



Article

Exploring the Impact of Integrated STEAM Education in Early Childhood and Primary Education Teachers

Marcela Silva-Hormazábal ^{1,*}  and Ángel Alsina ² ¹ Department of Pedagogical Specialties, Austral University of Chile, Puerto Montt 5400000, Chile² Department of Subject-Specific Didactics, University of Girona, 17004 Girona, Spain; angel.alsina@udg.edu

* Correspondence: marcela.silva@uach.cl

Abstract: In recent years, Integrated STEAM education has been positioned as an appropriate educational approach to face the challenges of today's society. Nevertheless, to implement this approach in the classroom requires trained and productively teachers. From this perspective, the objective of this article, is to analyse the impact of integrated STEAM education on teachers through their perceptions in a group of 31 in-service Chilean teachers teaching both in early childhood and primary education, with the aim to obtain a diagnosis for the future design of training processes in STEAM. To obtain data, the adaptation of an instrument that evaluates teachers' perceptions of integrated STEM education has been validated. Specifically, three dimensions of this instrument have been analysed: familiarity, attitudes, and confidence of teachers about this educational approach. The results show that: (1) Familiarity: only 6% of the participants consider themselves very familiar with the approach; (2) Attitude: 97% of the participants declare themselves to be very willing or moderately willing to learn more about STEAM; (3) Confidence: the data shows, in general, a moderate level of confidence to implement this approach. In relation to the impact of STEAM integrated education in the Chilean teacher's perceptions, it can be noted that despite the familiarity of the participants is very low, the scenario seems encouraging, because they show a very positive attitude towards this approach, together with a moderate confidence to implement it. Even though these early findings are encouraging, they also show that the teacher's formation is fundamental, because its impact in the teachers, reverberates directly in a positive impact on the students. Consequently, it is necessary to promote the professional development of teachers in STEAM through training programs that improve knowledge about the approach and deliver the necessary tools to implement it in the classroom.

Keywords: Integrated STEAM education; teachers' perceptions; early childhood education; primary education



Citation: Silva-Hormazábal, M.; Alsina, Á. Exploring the Impact of Integrated STEAM Education in Early Childhood and Primary Education Teachers. *Educ. Sci.* **2023**, *13*, 842. <https://doi.org/10.3390/educsci13080842>

Academic Editors: Jairo Ortiz-Revilla and James Albright

Received: 26 May 2023

Revised: 13 August 2023

Accepted: 16 August 2023

Published: 18 August 2023



Copyright: © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

We live in a society that is constantly and quickly facing several changes that impact the functioning of society and its institutions. Consequently, the school as a social institution, is affected by these changes and is always called upon to adjust its methods in order to adapt to the needs of a changing society. In this sense, some authors emphasise that contemporary problems require the development of different skills that prepare citizens to live, work, and learn in society [1]. This premise highlights the need to develop in citizens both life and work skills that allow them to make informed decisions [2].

Given the challenges posed, it seems natural to move towards a school that, through interdisciplinary education based on competencies, provides tomorrow's adults with the tools they need to better face the technological problems and challenges they will have to solve. UNESCO has organised these problems and needs around a proposal which includes 17 Sustainable Development Goals based on relationships with the natural world, personal and collective well-being, a fair and balanced economy, and education for a just society [3]. These are real problems faced by citizens and are inherently interdisciplinary, so solving them requires knowledge from different disciplines as well as interdisciplinary skills.

In this context, integrated STEAM education (from its acronym for Science, Technology, Engineering, Arts, and Mathematics) becomes relevant by providing a concrete opportunity to develop these skills, knowledge, and attitudes to solve current and future problems. Recent research emphasises that one of the characteristics of integrated STEAM education is precisely that it approaches “in an articulated way the different areas of knowledge that make up STEAM to respond to the challenges of real-life problems in daily life within a globalised and changing society” [4] (p. 473). In this way, implementing a contextualised STEAM approach in the classroom from real-life problems would generate opportunities for relevant and pertinent learning for students.

However, bringing this approach into the classroom requires teams of teachers with the necessary professional competencies to successfully implement this type of integrated education. Thus, it seems logical that when thinking about integrated STEAM education, one immediately thinks of STEAM teachers, especially considering that some research reports that teachers do not have enough experience for this type of reform [5,6]. These investigations highlight the need to strengthen initial and ongoing teacher training, both in the development of theoretical-practical knowledge about STEAM disciplines and in the skills to plan and implement the curriculum in an interdisciplinary manner, and of course, to evaluate under this approach.

Regarding this, a recent experience in this line provides a proposal for integrating Mathematics and Sciences in pre-Service teacher education [7], which signals progress in this area. However, before implementing these changes in teacher education, it is essential to investigate the perceptions of teachers about the integrated STEAM education, this, due to the fact that it has been studied that they impact behaviour [8]. Furthermore, if it is considered that the teachers’ perceptions will influence their ability to learn and be trained as STEAM educators [9]. Likewise, the perceptions, will also affect the teachers’ teaching procedures, regarding the planning, as well as the methods they use [9] and consequently, the students’ learning will be influenced by these perceptions [10].

A recent study anticipates that little is known about the perceptions of teachers or other professionals regarding this approach [8]. So, it is required to continue to investigate about this topic, in view of the assumption that the teachers’ thoughts and beliefs are crucial while practicing in the classroom and thus, influence directly in the teaching-learning process with their students [10]. Likewise, the beliefs about STEAM education affect its implementation in the classroom [11].

Considering these precedents, the objective of this study is to analyse the impact of integrated STEAM education on teachers through their perceptions in a group of 31 in-service Chilean teachers, both from early childhood and primary education. This, as a starting point to make decisions about the design of future teaching professional development programs so as to aboard the challenge of teaching under the integrated STEAM approach in Chile.

1.1. Integrated STEAM Education

Initially, the acronym STEM (Science, Technology, Engineering, and Mathematics) was proposed to refer to the disciplines considered important for the economic growth of countries [12]. In this way, economic, political, and educational leaders and organisations advocated for the incorporation of STEM in schools in order to prepare students for their future jobs [11]. In a similar vein, in Europe, for example, the need for a new pedagogy that promotes the development of the skills necessary for citizens to make informed decisions has been declared [2].

