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International Centre for STEM Education

European Report on mobility and the European dimension

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ICSE International Centre for STEM Education

Pädagogische Hochschule Freiburg
Université des Sciences de l'Education · University of Education

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European Report on mobility and the European dimension

WP5

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1. EXECUTIVE SUMMARY

This report outlines the results of the Status quo study and the pre-post study, drawing related conclusions within the framework of the ICSE Academy project. The study focuses on the perceptions and professional development needs of pre-service and in-service teachers from 13 European countries. Its purpose is to assess their motivation, attitudes toward international mobility, and the integration of European priorities such as sustainability, digitalization, and inclusive teaching in STEM education.

The study analysed the Status quo using a diverse sample of teachers and employed cluster analysis techniques to identify patterns based on factors such as gender, initial orientation toward the teaching career, perceptions of training needs, and attitudes toward international mobility. Additionally, a pre- and post-intervention analysis assessed the impact of the ICSE Academy activities on teachers' motivation and the acquisition of knowledge and skills related to European priorities in STEM.

The main findings of this study can be summarized as follows:

a.) Differences between pre-service and in-service teachers: Pre-service teachers demonstrated greater professional development needs and a higher perception of the importance of integrating sustainability, digitalization, and inclusion in STEM when compared to in-service teachers.

b.) Pre-service teachers exhibit greater motivation for the teaching profession than in-service teachers.

c.) Both in-service and pre-service teachers maintain very positive attitudes towards international mobility, viewing it as an opportunity for experience exchange and professional growth.

d.) While motivation and attitudes toward international mobility remain stable after the program, a significant increase is observed in teachers' knowledge and skills related to integrating sustainability, digitalization, and inclusion in STEM. Additionally, the perceived need for ongoing professional development in these areas rises. This can be regarded as a positive and transformative impact of the ICSE Academy.

Based on these results, we conclude that the ICSE Academy has significantly contributed to the professional development of STEM teachers, strengthening their competencies to integrate European priorities into teaching. However, However, we see that there is still need for training, which require a continuity of this type of programs. It is recommended: maintain and expand teachers´ professional development programs in sustainability, digitalization, and inclusion in STEM; implement strategies to sustain teacher motivation throughout their career; promote international mobility policies with support for teachers with family responsibilities and ensure the funding of initiatives based in experience and research evidence, like the ICSE Academy, to further strengthen teacher professional development in Europe.

2. INTRODUCTION

In this introductory section we will first provide the background and the context in which this deliverable is produced, referring to the call funding the ICSE Academy, which set clear goals to **improve teacher education in relation to the European priorities and to enhance teacher international mobility**. Secondly, we will present the main aims of this report and the objectives of the work package responsible for it and finally, we will set and an overview of the approach followed to develop it.

2.1. BACKGROUND

This report is part of the ICSE Academy funded to contribute to the improvement of teacher education policies and practices in Europe by creating networks and communities of practice on teacher education. These networks should bring together providers of initial teacher education (pre-service education for future teachers) and providers of continuing professional development (in-service), as well as other relevant actors, such as teacher association, ministries and stakeholders. Through these kinds of collaborations and the exchange of best practices, partners were asked to develop and test strategies and programs for professional learning that are effective, accessible and transferable to other contexts. In addition, **the call intended to enhance the European dimension and internationalisation of teacher education and to address the key priorities of the European Union** such as learning in the digital world, sustainability, equity and inclusion, also by offering teachers courses, modules and other learning opportunities on these topics.

Within this context, the ICSE Academy has provided opportunities to develop and test jointly different models of mobility (virtual, physical and blended) in initial teacher education and as part of teachers' continuous professional development in order to enhance the quality and number of mobility as well as to make mobility an integral part of teacher education provision in Europe.

Besides incorporating different forms of international mobility, the forms of teacher professional development tested in this project, have provided teachers with knowledge, skills, resources and strategies to address the European priorities through STEM education.

As a result, the project has developed sustainable collaboration between teacher education providers both for initial and continuous professional development, with an impact to the quality of teacher education in Europe and with a view to inform teacher education polices at European and national levels.

2.2. AIMS AND OBJECTIVES

In response to the call funding this project, **the main aim of this report** is to provide a European outlook of STEM teacher education and international mobility based on the quantitative research conducted by WP5. This **international outlook is based** on the results of the **initial Status quo study** conducted within the 13 partner countries and the

pre/post study designed to evaluate the impact of the action on the participant teachers.

In this respect, the results presented herein provide research evidence of how this project has improved teacher international mobility (including different forms) and teacher professional development related to the European priorities, as set by the call funding this project.

WP5 is responsible for this deliverable and the quantitative research related to the evaluation of the project. The objectives of WP5 are:

- To develop a Status quo study about teacher international mobility, motivation and needs in the first months of the project.
- To conduct a pre/post study to evaluate the impact of the Teacher Academy activities on the participant teachers.
- To evaluate the quality of the partnership.

The Status quo study intends to provide an insight into teachers' needs, their motivation and beliefs related to the teaching career and to the European priorities related to digitalisation, sustainability and inclusive teaching, the European dimension and teacher international mobility.

Furthermore, and as previously stated, WP5 is also responsible for the evaluation of the impact of the ICSE Academy on participants, in particular the summer schools and the international workshops series. As a means to enhance the European dimension and to improve their teaching practice, special attention was given to explore the impact of the activities on the teachers' motivation, relevance of their career, professional needs and attitudes and beliefs towards international mobility. In addition, we evaluated to what extent the participation in the ICSE Academy activities improved teachers' knowledge and skills to integrate the European priorities related to sustainability, digitalisation and inclusion into STEM teaching.

Finally, although it is out of the scope of this deliverable, WP5 is also responsible for evaluating the perceived quality of the partnership and the effectiveness of mutual learning and the joint activities carried out, both on a personal level and on community of practice level. In addition, partners were asked about the main barriers perceived and how they could overcome these barriers and about suggestions to improve the quality of the cooperation.

In addition, WP5 along with WP4 (case studies) will contribute to provide research evidence about to what extent the professional learning models and activities developed so far were effective, accessible and transferable for pre- and in-service STEM teachers. The activities will be considered satisfactory if they meet teachers' needs in terms of content, pedagogy, schedule, duration, and the digital tools required. They will be considered transferable, if the professional learning activities can be easily applied to other countries, contexts, regions or types of schools.

2.3. APPROACH

In the following paragraphs, we will briefly outline the approach followed and the methodology applied to produce the results reported herein:

In order to provide a coherent and well-founded evaluation concept, a participatory approach was undertaken, involving the whole consortium in the validation of the research questions and the instruments to be developed.

We started by doing a literature review in order to define the key constructs to be measured and to identify previously validated instruments that could be used or adapted to our purposes. As a result of the literature review, WP5 suggested initial versions of each of the questionnaires used for the purposes outlined above. The first versions of the questionnaires were subjected to experts' validation and were piloted in order to ensure its reliability and internal and external consistency.

