluster gradation, from 16.67% of inclusion in C1 to an increase in proportions reaching 60% of adscription in C4.

5. Discussion

This study mainly aimed to analyse the perceived motivation and technology acceptance level of primary education pre-service teachers towards maker education when involved in an innovative Collaborative Online International Learning experience.

The analysed quantitative data enabled us to compare the perception differences between pre-service teachers who experienced COIL and those who collaborated with faculty peers while immersed in maker education training. Overall, the results show that those students who were trained in maker education and designed teaching and learning plans through a COIL programme showed higher levels of motivation and technology acceptance. Other studies, such as the one carried out by Appiah-Kubi & Annan [16], compared the performance of COIL students with those who were not involved in COIL and found that those who were immersed in COIL performed better in project work. Moreover, they highlighted that the collaborative experience was positively perceived by participants, with this result being similar to our research.

Furthermore, the most notable differences in our research have been found in the subscale of perceived usefulness, which may be due to the fact that both the maker pedagogical approach and COIL have collaborative elements at their core, and when students are exposed to this international experience, they perceive it as useful and the experience becomes more relevant. This previous idea complements the finding that learning is collaborative, social and interactive [17]. When students are working together on a project, a collaborative environment is created where diverse ideas are generated and students also have the chance to approach the task from different perspectives.

When analysing motivation levels using the Reduced Instructional Materials Model Survey (RIMMS), an increase was observed in all subscales of the COIL group compared to the EHU control group. The most notable differences were found in the confidence and relevance subscales. It seems that those that took part in the internationalization experience feel more confident towards maker education.

Furthermore, the quantitative data analysed using the Technology Acceptance Model (TAM) also showed significantly higher results for the COIL participants. The perceived usefulness (PU) subscale showed the most significant positive differences, followed by intention to use (IU) and attitude towards use (ACU). These findings may be related to the fact that when participating in a virtual exchange, students interact and communicate through technology rather than physical travel [10]. Pre-service teachers may also have rated the perceived usefulness (PU) subscale higher due to the fact that the use of technology was essential to the co-development of the project, positioning both COIL [11] and maker education as emerging pedagogies.

The high intention to use (IU) score may also be related to the fact that learning in both COIL and maker education is collaborative, social and interactive. When considering the collaborative aspect of maker education and COIL, it is important to emphasise the importance of communication and collaboration in completing tasks. The project involved working with the 4 Cs, including creativity, critical thinking, communication and collaboration [49]. Therefore, these trainee teachers, who had been exposed to internationalisation at home, may have evaluated the perceived usefulness and intention to use it more positively due to its novelty and suitability to promote some of the skills of the twenty-first century.

Overall, it can be concluded that the results of both participant groups, those who undertook COIL and those who completed the five-week training course without COIL involvement, showed they regarded their involvement in a maker-oriented educational training programme as a highly motivational experience, and that acceptance of the technology was also high. There are several possible explanations that could be linked to these findings. The participants were enrolled in the trilingual format of the Information and Communication Technologies subject, so they were already immersed in a technology-based learning environment taught in English. Focusing on the international aspect of the experience, English was chosen as the language for COIL. This choice may not have been a particular problem as most of the students were competent in terms of their ability to communicate in a foreign language.

Research around COIL is still emerging as it can still be considered a new method [60]. Some previous studies in the field of COIL that have used control and experimental groups have explored the development of intercultural competence when immersed in COIL, such as the quasi-controlled design conducted by Hacket et al. [61]. Our study is similar to that of Hacket et al. [61] in the fact that even though the object analysed was different, both experiences have shown better results when it comes to working with COIL. This study has put its focus on analysing the perception of pre-service teachers in terms of motivation and technology acceptance when involved in maker education training, and by carrying out this study we have started to fill the gap of analysing the impact of the innovative pedagogical approach of COIL when working around maker education.

However, further empirical research in this field is needed. Future research could analyse the influence of other factors, including a larger sample or a comparison between different qualifications, such as early childhood education and primary education. Qualitative analyses could also be undertaken to understand and complement the findings of this particular study. One potential area for such an analysis could involve examining the confidence levels, as demonstrated in a previous research study carried out by Douglas and Verma [62]. This earlier investigation explored the impact of social and emotional needs on training teachers and determined that addressing these needs could mitigate the sense of lacking confidence.

6. Conclusions

Through this study, it can be concluded that taking part in a COIL programme enhances motivation and acceptance of technology towards the maker pedagogical approach among pre-service teachers. The majority of the pre-service teachers that participated in the COIL considered that the maker pedagogical approach has been highly positive in terms of acceptance of the intervention model. This could be attributed to the fact that collaboration is a crucial aspect of both innovative teaching practices, and when these are combined, the impact on the technology acceptance is increased.

It can also be inferred from this research that the integration of these two innovative pedagogical practices into a training programme could be beneficial, especially in higher education institutions, due to its potential to equip future teachers with the ability to reproduce similar practices in the future. It can also be concluded that learners have lived an experiential modelling experience, and, based on the statistical data analysed, this has been shown to have positive acceptance from pre-service teachers. As a consequence, it could be viewed as a valuable tool for educators that may want to provide meaningful international experiences to their students. It can also be considered a cost-effective and inclusive approach to international education where, through digital technologies, global collaboration may be fostered and quality education may be provided for all learners.

Author Contributions: Conceptualization, A.Q.-O., U.G.-R. and J.P.-B.; Methodology, A.Q.-O.; Software, E.C.-E.; Formal analysis, E.C.-E.; Investigation, A.Q.-O., U.G.-R., E.C.-E. and J.P.-B.; Resources, A.Q.-O. and U.G.-R.; Data curation, E.C.-E.; Writing—original draft, A.Q.-O.; Writing—review & editing, A.Q.-O., U.G.-R., E.C.-E. and J.P.-B.; Project administration, U.G.-R.; Funding acquisition, U.G.-R.. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Basque Government's Department of Education, particularly the funding for research teams working on the project "*Creating STEAM education through designing and implementing makerspaces*", with award number IT1685-22.

Institutional Review Board Statement: The study was approved by the Ethics Committee of The University of the Basque Country (Study no. M10_2023_019).

Informed Consent Statement: Data collection and processing for this study were conducted anonymously. Participants were provided with comprehensive information about the study, and only those who voluntarily chose to participate completed the questionnaire.

Data Availability Statement: Data from this research is not publicly available but may be available upon reasonable request to corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

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