However, over time, terms such as Integrated STEM Education or STEM Integrated [13] began to emerge, and its focus went beyond the economic imperative. In this way, the efforts start to focus on the interdisciplinary nature among the areas which shape the acronym [14]. However, there is no general agreement on its characterisation, as it considers opposing issues ranging from the segregated to the integrated, varying according to the need of different contexts. [13]. For example, one study states that integrated STEM

education is “a meta-discipline, an integrated effort that eliminates traditional barriers between STEM subjects and, instead, focuses on innovation and the applied design process of solutions to complex contextual problems using current tools and technologies” [15] (p. 246). Another author defines it as an approach that manages to integrate the teaching and learning of at least two STEM disciplines, or a STEM area with another area of the school curriculum [16]. In addition, the latest trends integrate an A into the acronym, giving rise to STEAM education, a more comprehensive approach that includes the arts or humanities, allowing educating the student in their entirety [17] and, with it, becoming more integral by expanding the curricular coverage [18].

Consequently, various authors have declared both STEM and STEAM as an integrated knowledge approach that promotes the development of the competencies necessary for tomorrow's adults [5,17–22]. Along the same lines, for example, the new American Standards for Technological and Engineering Literacy state that the essence of education is based on the connection of disciplines, which is naturally interdisciplinary and highlights the bridges between technology, engineering, science, and mathematics. However, connections with the arts and humanities should not be neglected [23].

Regarding the implementation of integrated STEAM education [17], it is indicated that it is necessary to carry it out through authentic didactic units that arise from real questions. In this sense, the experiences and contexts of students, their families, communities, and the environment in which they operate are especially relevant. In this regard, in empirical research, it has been considered that working from these relevant contexts implies not only their use to explore prior knowledge but also becomes a transversal axis of the teaching-learning process [24]. From this point of view, the context can be considered a fundamental bridge between school learning and learning for life. Likewise, it is important to highlight that working from the reality of students, through authentic problems, necessarily implies a multi and interdisciplinary approach, since real-life issues are inherently interdisciplinary.

Thus, integrated STEAM education is seen as an opportunity to educate competent citizens for the challenges of tomorrow. For this reason, it has been considered as an appropriate approach to answer to the 21st century challenges [25], due to the fact that is an approach based on the use of significative contexts [26]. Complementing this idea, some authors have considered that students trained in STEAM are much more capable of adapting and advancing in global society [17]. UNESCO has also emphasised this, stating that “those who are trained in this approach develop the knowledge, skills, attitudes, and behaviours necessary to create inclusive and sustainable societies” [27] (p. 11). All these aspects favour in the students' attitudes such as motivation, participation, positive discipline, etc. [28]. Besides, understand the teachers' perceptions, allows us to anticipate to challenges which come with the STEAM implementation, such as the complexity of an interdisciplinary approach, the preparation of teachers, and the school culture [29].

Nevertheless, bringing integrated STEAM education to the classroom, required certain adaptations, which, majorly keep relationship with teachers' formation; for instance, innovate in the use of approach adjusted methodologies in the classroom [26,30], like Project Based Learning, Problems of Games, gamification, etc. [31,32]. However, teachers do not always have the disciplinary and pedagogical formation about it [26]. Moreover, many teachers manifest difficulty regarding the formation to face this challenge [33]. These knowledge blanks become an obstacle when considering that teachers are the cornerstone to implement any innovation [2] and additionally, are agents of change in the students' perceptions about STEAM [33]. For this matter, as has been pointed previously, it is necessary to continue investigating around teachers' perceptions [8] and the design and evaluation of teaching training programs about the approach [34,35].

1.2. Previous Studies on Teachers' Perceptions about Integrated STEAM Education

The growing importance given to the development of STEAM abilities to address current and future challenges [4,8] has led to concerns about educational environments, and with it, the relevance of having teachers with the necessary knowledge and skills to design

and implement STEAM learning sequences [36] that address contextual and significant issues [7] from early childhood [37]. In this line, UNESCO affirms that “the quality of teaching and specialisation in STEM disciplines are essential for quality education in this area” [27] (p. 12).

This situation highlights the urgency of teacher training in STEAM and, with it, gathering information on their knowledge and perceptions towards this approach. Perceptions are considered as the way individuals understand the environment, assigning meaning to external stimuli [38]. Perceptions give us an idea of how individuals interpret and understand the world [36]. Considering this premise, each individual could have their own conception about a certain topic. In this case, each teacher could have a different way of perceiving and understanding STEAM. In this regard, it has been documented that the way teachers perceive STEAM education would have a direct impact on its implementation in the classroom [39] and, consequently, on the development of a positive attitude towards STEAM in students [33].

Addressing this problem, various researchers and organisations have explored teachers’ perceptions of STEM/STEAM [8,9,11,12,34,36,40,41]. For example, a study suggests that both the implementation of integral STEAM education in classrooms and student participation require dynamic teachers who can manage a conducive learning environment [11,42]. In addition, they emphasise the role of teacher training in improving learning outcomes. Similarly, it has been reported that teachers have a positive view of STEAM and consider it important to incorporate the arts; however, when it comes to putting this into practice in a trans disciplinary education, they question whether they have the understanding to do so [11]. In the same vein, a study indicates that in countries such as South Korea, where STEAM is part of educational reforms, the level of implementation of the approach has been a key challenge [5]. In this sense, they emphasise that the main reason for teachers’ negative perception of STEAM is the belief that they lack sufficient experience for this type of reform. Additionally, other research reports that many teachers may feel unprepared to teach within an interdisciplinary curriculum due to the specific scope of their own education [5,14,33].

In this line, a systematic review of 25 studies [9] highlights that teachers’ beliefs, perceptions, and knowledge are of great importance, as they influence how they design and implement integrated STEAM teaching activities. Among the findings described by the authors, three dimensions can be identified: personal beliefs, implementation barriers, and professional needs. Regarding beliefs, on the one hand, teachers express that the integrative nature of STEAM is beneficial for students and influences their motivation. Despite this, they believe that students cannot or do not want to succeed with STEAM education or initiatives. On the other hand, teachers’ beliefs about their own efficacy and the value they give to STEAM education could influence their willingness to participate and implement it. Regarding implementation barriers, teachers identify traditional school structures as a challenge when it comes to implementation. They also recognise the need to incorporate changes in their own practices, both in how they organise their class and how they teach. However, these changes are not always seen positively by them. Additionally, the integrated nature of STEAM is seen as a challenge in itself by the teachers, both in terms of implementation and evaluation, recognising factors that influence it, such as the lack of quality assessment tools, planning time, and knowledge of STEAM disciplines. Moreover, beliefs about the viability of implementation can be identified, one of which is that teachers see collaboration as a positive factor when thinking about the approach’s projection. Another factor they perceive is the need for support and guidance from principals, as well as flexibility for implementation. They also mention that a quality curriculum would improve the chances of success for initiatives. Finally, teachers believe that it is important to have continuous teacher development opportunities to successfully implement STEAM initiatives in the school context. Subsequently, information has been provided on the willingness of primary and secondary math teachers, both in Brazil and Spain, revealing that a large portion of the teaching staff consider that STEAM activities

influence students' affective perception towards math and the development of their math competence [43].