The evaluation concept and the questionnaires entailed were developed on the basis of the description of work, the bibliography consulted and the feedback received from the consortium as a whole, in different meetings, as well as from specific partners acting as expert reviewers (Bracht et al., 2006; Engel, 2010; Rodrigues and Branco, 2021; Svensson and Wihlborg, 2010).

To serve the three main objectives defined above, the evaluation concept involves three aspects. Firstly, it intends to define the starting point, through an analysis of the state of the art in relation to the vision that teachers have about internationalisation in the Status quo analysis about STEM teachers' international mobility. Secondly, it intends to evaluate the impact of the summer schools and the international workshop series on the participant teachers, using a pre and post research design. Thirdly it intends to evaluate the quality of the ICSE Academy partnership, although this latter study is out of the scope of this report.

The dimensions studied in the Status quo and in the pre/post study were teachers' motivation for the teaching career (intrinsic motivation), perceived relevance of the European priorities, teacher professional development needs related to those priorities, knowledge/skills about how to teach in relation to the European priorities and beliefs and attitudes towards international mobility and the exchange/collaboration with colleagues from other countries.

Therefore, the Status quo study intended to provide an initial overview about the key areas of interest in the 13 partner countries before delivering the ICSE Academy activities, while the pre and post study allowed us to evaluate the impact of the ICSE Academy activities on the participant teachers. For the latter study teachers were asked to fulfil the questionnaires developed for this purpose, before and after participating in them.

The Status quo analysis intends to respond to the following research questions:

- To what extent do STEM teachers feel motivated for their profession?
- What are STEM teachers' needs in terms of teacher professional development?
- What relevance do STEM teachers see in relation to European priorities and the European dimension of STEM teaching?
- How mobile are STEM teachers across Europe and why?

The pre and post questionnaires distributed at the beginning and the end of the participation in the ICSE Academy activities provide research evidence to respond to the following questions:

- What is the impact of the intervention on STEM teachers' motivation for their career?
- What is the impact of the activity on teachers' STEM teaching (as perceived by teachers)?
- What is the impact of the activity on teachers' attitudes, knowledge and skills in relation to the European key priorities and the European dimension?
- What is the impact of the activity on teachers' attitudes in relation to mobility?

In addition, information related to teachers' willingness to participate in new European activities was collected in the post-test questionnaire.

More methodological details will be provided in the corresponding sections of the report.

3. METHODOLOGY

This research employed a quantitative approach, utilizing the analysis of survey data to examine the dimension proposed in our evaluation concept. Statistical methods, including different correlation test, non-parametric and parametric test for study differences, factor analysis and cluster were employed to identify patterns and trends within the data. The primary objective was to quantify and measure the variables (demographics and scales) enabling the identification of relationships and the extraction of conclusions based on numerical evidence. The data source consisted of questionnaires administered to teachers across the consortium countries. Statistical analysis was performed using IBM SPSS Statistics software, complemented by Microsoft Excel for data curing organization and preliminary analysis. Graphs has been produced through *matplotlib.pyplot* library in a python environment. The following section will discuss aspects of the questionnaire validation and the sample description for both the Status quo and the pre-test post-test.

3.1. INSTRUMENTS

3.1.1. General description of instrument development and validation

Questionnaires used in the Status quo study and the pre- and post-questionnaires are extensively described in the report on the development of the evaluation instruments (MS9). The initial questionnaire versions were based on a literature review and were subjected to a validation process carried out in different phases, as described in a previous report. Subsequently, only items that passed the validation process were retained for the questionnaires in the WP5 study. Questionnaires also includes certain fields that allow us to carry out a descriptive analysis of the sample considering demographic variables. Table 2 (appendix I) shows the coding of these variables. such as "gender", "previous experience in mobility actions", "age range", "initial orientation towards teaching" and " background". Post-test questionnaire also include additional questions having in consideration the number of actions where teachers took part.

In the case of the Status quo study, the validation process was carried out in English, and after refining the questionnaires and defining the final versions, each partner translated it into their native language. For the validation phase, the questionnaire was distributed to a sample of teachers in both initial and in-service education. The Kaiser-Meyer-Olkin (KMO) sampling measurement reached a value of 0.870, indicating good data adequacy for factor analysis. Additionally, Bartlett's sphericity test was statistically significant ($\chi^2 = 1888.672$; $p < 0.001$), confirming the existence of significant correlations between the items and justifying the use of factor analysis. First, responses were analysed using the Principal Component Analysis (PCA) and Exploratory Factor Analysis (EFA). Exploratory factor analysis led to the selection of items that would finally form part of our measurement scales to be also later used in the questionnaire for the pre-post measurement. Table 3 (appendix I) lists the representative statistics used to evaluate sample adequacy, factorization suitability, and retained factors. These results support the underlying structure of the questionnaire in the intended theoretical dimensions

and its validity as a measurement instrument. It should be noted that the dimension previously defined as relevance concerning the European priorities is fully integrated into the Teacher Professional Development Needs scale within the pre-post-test questionnaire, focusing on perceptions of needs for professional development in this line. In this sense, the need itself can be seen as a motivational factor. Table 4 (appendix I) shows the reliability index for analysis of the theoretical dimensions taking the pre-unpaired sample as a reference. The analysis with the post sample reinforces the reliability re-test.

3.2. Status quo sample description

This descriptive data provides an overview of the demographic characteristics of teachers, allowing subsequent analyses to be appropriately contextualized and interpreted.

The sample for the Status quo study included both pre-service and in-service teachers with different degrees of experience, backgrounds, and ages of expertise from all consortium partner countries. A total of 442 teachers responded to the questionnaire. An analysis of outliers (with different criteria) led to a final 400 selected responses from the entire sample (218 from in-service teachers and 182 from pre-service teachers). Figure 1 shows the distribution of countries that participated in the Status quo study.

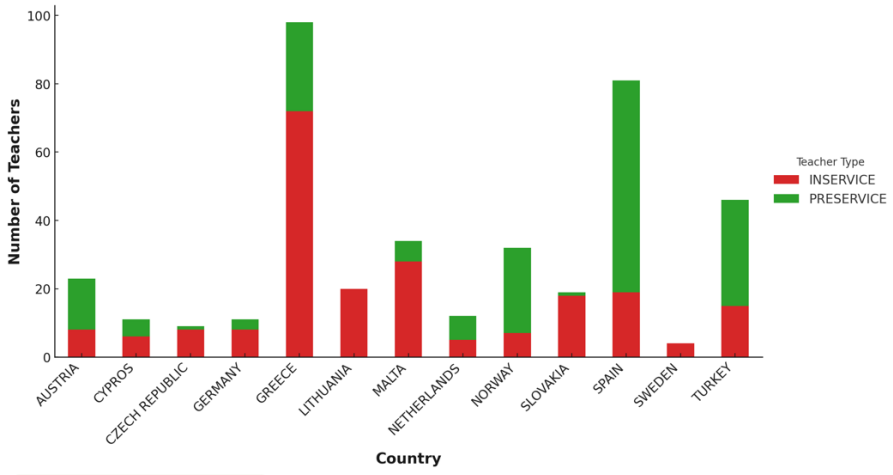

Figure 1. Distribution of teachers by country and type. The bar chart represents the number of In-Service and Pre-Service teachers in each country. The stacked format allows for an easy comparison of the relative distribution of each category across different locations.