In summary, these studies suggest the importance of understanding teachers' perceptions of integrated STEAM education in order to plan effective professional development interventions focused on teachers' needs [36]. However, in the Chilean context, there is a lack of evidence on STEAM perceptions specifically, although there are some approaches to teachers' perceptions of STEAM disciplines such as Sciences, Mathematics and Technology. As a result, after the identification of this knowledge gap and the theory support that declare the importance of knowing teachers' perceptions, an exploratory study has been designed to investigate the perceptions of a group of in-service Chilean teachers about of integrated STEAM education. With the purpose of obtaining information that can serve as a platform for designing and subsequently implementing professional development programs for Chilean teachers. These programs would help teachers increase their knowledge and the necessary confidence to design, co-design, and re-design STEAM activities suitable for the particular contexts of various territories.

2. Materials and Methods

In order to achieve the objective proposed in this study, it has been planned quantitative research with a cross-sectional design and an exploratory purpose [44] was carried out since previous studies with similar characteristics have recommended this type of design [45]. An analysis was performed using descriptive statistics, employing absolute frequency counts, percentages, and the calculation of measures of central tendency [46].

2.1. Participants (Sample and Sampling)

The subjects of the study are active teachers from early childhood and primary school from the little Chiloe Island in the South of Chile.

To obtain the data, the first step was to contact the island schools' headmasters by email to explain the objectives of the investigation and to offer free of charge formation on STEAM, for it is a geographical context in which the formation about this matter is very limited or even nil. As early as this contact was made, for schools accepted the process. Secondly, a volunteer convocation was opened to these schools' teachers to be part of the first integrated STEAM teaching development program on the island. This, under two criteria: (a) teach in levels K-4 (5–10 years old); and (b) accept, through an informed consent, to participate in the study. In total, 31 in-service early childhood and primary school teachers responded to the call, who are the ones who showed interest in improving their STEAM skills and participating in the study, which explains the size of the sample.

The participants in the study are between 28 and 59 years old, with work experience ranging from 5 to 39 years. The academic training of the group of teachers is heterogeneous, including 5 early childhood and 19 primary school teachers. In addition, 7 high school teachers or teachers from other areas of education, who have teaching qualifications to teach in primary education, were included. All participants belong to the public education system. They work in localities distributed within three communes of Chiloe Island, (Chile). Within the total teachers, 17 of them work in the rural education context and 14 in urban areas. It should also be noted that, four of the total teachers included, hold managerial and/or technical pedagogical leadership positions.

2.2. Data Collection

The data was collected by using a Spanish-language adaptation of the short version [47] of the instrument that evaluates teachers' perceptions of integrated STEM education [48]. Although the initial instrument specifically focuses on STEM, in this study, the term STEAM was used due to the recent inclusion of the arts in the acronym, which makes the approach more integrated [17]. The linguistic-cultural adaptation of the instrument [49] involved a translation from English and an adaptation to the educational nomenclature in Chile, as well as an adjustment to include the Arts in the acronym. The translated version is validated by

experts in both the native and target languages and in the STEAM disciplines. Specifically, the consecutive procedure is followed: (a) a bilingual teacher independently translates the items from English to Spanish; (b) a bilingual science teacher with publications in STEAM also translates the items from English to Spanish; (c) consecutively, both teacher-translators and the author of this study jointly review both translations to arrive at a final common version in Spanish; (d) finally, a researcher with extensive experience, knowledge, and publications in the STEAM area and in the English language validates the final instrument.

The adapted instrument, the Chilean version, consists of 10 items that focus on understanding teachers' general perceptions of carrying out STEAM teaching practices, which evidences the impact this approach has in the classrooms. Of these items, two focused on the familiarity dimension, four on the attitudes dimension, and four on the confidence dimension. In parallel, the instrument collects demographic information from participants, such as gender, years of teaching experience, level of education, categorisation of the educational establishment (public, subsidised, or private), and its geographical location.

To examine the validity and reliability of the Chilean version of the instrument, an exploratory factor analysis and Cronbach's α analysis were performed with the data obtained in the sample ($n = 31$). Table 1 shows the level of Cronbach's Alpha by dimension and the value it would reach if each item was eliminated.

Table 1. Cronbach's alpha level per dimension.

Dimension	Cronbach's Alpha	Item	Cronbach's Alpha without the Item
Familiarity	0.828	1. Are you familiarised with STEM integrated education?	-
		2. Have you ever attended a workshop or conference relevant to the STEM integrated education system?	-
Attitudes	0.921	3. Are you willing to know more about STEM integrated education?	0.890
		4. To what extent do you believe that integrated STEM education can be implemented in the institution?	0.916
		5. Do you think it's important to incorporate technology and engineering into the current science and math curriculum?	0.923
		6. Are you willing to incorporate integrated STEM education in your classroom?	0.850
Confidence	0.870	7. Do you feel confident when talking about technology or engineering with young children?	0.866
		8. Can you take advantage of STEM opportunities in your daily practice?	0.822
		9. Do you feel capable of incorporating STEM content into the current curriculum?	0.812
		10. Do you feel confident in organising STEM activities in your classroom?	0.836

In Table 1, it is possible to identify that all the indices exceeded the limit value of 0.7; furthermore, no item elimination generates a significant increase in the Cronbach's Alpha of the dimension, so the elimination of any item is not necessary.

Regarding the factorial analysis, first, two measures are reviewed to conclude whether it is appropriate to perform the analysis with the available data. These are: the Kaiser-Meyer-Olkin measure (KMO), for which a value of 0.5 is considered an acceptable limit according to many studies [50]; and the Bartlett's sphericity test, which provides the statistical significance that the correlation matrix has significant correlations among at least some of the variables (items) [51], so the null hypothesis is expected to be rejected, establishing that the correlation matrix is an identity matrix (there is no correlation between the items).

The KMO measure corresponds to 0.643, which is within the appropriate values for the factorial analysis (>0.6). Also, the null hypothesis of Bartlett's sphericity test is rejected, indicating that there are significant correlations among at least some variables in the study.

The aforementioned is a good signal, since both measures reviewed meet the required levels for the factorial analysis; however, the sample size is still small to obtain conclusive results. It is important to notice that this instrument has been validated previously and, for this article, the Spanish version has been endorsed too.

After the validation, and before the first session of the formation about integrated STEAM education, the study's participants received a link through which they could access the Spanish version of the instrument, with the purpose of collecting their perceptions about the approach before acknowledging information about it.

3. Results

Hereafter, according to the objective of the study, the general results are presented first, and subsequently, the data referring to the three explored dimensions: familiarity, attitudes, and confidence of early childhood and primary education teachers towards integrated STEAM education (Figure 1).

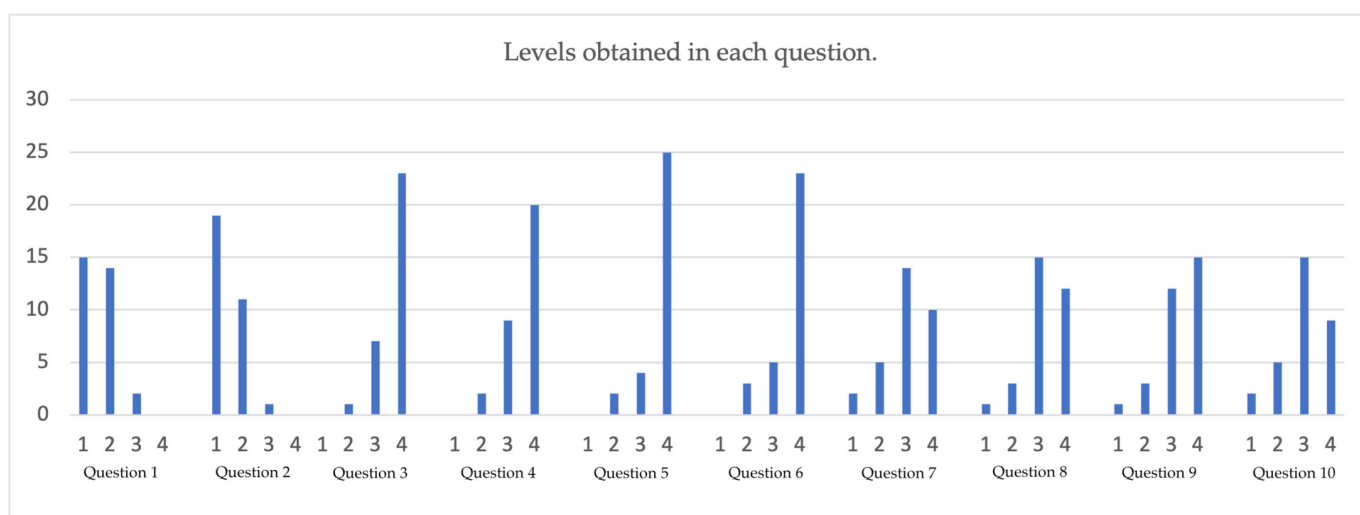


Figure 1. Levels obtained in each question.

It has been assigned a quantitative value to the answer scale of the instrument, obtaining four levels. In this way, the most frequent questions in level 1, show a very low degree of achievement with regard to familiarity, attitude, or confidence about integrated STEAM education, meanwhile, on the opposite end, the most frequent in level 4, indicate a very high degree of achievement about these dimensions.

The global data, show a very irregular scenario, demonstrating pronounced differences through the analysed dimensions. The attitude dimension is the one which presents elevated frequencies with 74% of the participants in the highest level; on the opposite, the punctuations in the familiarity dimension are lower, making it impossible to find any of the teachers in the highest level.

To follow, the data obtained in each dimension are exposed in detail.

3.1. Familiarity

The first two items of the instrument, as noted, seek to inquire about the level of familiarity of the participants regarding integrated STEAM education. As can be seen in Figure 2 the results show that the familiarity of the participants with the approach is very low or non-existent.

Specifically, in question 1, it can be seen that almost all participants (93.6%) are not at all or only somehow familiar with integrated STEAM education, which highlights that the knowledge of this educational approach is very low or non-existent and consequently, its impact will be very low.

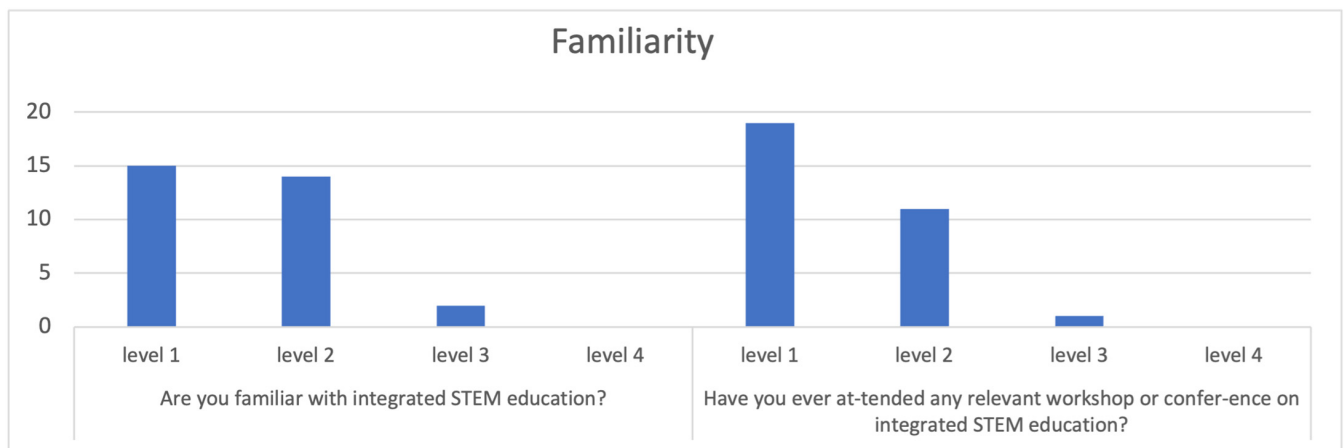


Figure 2. Familiarity dimension on integrated STEAM education.

In relation to the second question, it focuses on understanding teachers' approach to training in the STEAM field. The data from this item show that 61.3% of the participating teachers have never had any training related to integrated STEAM education.

3.2. Attitudes

Although the results obtained from the first two questions indicate that teachers do not have a formal or informal approach to integrated STEAM education and how it is implemented, with the following questions it is inferred that teachers have a positive attitude towards the possibility of delving into this approach.

As observed in Figure 3 the third question "Are you willing to learn more about integrated STEM education?" provides information that allows us to distinguish that 74.2% of the participants are very willing to learn more about integrated STEAM education. Likewise, item 6 provides information along the same line, through the question "Are you willing to incorporate integrated STEM education in your classroom?". The data shows that 74% are very willing to bring integrated STEAM education to their classroom, implementing the approach within their own classroom. If we add the following category (moderately willing), practically all participants show a favourable disposition (90.3%).