In the following sections, a summary of the demographic description of the Status quo sample is presented. First, an overview of the sample is presented with some statistical inferences because some measurement for pre-service and in-service teachers presented significant differences in their responses.

3.2.1. Demographic information and other study variables for Status quo sample

3.2.1.1. Gender

In terms of gender distribution, 60.8% of the sample were female (n = 243), 38.2% were male (n = 153), and 1% were of other genders (n = 4). These data reflect the predominance of female respondents in the sample. Within the in-service group, 61.9% were female (n = 135) and 30.1% were male (n = 83). On the other hand, among the pre-service group, 59.3% were female (n = 108), 38.5% were male (n = 70), and 2.2% were of other gender (n = 4). The chi-squared independence test was also applied. The results showed no statistically significant differences between the proportions observed in both samples (χ^2 (1) = 0.023, p-value 0.880). This indicates that the gender proportions in the two samples -pre-service teachers and in-service teachers- is homogeneous, suggesting a similar distribution in terms of gender between both groups.

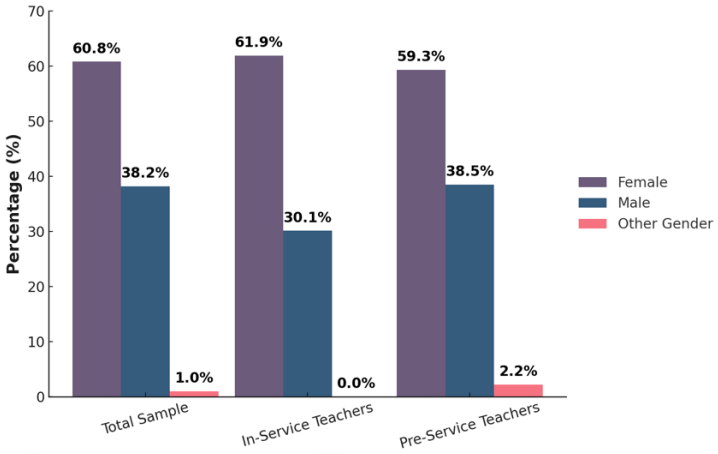

Figure 2. Gender distribution within the Status quo sample

Given the previous values, a binomial test was applied. In both subsamples, the proportion of females was significantly higher than the expected value (p-value in-service < 0.00054; p-value pre-service 0.0054). These results show that in both samples, female is overrepresented compared with an equal distribution by gender.

3.2.1.2. *Range of Age*

Participants were distributed according to their age range in the following terms: the most representative age group is 21-30 years (50.0%), followed by 41-50 years (19.3%), 51-60 years (15.5%), and 31-40 years (11.5%). The group of individuals older than 60 years constituted the lowest proportion (3.8%). However, the pre-service group had the highest proportion in the 21-30 group, accounting for 100% of this cohort. The analysis of the distribution within the in-service group corresponds to the following data: 41-50 (35.3%), followed by 51-60 (28.4%), 31-40 (21.1%), and 21-30 years (8.3%), while the group of people over 60 years old represents 6.9%. This distribution reflects diversity in terms of age and experience across the entire sample, allowing room for a variety of attitudes and beliefs in the sample and providing a rich and comprehensive picture.

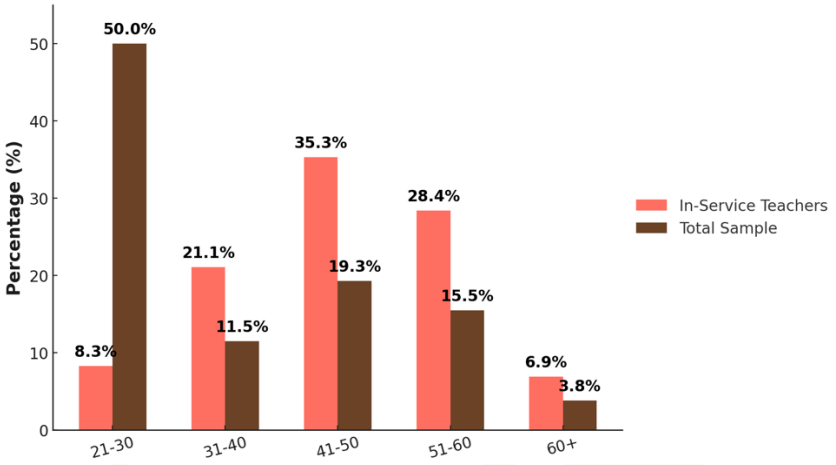

Figure 3. Age range or the Status quo sample

3.2.1.3. *Subjects taught and years of Experience*

In-service teachers report on their professional experience as follows: 65.15% had more than 15 years of experience, followed by the 11–15 years of experience group (14.7 %), and 13.3% corresponds to the cohort in the initial stage of their career (from 0–5 years of experience). The smallest group represented in this sample is the one whose experience ranges between 5 and 10 years (6.9%).

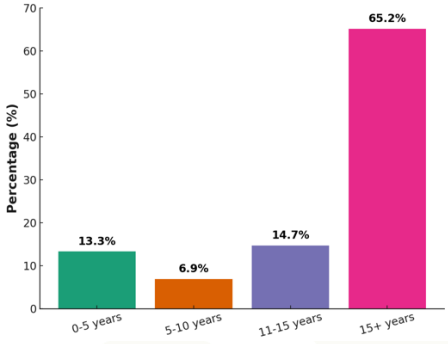

Figure 4. Distribution of professional experience among in-service teachers.

Although it is obvious that no other result can be expected for correlation range of age and experience, there is a strongly significant relationship between these variables (p-value < 0.001).

The descriptive analysis of the subjects taught by the in-service teachers shows that **Mathematics** is the most frequently taught subject in this cohort, with a 43.1. A lower representation, include **Mathematics and Physics** (5.5%), **Biology** (4.6%), **Physics** (4.1%) and **other subjects** (10.1%). The analysis of the subjects taught tagged as "other subjects" showed a noteworthy thematic diversity. The most represented areas in our study were Computer Science (18.8% over 10.1%), which falls under the category of "Technology", Science Education (10.4% over 10.1%) and Foreign Languages (12.5% over 10.1%). The results indicate a predominance of STEM areas, as evidenced by the responses, indicating as well "**Mathematics and others**," what refers to other disciplines, thereby increasing the percentage of these subjects that are represented. Other responses are presented, although in a smaller proportion. These results underline the diversity of teaching experience and background in the sample of study.