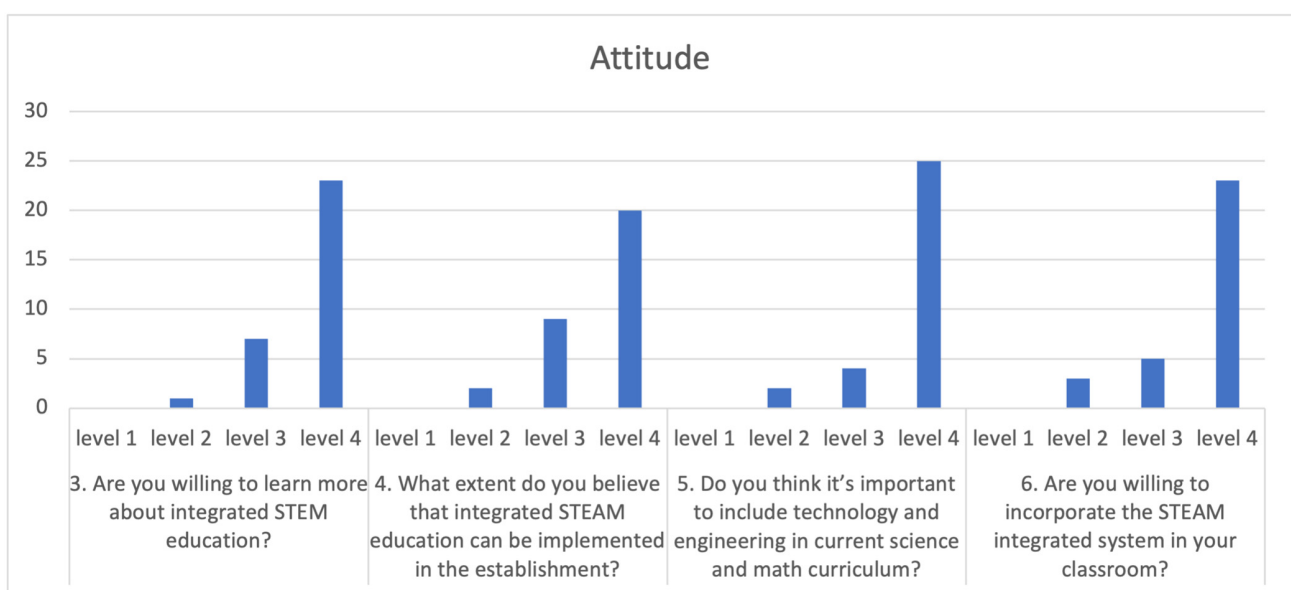


Figure 3. Attitude dimension over integrated STEAM education.

In question 4, it is observed that 35.5% of teachers indicate that it could be implemented in their classrooms, but not completely. However, a majority group (64.5%) expresses that incorporating the approach is achievable to a great extent, and none of the teachers believe that it could not be implemented.

Question 5 specifically asks about the incorporation of technology and engineering. As observed in Figure 3, 80.6% of the participants consider it very important to include these disciplines in the current science and math curriculum, demonstrating that teachers are aware of the level of importance these disciplines have for school education.

3.3. Confidence

Unlike the results of the previous dimension, when asked about the level of confidence they have in the possibility of implementing integrated STEAM education in the classroom, participants are more conservative, as shown in Figure 4.

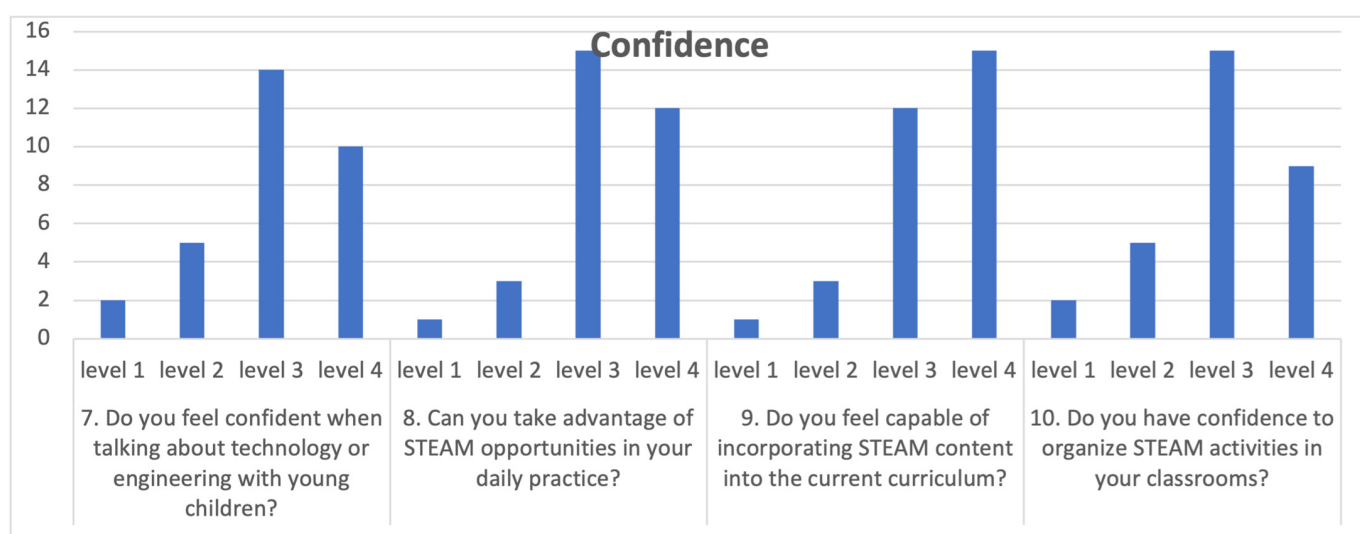


Figure 4. Dimension: Confidence in integrated STEAM education.

On the one hand, by observing these results, it is possible to indicate that teachers express a certain degree of confidence in implementing integrated STEAM education in their classrooms. However, their responses tend towards moderation. For example, in question 7: “Do you feel confident when talking about technology or engineering with young children?”. Although the participants express moderate confidence, it is important to highlight that 6.5% do not feel confident at all in these disciplines, and if we add the next category of responses (slight confidence), 22.6% express a low level of confidence in two of the areas that make up STEAM.

Likewise, when considering the possibility of implementing the approach in the current curriculum, the results show a high level of confidence among teachers. Along the same lines, we can appreciate that an important group of teachers (87.1%) are at the highest levels of confidence to incorporate STEAM content. However, it cannot be ignored that some teachers do not consider themselves capable or do not have the necessary confidence to do so.

Finally, regarding question 10: “Do you have confidence in organising STEAM activities in your classroom?”, 6.5% express no confidence at all to do so. However, 93.5% of teachers express some degree of confidence. Based on these findings, it is possible to state that in general, the confidence of the participating teachers in this study regarding the incorporation of integrated STEAM education is moderate.

However, in general, they demonstrate a high level in the Confidence towards STEM education dimension, which indicates that their perception towards integrated STEM education is very positive, despite not knowing much about the approach. These findings

detect two elements: on the one hand, a need for teacher updating in the STEAM line, both in knowledge and strategies. And on the other hand, an opportunity, because the positive attitude of the teachers makes them receptive to a future training process.

Also, the low results in the Familiarity dimension are directly related to the moderate level identified in the Confidence dimension, which shows that confidence in their ability to implement integrated STEAM education is moderate. This finding is understandable, since they have not received training about what integrated STEAM education is and how it can be implemented.

4. Discussion and Conclusions

The aim of this paper is to analyse the perceptions of 31 Chilean early childhood and primary in-service teachers on the impact of integrated STEAM education. To do this, the brief version of the instrument that evaluates teachers' perceptions of integrated STEAM education [47] has been adapted to the Chilean context. Methodologically, after translation, expert validation, and analysis of the validity and reliability of the Chilean version of the instrument, it is presented as a suitable tool for the study of STEAM perceptions of teachers in the Chilean context.

Regarding the information provided by the instrument on teachers' perceptions towards STEAM, it yields findings in its three dimensions: familiarity, attitudes, and confidence, from which evidence can be obtained about the impact of this educational approach in the study's participants. On the one hand, in relation to familiarity, it is possible to conclude that the surveyed teachers show a low level of familiarity with integrated STEM education. In contrast with other studies, such as the one carried out by Navy et al. [8], in which it is observed that active service teachers have a greater comprehension about the significance of the approach. Notwithstanding, this finding is understandable because all participants declare not having participated in many training instances. This phenomenon may be largely due to two factors: on the one hand, in Chile in general, integrated STEAM education is quite incipient, making it still an unknown approach for many teachers, and on the other hand, the difficult access, in general, to the continuous training of teachers due to the geographic characteristics of this territory. However, this phenomenon transcends borders, as a study carried out in the United States also reports the lack of STEAM professional development offer [33]. For this reason, it is essential to direct efforts towards the professional development of teachers, since the little familiarity with the approach could influence their perception and, consequently, their impact in the classrooms. Other authors who have investigated this line, assert that the negative perception of teachers is based on the lack of sufficient experience to face these innovations, which could be attributed to their training as teachers [5].

Regarding teachers' attitudes, the scenario is hopeful, since despite not knowing the approach, most of them (74%) are very willing to learn more about integrated STEAM education and even implement it in their classrooms. This finding is consistent with previous studies which indicate that teachers are willing to implement the approach with frequency and regularity [29].

However, in terms of confidence, the participants are more conservative, with 61% below the high level of confidence to implement STEAM activities. Several factors could explain this observation. First, the initial of teachers, which generally does not include interdisciplinary, as well as the lack of offer regarding professional development on integrated STEAM education [33]. In the same line, previous studies have shown that teachers feel unprepared to teach within an interdisciplinary curriculum [5,11].

Second, external elements such as the rigidity of the curriculum, the compartmentalisation of subjects, and the demands of their superiors regarding curriculum coverage. [5,11]. On the contrary, investigations made in countries which have given priority to integrated STEAM/STEM education (Science, Technology, Engineering, Arts and Mathematics) as part of the curriculum reformation, report that teachers show themselves more peaceful and satisfied about the support given by their schools for the future implementation [3],

this shows a new line of work in countries where the approach is emergent. Additionally, if the internal policies of educational centres do not align with the needs of integrated STEAM education implementation, teachers will perceive a lack of support [8]. This perception of a lack of support for implementation directly affects their confidence levels and could even influence their attitude.

In summary, we can affirm that despite teachers do not know the approach, they show themselves receptive to implement it, manifesting a positive attitude. A fact that evidence itself by their willing disposition to be part of the first group of teachers in taking part of an integrated STEAM education formation process in the little Chiloe Island. Besides, it is reflected in their low levels of trust, because despite not possessing deep knowledge about the approach, their belief that it can be implemented is expressed in the levels of confidence shown in this study. Likewise, these are coherent with the results obtained in the attitude dimension, with which it might be assumed that, even before beginning a continuous formation process, the fact of taking part, influences the dimensions of trust and attitude, which increases the possibility on integrating the approach in their classrooms for future practices. Seeing this, the scenario is very encouraging, considering that it gives lights that no matter the geographical context it is possible to develop a continuous formation program for teachers in the STEAM approach.

This scenario is hopeful, taking into account that it is vital to consider the teachers' perception before starting any education innovation, because the teachers are the cornerstone of these reforms. Likewise, counting with teachers who are positively willing to integrate STEAM education in their teaching practices within the classroom, shows us an auspicious prospect regarding the results, which will be noted in the students' learning processes.

The above highlights the need to design, validate, and implement teacher training programs on integrated STEAM education in educational contexts where the formation about this approach is limited or null, like the case of Chile. Additionally, it is essential to converge efforts among different entities to ensure that both urban and rural teachers have equal opportunities to access training. In this way, a trained and updated teacher will be able to conduct authentic teaching and learning processes that not only provide opportunities for students to develop knowledge but also skills and attitudes. This has been demonstrated in previous research, which has highlighted the role of teachers in the development of STEAM learning [42], and how this has positive effects on students, both in the development of skills and affective domain mastery [43].

The main limitation of the study has been the reduced size of the sample that, as has been justified, responds to several factors, such as the previous acceptance from the Chiloe schools' headmasters to participate in the study. This, together with the availability of the teachers or the levels in which they practice. For this reason, despite the fact that a positive outlook is observed regarding the teachers' perceptions about integrated STEAM education, in the future, it will be necessary to expand the investigation in terms of the size of the sample as well as the diversification of contexts. Moreover, it will also be necessary to analyse the impact that a teaching formation process might have in the perceptions, knowledge, and practices of the teachers, in order to advance to a more efficient formation that allows the teachers to develop the professional competences needed to implement the STEAM approach from the early ages.

Author Contributions: Conceptualization, M.S.-H. and Á.A.; Methodology, M.S.-H. and Á.A.; Formal analysis, M.S.-H.; Investigation, M.S.-H.; Writing—original draft, M.S.-H.; Writing—review & editing, M.S.-H. and Á.A.; Supervision, Á.A. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The Academic Committee of the University of Girona; 22 February 2023.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Not applicable.