3.2.1.4. Background and initial orientation to become teacher

The analysis of the answers for in-service teachers, related to their previous training, can be highlighted in the area of **Mathematics**, with 61.53% together with **Physics** (8.7%), **Biology** (6.9%) and **Chemistry** (6.4%). Regarding the "Others" responses, 12.8% identified contributions in various areas. As it might be expected, there is a significant association between teachers' **academic background** and **subjects they teach**. This shows, in the context of this study, that teachers' background and previous education is closely linked to the subject they later teach at school. Initial orientation to become a teacher

The questionnaire for the Status quo study also included some items designed to learn about teachers' motivation to become a teacher. The analysis of responses shows that 70.3% of the whole sample reported that the teaching career was their first option. When analysed separately, 76.1% of in-service teachers stated that the teacher career was their first career option versus 63.2% or pre-service teachers. Most teachers consider the teaching career as their first option **and the motivation to become a teacher**, as initial orientation, was significantly higher in in-service teachers than in pre-service teachers.

3.2.1.5. Additional Professional Development Needs

In the Status quo study, teachers were asked about their perceived professional development needs (figure 5). In this respect as a whole, **68.7%** of the sample stated they feel that they need to keep on learning and growing professionally, where **31.9 %** responded that they did not require more training needs. When the analysis was conducted in the two different sub-samples separately, 62.4% of in-service teachers claimed for more training versus 74.7% of pre-service teachers. This distribution seems to point out (we will confirm later with the scale teacher professional needs) that with a p-value less than 0.05, there is statistically significant evidence to suggest that **additional professional development needs** distributions **differ** among the two sub-

samples with Chi-square: 6.57; dof: 1, p-value = 0.010. In addition, within each group of teachers (and setting an equal distribution of 50%) there are also significant differences in the perception of their additional professional needs (p-value < 0.001).

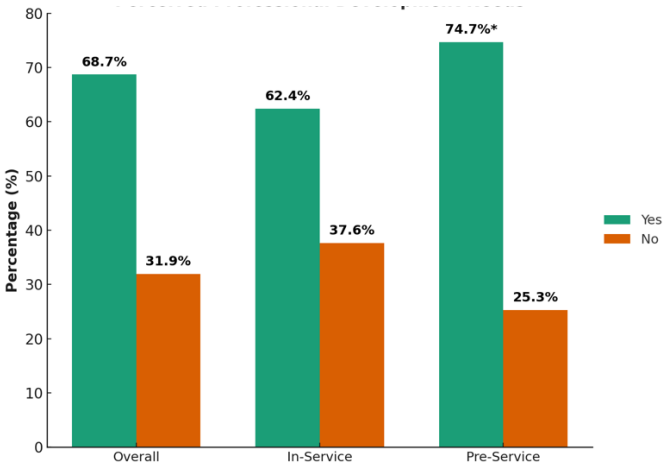

Figure 5. Perceived professional development needs among teachers in the Status quo sample

3.2.1.6. International mobility and previous experiences

Participants were asked about the possibilities for international mobility for training, their experiences related to international mobility and to what extent they considered them positive experiences.

The analysis of the international mobility variable revealed that 269 participants **did not have international mobility**, which implies **67.3%** of the sample. Among those who reported having international mobility experiences (32.7% of the whole sample), 11.5% stated that they experienced it as students, 12.8% as teachers, and only 1% as researchers. Some respondents also reported mobility in different roles (e.g., as student-teacher or as student-researcher). When disaggregating these results by type of teachers, 136 **preservice** teachers (approximately **76.4%** of that cohort) reported having no experience of international mobility. In the **in-service** group, 133 participants (circa **61%** of that cohort) had not experienced this. In addition, 47% of the whole sample reported that they did not have opportunities for international mobility. A positive and statistically significant relationship was observed between the items related to experiences and opportunities for international mobility. However, given the moderate correlation coefficient, the relationship was not particularly strong.

Another interesting result is that only 35.8% of respondents agreed that they had positive experiences with international mobility. A positive correlation between mobility and positive experiences in this field was detected. Although the relationship is weak, it could have relevance in certain contexts of study, suggesting different questions, for example, why do they value these experiences negatively? In the case of positive experiences, it may be interesting to determine whether the participants are referring to their own experiences or whether their opinions are based on the experiences of other people. To better interpret this relationship, additional analyses, such as

regression or mediation analyses, should be performed. These data could be read carefully but seem to be very inspiring for the design of international professional development actions since the "external" opinion can be a "triggering" element to make decisions about one's own mobility.

3.2.1.7. Clustering Summary

As can be seen in the previous sections, our sample is quite diverse based on the variables studied. Appendix II shows a graphical summary of the most representative cases in which it has been possible to organize the Status quo data taking into account demographic variables and using a clustering data arrangement. This set of clusters could be simplified fixing some parameters. The three clusters with the highest number of cases are described below:

1. **Cluster I**: This group includes 106 individuals (63.21% female), with a positive initial orientation towards the teaching career and with no predominant needs related to teacher additional professional development.
2. **Cluster II**: in this group, with 92 cases, the representative characteristics are a positive initial orientation towards the teaching career and absence of teacher professional needs. This group is predominantly female with a 30.43% of males.
3. **Cluster III**: The third largest group, with 60 cases, has a predominant orientation to initial orientation to be teachers and is predominantly composed by females (circa 65%), with 35.00% of males. This cluster stands out for combining professional needs and a predominance of female.

These results allow us to identify common patterns and key differences between the elements analysed, offering a basis for deeper interpretations and specific applications in future study contexts. Overall, in our sample and taking into account all the categorical variables, the clusters **reveal clear patterns** related to gender, international mobility and initial orientation towards the teaching career. Participants are grouped in ways that reflect specific profiles, such as those with initial orientation and mobility experiences versus those without both. These results underline the usefulness of the method to identify subgroups and to be able to analyse the results aligning it with case studies.

3.3. PRE-POST STUDY SAMPLE DESCRIPTION

Our sample consisted of over 300 participants who completed the questionnaires at different stages of the project implementation. The sample included a diverse group of teachers from various nationalities, representing countries participating in the project consortium: Spain, the Netherlands, Norway, the Czech Republic, Lithuania, Slovakia, Cyprus, Germany, Malta, and Austria. Of those teachers, 295 completed the pretest and 212 completed the post-test questionnaires. The summary data for the entire sample and the proportion by gender are presented in **table 5** (appendix III).

3.3.1. Demographic information and other study variables for pre post sample

3.3.1.1. Gender

Regarding the distribution by gender in the pre-test data, it was composed of approximately 75% females and 25% male teachers, showing a predominance of the female gender in this sample population (figure 6). These values are consistent with those for the Status quo. The gender ratio of *female:male* remains almost constant in the pretest and post-test even when there is a decrease in the number of questionnaires collected. There seem to be no significant differences in the pre- and post-tests in relation to gender considering the whole sample (Chi-squared = 0.494; dof :1; p-value = 0.482) or exclusively for paired data. However, the proportion of female teachers was significantly higher than that of male teachers.