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

References

- Voogt, J.; Erstad, O. Section Introduction: Curricular Challenges of the Twenty-First Century. In *Second Handbook of Information Technology in Primary and Secondary Education*; Springer: Cham, Switzerland, 2018; pp. 15–17.
- The correct reference is: Rocard, M.; Csermely, P.; Jorde, D.; Lenzen, D.; Walberg-Henriksson, H.; & Hemmo, V. *Science Education Now: A Renewed Pedagogy for the Future of Europe*; European Commission: Brussels, Belgium, 2007.
- UNESCO. *Education for Sustainable Development Goals: Learning Objectives*; UNESCO Publishing: London, UK, 2017; pp. 1–68.
- Santillán-Aguirre, P.; Jaramillo, E.; Santos, R.; Cadena, V. STEAM como metodología activa de aprendizaje en la educación superior. *Polo Conoc.* **2020**, *5*, 467–492.
- Kim, D.; Bolger, M. Analysis of Korean Elementary Pre-Service Teachers' Changing Attitudes About Integrated STEAM Pedagogy Through Developing Lesson Plans. *Int. J. Sci. Math. Educ.* **2017**, *15*, 587–605. [\[CrossRef\]](#)
- Shernoff, D.J.; Sinha, S.; Bressler, D.M.; Ginsburg, L. Assessing teacher education and professional development needs for the implementation of integrated approaches to STEM education. *Int. J. STEM Educ.* **2017**, *4*, 13. [\[CrossRef\]](#) [\[PubMed\]](#)
- Iturbe-Sarunić, C.; Silva-Hormazabal, M. Desarrollo de una propuesta de integración de Matemática y Ciencias Naturales en la Formación Inicial Docente. *Estud. Pedagógicos* **2022**, *48*, 255–279.
- Navy, S.L.; Kaya, F.; Boone, B.; Brewster, C.; Calvelage, K.; Ferdous, T.; Hood, E.; Sass, L.; Zimmerman, M. “Beyond an acronym, STEM is...”: Perceptions of STEM. *Sch. Sci. Math.* **2021**, *121*, 36–45. [\[CrossRef\]](#)
- Margot, K.C.; Kettler, T. Teachers' perception of STEM integration and education: A systematic literature review. *Int. J. STEM Educ.* **2019**, *6*, 2. [\[CrossRef\]](#)
- Srikoom, W.; Faikhamta, C. Assessing In-service Teachers' Self-efficacy and Beliefs about STEM Education. *J. Educ.* **2018**, *12*, 169–186.
- Herro, D.; Quigley, C. Exploring teachers' perceptions of STEAM teaching through professional development: Implications for teacher educators. *Prof. Dev. Educ.* **2017**, *43*, 416–438. [\[CrossRef\]](#)
- Wang, H.-H.; Moore, T.J.; Roehrig, G.H.; Wang, H.; Moore, T.J.; Roehrig, G.H. STEM Integration: Teacher Perceptions and Practice. *J. Pre-Coll. Eng. Educ. Res. (J-PEER)* **2011**, *1*, 2.
- Nadelson, L.S.; Seifert, A.L. Integrated STEM defined: Contexts, challenges, and the future. *J. Educ. Res.* **2017**, *110*, 221–223. [\[CrossRef\]](#)
- Kelley, T.R.; Knowles, J.G. A conceptual framework for integrated STEM education. *Int. J. STEM Educ.* **2016**, *3*, 11. [\[CrossRef\]](#)
- Kennedy, T.J.; Odell, M.R.L. Engaging Students In STEM Education. *Sci. Educ. Int.* **2014**, *25*, 246–258.
- Sanders, M. STEM, STEM Education, STEMania. *Technol. Teach.* **2009**, *68*, 20–26.
- Yakman, G.; Lee, H. Exploring the Exemplary STEAM Education in the U.S. as a Practical Educational Framework for Korea. *J. Korean Assoc. Sci. Educ.* **2012**, *32*, 1072–1086. [\[CrossRef\]](#)
- Perignat, E.; Katz-Buonincontro, J. STEAM in practice and research: An integrative literature review. *Think Ski. Creat.* **2019**, *31*, 31–43. [\[CrossRef\]](#)
- Alsina, Á. Conexiones matemáticas a través de actividades STEAM en Educación Infantil. *UNIÓN-Rev. Iberoamérica Educ. Matemática* **2020**, *16*, 168–190.
- Castro, Á.; Iturbe-Sarunić, C.; Jiménez, R.; Silva-Hormazabal, M. ¿Educación STEM o en humanidades? Una reflexión en torno a la formación integral del ciudadano del siglo XXI. *Utop. Y Prax. Latinoam.* **2020**, *25*, 197–208.
- Couso, D. Per a què estem a STEM? Un intent de definir l'alfabetització STEM per a tothom i amb valors. *Ciències Rev. Profr. Ciències Primària I Secundària* **2017**, *34*, 22–28. [\[CrossRef\]](#)
- Domínguez, P.; Oliveros, M.; Coronado, M.; Valdez, B. Retos de ingeniería: Enfoque educativo STEM+A en la revolución industrial 4.0. *Innovación Educ.* **2019**, *19*, 15–32.
- International Technology Education Association (Ed.) *Standards for Technological Literacy: Content for the Study of Technology*; ITEA: Reston, VA USA, 2000.
- Silva Hormazabal, M.A.; Iturbe Sarunić, C.V. Contextualizando el aprendizaje matemático desde la sostenibilidad: Una experiencia de codocencia integrada. *Uno Rev. Didáctica Mat.* **2022**, *95*, 15–22.
- Wahyuningsih, S.; Nurjanah, N.E.; Rasmani, U.E.E.; Hafidah, R.; Pudyaningtyas, A.R.; Syamsuddin, M.M. STEAM Learning in Early Childhood Education: A Literature Review. *Int. J. Pedagog. Teach. Educ.* **2020**, *4*, 33–44. [\[CrossRef\]](#)
- Romero-Ariza, M.; Quesada, A.; Abril, A.M.; Cobo, C. Changing teachers' self-efficacy, beliefs and practices through STEAM teacher professional development (Cambios en la autoeficacia, creencias y prácticas docentes en la formación STEAM de profesorado). *Infanc. Y Aprendiz.* **2021**, *44*, 942–969. [\[CrossRef\]](#)
- UNESCO. *Cracking the Code: Girls' and Women's Education in Science, Technology, Engineering and Mathematics (STEM)*; UNESCO: Paris, France, 2017.
- Hyseni Duraku, Z.; Blakaj, V.; Shllaku Likaj, E.; Boci, L.; Shtylla, H. Professional training improves early education teachers' knowledge, skills, motivation, and self-efficacy. *Front. Educ.* **2022**, *7*, 980254. [\[CrossRef\]](#)