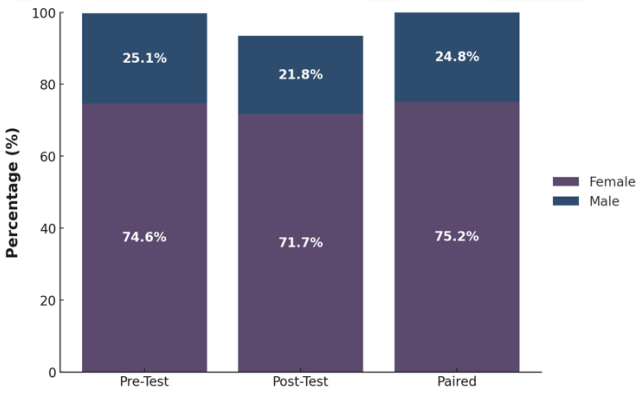

Figure 6. Gender distribution in the Pre-Test, Post-Test, and Paired Data.

3.3.1.2. Groups of age

In relation to the age range variable, the results in the pre-test sample showed that the most represented categories correspond to the age range 21-30 years (49.2%), indicating that this is a sample that is mainly at the beginning of its teaching career. We can also see that the following ranges, 31-40 years and 41-50 years, approximately have the same distribution (circa 20%) for each group. In total, 11.0% of the participants were aged over 51 years.

3.3.1.3. Background

In relation to the teacher´s background, **41.7%** of the sample responded **"Mathematics"** and "Mathematics and others", of which 25.8% specified only Mathematics as the main background discipline and 20.6% "Mathematics and others". This 20.6% proportion includes a 15.9% proportion that specifies **"Mathematics and other scientific subjects". 21.6%** of teachers show diverse **scientific education (biology, chemistry, physics)**. Table 6 (appendix III) summarizes these data. It is noteworthy that in the pretest sample, 21% of teachers indicated "other" as their initial education background, which means other than mathematics, science, or technology. A detailed analysis of these "other" responses indicates that this background is mainly related to education, primary education, or elementary education, although other humanistic disciplines, such as languages, arts, and geography, are also present in a very low proportion.

3.3.1.4. Initial career orientation, previous experiences in mobility and interest for educational professional development activities

In relation to the initial career orientation variable, teachers' choice of teaching as the first option for a career is the predominant response, with an approximate a 68% of affirmative responses to the question: "Was teaching your first career choice?" The same pattern was obtained in relation to previous mobility experiences related to training. In relation to the interest in participating in the project´s activities it is noteworthy that more than 60% of teachers indicate their interest in participating again in these types of actions.

Results of this sections are in table 7 and 8 (appendix III).

4. RESULTS

4.1. STATUS QUO RESULTS.

As previously stated, the purpose of the Status quo study is to develop a European outlook of STEM teacher education, with a focus on teachers' motivation and teachers' professional development needs, especially those related to the European priorities related to sustainability, inclusion and digitalization. Finally, the Status quo analysis also looked at teachers' beliefs and experiences related to international mobility and how this mobility could impact their profession as teachers. As we have seen in the description of the Status quo sample the diversity of cohorts is evident. In this sense, it has been decided to carry out the Status quo study only focusing on the in-service *vs* pre-service teachers comparison. Tables with the results of the comparison of mean and mode (in the item analysis) can be found in appendix IV, and the extended results are discussed in the following sections. Table 1 presents the main statistics description of the dimensions of motivation, perception of relevance for EU priorities, professional development needs and internationalisation (as mean values and standard deviations) and significant tests. This data has been graphically summarized and showed in figures 7 and 8.

Table 1. Summary for the Status quo analysis of the selected dimensions

	In-service (n = 218)	Pre-service (n = 182)
Motivation	4.36 (.51)	4.45 (.53) *
Extrinsic Motivation	4.67 (.45)	4.72 (.63)
Intrinsic Motivation	4.06 (.75)	4.17 (.81) **
Relevance for European priorities	4.26 (.48)	4.44 (.48) ***
Teacher professional development Needs	3.87 (.61)	4.11 (.63) ***
Internationalisation	4.21 (.59)	4.23 (.56)

* p-value = 0.046
** p-value = 0.048
*** p-value <0.001

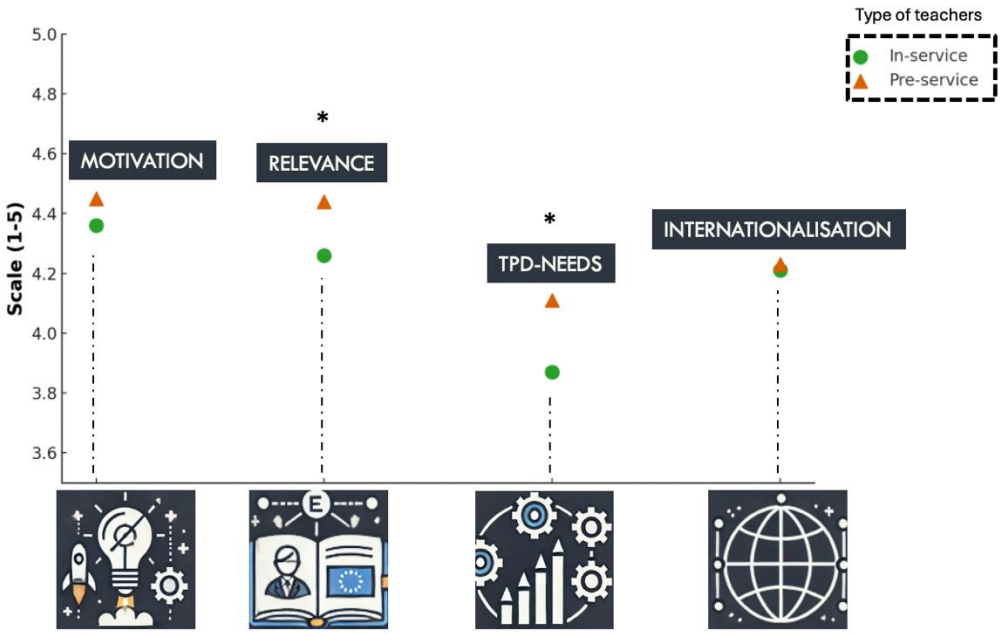

Figure 7. Graphical abstract for the dimensions analysed in the Status quo study showing the average median values both for pre-service and in-service (*significant differences found)

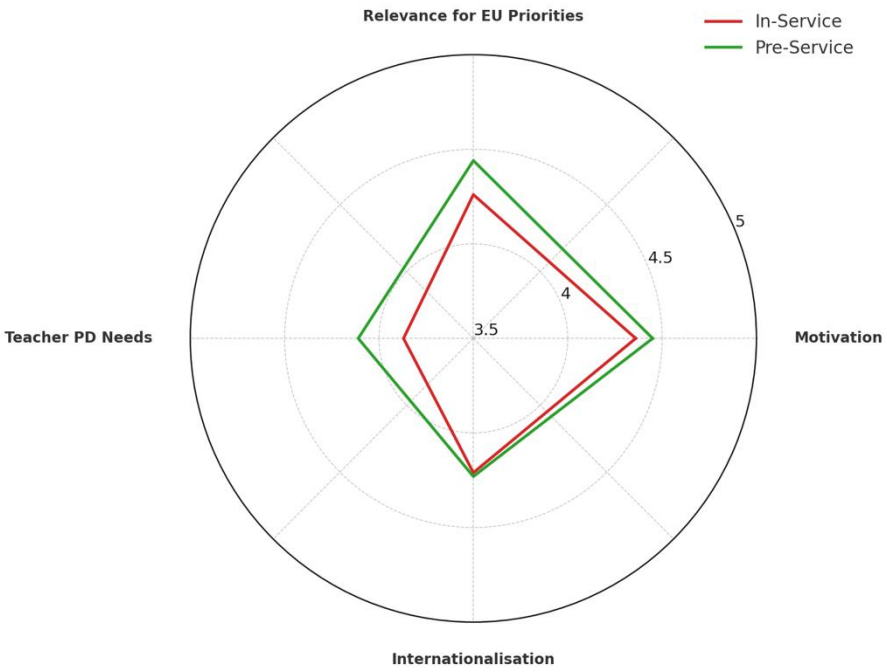

Figure 8. Radar chart comparing (mean values) for Motivation, perceived Relevance of EU priorities, Internationalisation, and Teacher Professional Development Needs between In-Service and Pre-Service teachers in the Status quo Study

4.1.1. Attitudes towards change or facing new situations

Responses to items related to those attitudes towards change are listed in table 9 (appendix IV). These aspects show the opinion about some personal aspects and their attitudes towards change. The treatment of these items as a scale (Cronbach's $\alpha = 0.58$) yielded a mean value of the sum for in-service of 19.54 (with a standard deviation of 2.71) and for preservice as 19.67 with a standard deviation of (2.82) which was not statistically significant different (p-value = 0.69). These values, on a maximum score of 25 in the scales show **a high readiness to professional** growth driven by personal dimension. Both groups share similar responses in the scoring of the items, except for item "*My personal/family situation favours my international mobility*.". However, no significant differences are observed in this value (p-value = 0.34). Therefore, we could say that in this dimension both for in-service teachers and pre-service ones present the same pattern of responses. We can conclude that the study of the differences between pre-service and in-service teachers in the whole sample shows **that both groups exhibit a similar pattern of responses concerning their attitudes towards change or facing new situations**, as well as their attitudes towards international mobility experience. The only difference detected in this dimension refers to how family conditions may affect teachers' availability towards international mobility. This result is reasonable considering that both sub-samples are in different stages of their lives and may have different family responsibilities.

4.1.2. Perceived relevance of European Priorities

This dimension includes items intended at evaluating to what extent teachers consider that they should keep on learning about topics related to European priorities and to what extent those priorities are considered relevant (table 10, appendix IV). Although this dimension is not included in the later pre and post study, it may shed some light in relation to teachers perceived teacher professional development needs, providing an interesting insights within our Status quo study.

Pre-service teachers manifest a somewhat higher perception in the **relevance dimension** than in-service teachers. In fact, considering these items as a scale (Cronbach's $\alpha = 0.67$ overall, 0.66 for in-service and 0.67 for pre-service); summing up mean values for all the items, pre-service teachers show a higher perception of relevance (mean value of 22.2 on a maximum of 25 with a standard deviation of 2.4) than in-service teachers (mean value of 21.3 with a standard deviation of 2.4), being this difference significant (p-value < 0.001).

Therefore, we can conclude that the Status quo analysis shows **significant differences** between pre-service and in-service teachers concerning **their perception of relevance of learning about the European priorities** related to sustainability, digitalisation and inclusion. In this respect, pre-service teachers recognise the relevance of those priorities and exhibit significantly higher needs to be trained about how to integrate them into STEM teaching.

4.1.3. Motivation

The motivation dimension was assessed using four items included in table 11 (appendix IV). Concerning the items oriented to intrinsic motivation, differences were observed in the mode values when comparing the groups of in-service and pre-service teachers. For item "*I find the teaching career attractive*", the in-service value mode was 4, whereas that of the pre-service group was 5, indicating a slightly greater tendency toward higher scores in the latter group. This has already been reported in the literature because some intrinsic motivational aspects are better valued in initial training, suggesting that pre-service teachers seem to be more "optimistic" about the teaching career than in-service teachers. In the same line, the mode for item "I feel passionate about the teaching career" in the in-service group was 4, while it was 5 in the pre-service group, which reinforces the same trend observed in the previous item**. These findings could suggest differences in teachers' perceptions of the intrinsic motivational aspects** evaluated by these items in terms of their career stage (pre-service or in-service), which may be influenced by their experiences in the work context. These results provide evidence of subtle but significant differences in teachers' responses according to their career development stage, highlighting the importance of disaggregating the motivation dimension as subscales of intrinsic and extrinsic motivation.

The analysis of the motivation scale for the entire sample yielded a mean value of the sum of these items as 17.63 (on a maximum of 20 and standard deviation of 1.99). When analysing the results by group, the average values for in-service teachers were 17.45 (standard deviation of 2.04) and 17.79 (standard deviation of 2.12) for pre-service teachers. This difference reflects a **higher scoring** trend in the **pre-service group**, mainly due to the intrinsic motivation scale, but without statistical significance.

The analysis of the motivation scale comparing in-service and pre-service participants showed differences (p-value = 0.046 as a whole and 0.048 for intrinsic motivation). These values suggest statistical differences, but more evidence is needed, in this scale, because the p-value is close to the 0.05 threshold for significance.

4.1.4. Internationalisation dimension

The perceived benefits of international mobility have been measured through the items and the scale showed in table 12 (appendix IV). In terms of central values, both the median and mode were similar between the two groups of teachers. For the global sample, the median and mode were consistent among in-service and preservice groups. These trends were also observed when disaggregated by groups of teachers, where medians and modes coincided with global values.

These results suggest a homogeneous perception among teachers regarding the aspects evaluated by this scale. The high internal consistency reinforces the validity of the scale used in this study. Analysis of the scale showed a high internal consistency, with a Cronbach's alpha of 0.87 for the overall sample. When disaggregating the results by groups, the alpha was 0.89 for in-service teachers and 0.83 for preservice teachers, indicating that the scale is reliable in both groups.

There are no significant differences (p-value= 0.75) in the sum values between the in-service (21.05 with a standard deviation of 2.95) and pre-service groups (21.15 with a standard deviation of 2.82). This suggests that both groups **share similar patterns** in their responses concerning the perceived **benefits of internationalisation for their professional development.**

4.1.5. Teacher professional development needs dimension

Table 13 (appendix IV) shows the results of the analysis by item related to the perception of needs concerning teacher professional development (TPD) linked to European priorities.