29. Hamad, S.; Tairab, H.; Wardat, Y.; Rabbani, L.; Alarabi, K.; Yousif, M.; Abu-Al-Aish, A.; Stoica, G. Understanding Science Teachers' Implementations of Integrated STEM: Teacher Perceptions and Practice. *Sustainability* **2022**, *14*, 3594. [\[CrossRef\]](#)
30. Rodrigues-Silva, J.; Alsina, Á. Educación STEAM y el aprendizaje lúdico en todos los niveles educativos. *Rev. Práxis* **2023**, *1*, 188–212. [\[CrossRef\]](#)
31. Ortiz-Revilla, J.; Adúriz-Bravo, A.; Greca, I.M. A Framework for Epistemological Discussion on Integrated STEM Education. *Sci. Educ.* **2020**, *29*, 857–880. [\[CrossRef\]](#)
32. Rodrigues-Silva, J.; Alsina, Á. STEM/STEAM in Early Childhood Education for Sustainability (ECEfS): A Systematic Review. *Sustainability* **2023**, *15*, 3721. [\[CrossRef\]](#)
33. Wong, J.T.; Bui, N.N.; Fields, D.T.; Hughes, B.S. A Learning Experience Design Approach to Online Professional Development for Teaching Science through the Arts: Evaluation of Teacher Content Knowledge, Self-Efficacy and STEAM Perceptions. *J. Sci. Teach. Educ.* **2022**, *34*, 593–623. [\[CrossRef\]](#)
34. Nadelson, L.S.; Callahan, J.; Pyke, P.; Hay, A.; Dance, M.; Pfister, J. Teacher STEM Perception and Preparation: Inquiry-Based STEM Professional Development for Elementary Teachers. *J. Educ. Res.* **2013**, *106*, 157–168. [\[CrossRef\]](#)
35. Yang, K.L.; Ball, L. STEM teacher education programs for preservice and in-service secondary mathematics teachers: A review study. *J. Math. Teach. Educ.* **2022**, 1–23. [\[CrossRef\]](#)
36. Zhang, J.; Zhou, M.; Zhang, X. Interventions to promote teachers' perceptions about STEM education: A meta-analysis. *Educ. Inf. Technol.* **2023**, *28*, 7355–7390. [\[CrossRef\]](#)
37. Ata Aktürk, A.; Demircan, H.Ö.; Şenyurt, E.; Çetin, M. Turkish early childhood education curriculum from the perspective of STEM education: A document analysis. *J. Turk. Sci. Educ.* **2017**, *14*, 16–34.
38. Naidoo, J.; Kapofu, W. Exploring female learners' perceptions of learning geometry in mathematics. *S. Afr. J. Educ.* **2020**, *40*, 1–11. [\[CrossRef\]](#)
39. Bush, S.B.; Cook, K.L.; Edelen, D.; Cox, R. Elementary Students' STEAM Perceptions. *Elem. Sch. J.* **2020**, *120*, 692–714. [\[CrossRef\]](#)
40. To Khuyen, N.T.; Van Bien, N.; Lin, P.L.; Lin, J.; Chang, C.Y. Measuring teachers' perceptions to sustain STEM education development. *Sustainability* **2020**, *12*, 1531. [\[CrossRef\]](#)
41. Mafugu, T.; Tsakeni, M.; Jita, L.C. Preservice Primary Teachers' Perceptions of STEM-Based Teaching in Natural Sciences and Technology Classrooms. *Can. J. Sci. Math. Technol. Educ.* **2022**, *22*, 898–914. [\[CrossRef\]](#)
42. McMullin, K.; Reeve, E. Identifying perceptions that contribute to the development of successful project lead the way pre-engineering programs in Utah. *J. Technol. Educ.* **2014**, *26*, 22–46. [\[CrossRef\]](#)
43. López, P.; Rodrigues-Silva, J.; Alsina, Á. Brazilian and Spanish Mathematics Teachers' Predispositions towards Gamification in STEAM Education. *Educ. Sci.* **2021**, *11*, 618. [\[CrossRef\]](#)
44. Hernández, R.; Fernández, C.; Baptista, P. *Metodología de la Investigación*, 6th ed.; México, D.F., Ed.; McGraw-Hill: New York, NY, USA, 2014.
45. Prieto Prieto, J.; Cerro Herrero, D. Percepciones de futuros maestros sobre motricidad en educación infantil: Un estudio exploratorio en estudiantes de último curso (Perceptions of future teachers on motricity in early childhood education: An exploratory study with last-year students). *Retos* **2020**, *39*, 155–162. [\[CrossRef\]](#)
46. Mcmillan, J.H.; Schumacher, S. *Investigación Educativa*, 5th ed.; Pearson Addison Wesley: Madrid, Spain, 2005.
47. Tao, Y. Kindergarten Teachers' Attitudes toward and Confidence for Integrated STEM Education. *J. STEM Educ. Res.* **2019**, *2*, 154–171. [\[CrossRef\]](#)
48. Yaşar, Ş.E.; Baker, D.; Robinson-Kurpius, S.; Krause, S.; Roberts, C. Development of a Survey to Assess K-12 Teachers' Perceptions of Engineers and Familiarity with Teaching Design, Engineering, and Technology. *J. Eng. Educ.* **2006**, *95*, 205–216. [\[CrossRef\]](#)
49. Ursin, J.; Hyytinen, H.; Silvennoinen, K.; Toom, A. Linguistic, Contextual, and Experiential Equivalence Issues in the Adaptation of a Performance-Based Assessment of Generic Skills in Higher Education. *Front. Educ.* **2022**, *7*, 885825. [\[CrossRef\]](#)
50. Naseer, M.; Ashfaq, M.; Hassan, S.; Abbas, A.; Razzaq, A.; Mehdi, M.; Ariyawardana, A.; Anwar, M. Critical Issues at the Upstream Level in Sustainable Supply Chain Management of Agri-Food Industries: Evidence from Pakistan's Citrus Industry. *Sustainability* **2019**, *11*, 1326. [\[CrossRef\]](#)
51. Hair, J.; Black, W.; Babin, B.A.; Anderson, R. *Multivariate Data Analysis*, 7th ed.; Prentice-Hall, Inc.: Upper Saddle River, NJ, USA, 2010.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.