The analysis suggests that the scale formed by the complete set of 5 items (see notes in appendix II) presents an adequate consistency for the global sample (Cronbach's α = 0.75). When analysed by group of teachers, the alpha values are similar, and equal to 0.75 for the in-service and pre-service groups, indicating a coherent internal structure in both groups. Non-parametric analyses (Mann-Whitney U tests) were run to evaluate the differences, in an analysis by item, between the in-service and preservice groups. The results showed, with different levels, significant differences in the items "I need professional development to improve students' learning in my classes" (p-value < 0.01), "I need professional development to use digital tools to enhance learning" (p-value < 0.05), "I need professional development to integrate sustainability education in my daily teaching" (p-value < 0.05) and "I need professional development to support girls and boys equally in my classes" (p-value < 0.001), which indicates that responses for this dimension differ between both groups in those aspects addressed. However, no significant differences were found for items "I need professional development to engage students with different backgrounds and capacities" (p-value = 0.363) neither "Learning how to teach maths and/or science in relation to sustainability problems is relevant for me" (p-value = 0.26).

The analysis using the scale "Teacher professional Needs" is coherent with the previous analysis by differences in items. For the whole sample, the mean value was 19.89 (standard deviation of 3.14). When disaggregating the sample, in-service teachers show a value of 19.31 (standard deviation of 3.03), while that of the pre-service ones was 20.54 (standard deviation of 3.15). The non-parametric Mann-Whitney U test revealed significant differences between both groups (p-value = 0.0001).

Thus, given that the maximum of the scale is 25 points (excluding item Q27), the average values obtained reflect high or very high levels of perceived training needs in both groups of teachers. The overall mean of 19.89 (representing approximately 79.5% of the maximum possible value) points out that, on average, the participants identify a high need of professional development considering EU priorities. The proportion of individuals in each segment is shown in the figure 9.

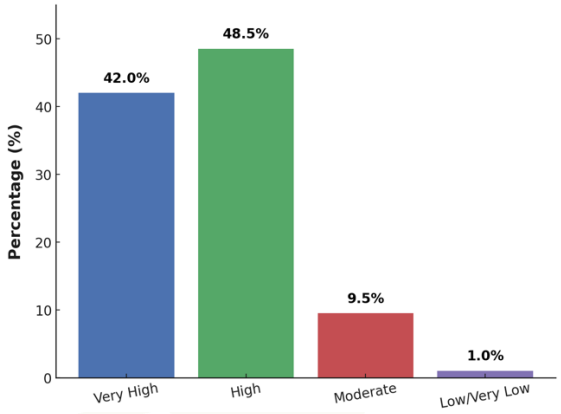

Figure 9. Distribution of responds for professional development needs among teachers in the sample of Status quo

4.2. PRE-POST RESULTS

In this section, we report the results regarding the impact of the ICSE Academy Summer Schools and the International Workshop series on teachers. The impact was assessed using the pre-post questionnaire partly based on the scales validated for the Status quo study, allowing us to develop a European outlook incorporating both studies. Table 14 (appendix V) shows the main results for the non-paired sample in the pre-test post-test study

4.2.1.1. Non-Paired-Sample

In relation to the motivation (MOT) and perception of professional need (TPD-NEEDS) dimensions, slightly higher values were observed in the post-test compared to the pre-test ones, but these were not significant. The motivation values were high already before the intervention, which leaves little room for gain, but a relevant aspect is that this value remains constant in the longitudinal measurement. In other words, the teacher does not "lose" his motivation for the teaching career or modify his beliefs about the benefits of internationalisation. The perceived benefits of internationalisation (INT) remain virtually unchanged.

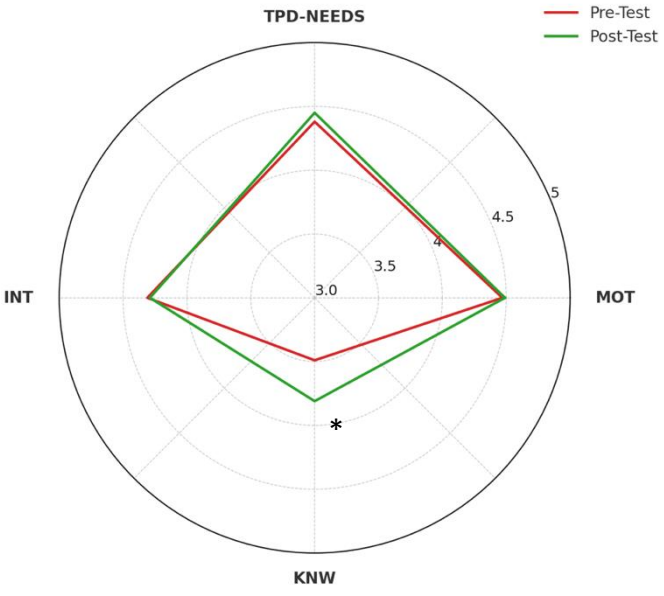

Figure 10. Radar chart comparing (mean values) for Motivation (MOT), Teacher Professional Development Needs (TPD-NEEDS), Internationalisation (INT), and Knowledge (KNW) between Pre-Test and Post-Test phases within the non-paired sample

For clarity of comparisons, values of analogues dimensions in the Status quo have been included in parallel and are shown in table 15 (appendix V). Also noteworthy is that the normalized value of the perception of professional needs for dimension (TPD-NEEDS) is higher than that described in the Status quo. This is consistent with the fact that teachers who identify the need for training attend training actions. The most remarkable issue in the analysis of this cohort is the detection of a gain on the knowledge scale (KNW) that

is statistically significant (p-value < 0.001), which can be interpreted as a very positive impact of the intervention on this dimension.

4.2.1.2. Paired-Sample

The paired sample analysis (n =133) has yielded very interesting results in almost all dimensions (table 16, appendix V) Values similar to those found in the non-paired sample are observed. Following the trend of the non-paired sample in all dimensions there is an increase in the values after the intervention (post-test) but, in this case, the **perceived needs for teacher** professional development dimension **is** also **significantly affected** after the participation in the ICSE Academy activities. If we compare the results with those of the Status quo, a higher score is detected on this dimension, but even so, after the intervention, teachers continue reporting more needs, and in a statistically significant way.

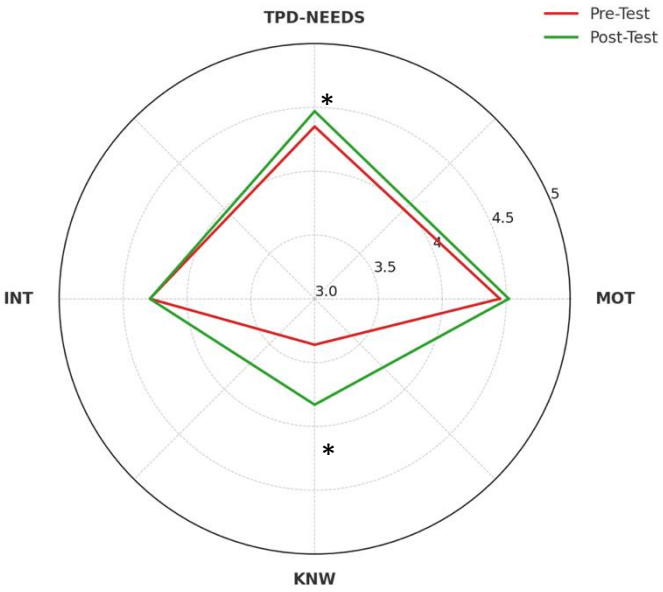

Figure 11. Radar chart comparing (mean values) Motivation (MOT), Teacher Professional Development Needs (TPD-NEEDS), Internationalisation (INT), and Knowledge (KNW) between Pre-Test and Post-Test phases within the paired sample

In the following subsections we will graphically show the results found when disaggregating the paired-sample responses into the two typologies of the project's training actions in which there was enough representativeness within our subsample, that is; the first edition of the Summer School and the second of Workshop Series (tables 17 and 18 in appendix V)

4.2.1.3. Summer School

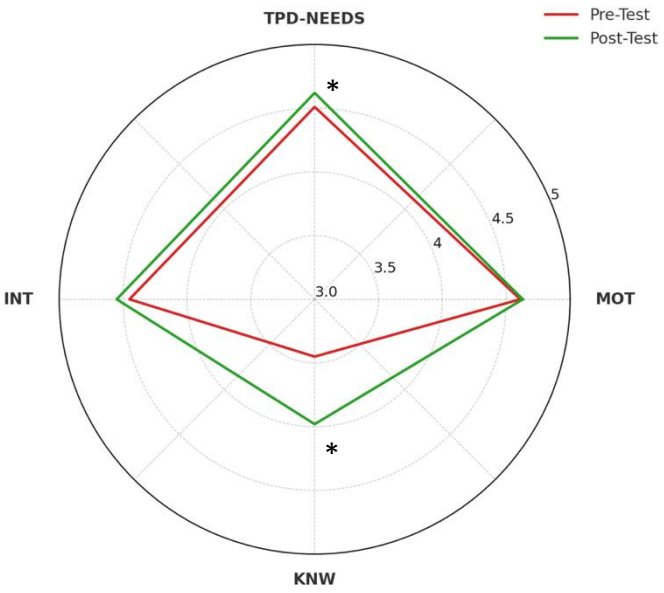

Figure 12. Radar chart comparing (mean values) Motivation (MOT), Teacher Professional Development Needs (TPD-NEEDS), Internationalisation (INT), and Knowledge (KNW) between Pre-Test and Post-Test phases within the paired sample in Summer School

4.2.1.4. Working Series II

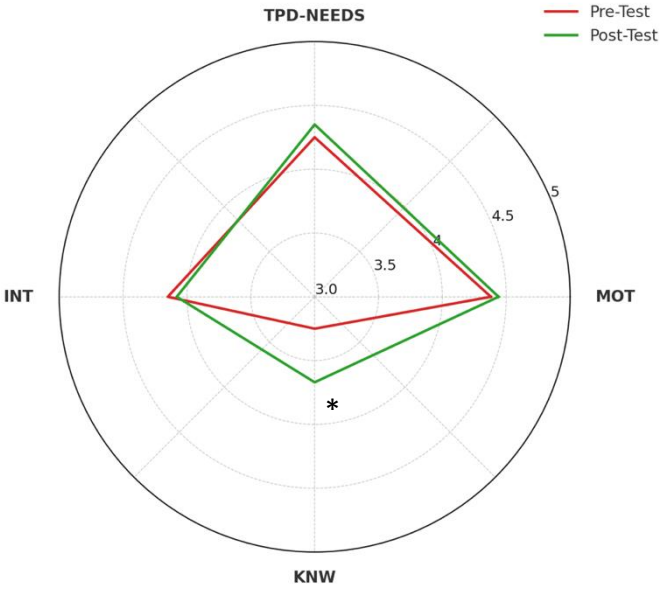

Figure 13. Radar chart comparing (mean values) Motivation (MOT), Teacher Professional Development Needs (TPD-NEEDS), Internationalisation (INT), and Knowledge (KNW) between Pre-Test and Post-Test phases within the paired sample in Working Series II

5. DISCUSSION OF RESULTS

The Status quo analysis was made using a non-random sample of pre-service and in-service teachers from the 13 European countries. It was a varied sample concerning age, gender and views and experiences related to the teacher career and international mobility. A cluster analysis allows us to identify 3 distinctive groups varying in the variables studied. Each group is characterised by gender, initial orientation towards the teaching career, their perceptions of training needs and their attitudes towards international mobility.

The study of the differences between pre-service and in-service teachers in the whole sample shows that both groups exhibit a similar pattern of responses concerning their attitudes towards change or facing new situations and about international mobility experiences. The only difference detected in this dimension refers to how family conditions may affect teachers' availability towards international mobility. This result is reasonable considering that both sub-samples are in different stages of their lives and may have different family responsibilities.

The Status quo analysis shows significant differences between pre-service and in-service teachers concerning their perception of relevance of learning about the European priorities related to sustainability, digitalisation and inclusion. In this respect, pre-service teachers recognise the relevance of those priorities and exhibit significantly higher needs to be trained about how to integrate them into STEM teaching.

Results concerning the perception of relevance of digitalisation, inclusion and sustainability for STEM teaching are consistent with the ones obtained for the scale measuring teachers' professional development needs related to the European priorities. The study shows that concerning teacher professional development needs related to the European priorities, the average score for in-service teachers is 19.31 out of 25 maximum score (standard deviation of 3.03), while that of the pre-service ones was 20.54 (standard deviation of 3.15). The non-parametric Mann-Whitney U test revealed significant differences between both groups in this respect (p-value=0.0001). These results might be due to a difference in the perception of relevance or to differences in teaching experience, showing that longer teaching experience may result in lower perception of needs for teacher professional development related to digitalisation, inclusion and sustainability. If we consider the sample as a whole, 85.5 % of teachers exhibit high or very high needs, while 10.5% of them show moderate or low needs. These results highlight the relevance of the ICSE Teacher as a means to satisfy these needs providing teachers with the knowledge and competences required to integrate the European priorities into STEM teaching.

In relation to intrinsic motivation towards the teacher career, results show that the mode in the pre-service teacher sub-sample is 5 in a Likert scale, versus 4 for in-service teachers in relation to agreement with the statements "I find the teaching career attractive" or "I feel passionate about the teaching career". This is a relevant result suggesting that teachers' intrinsic motivation may decrease after getting into the profession and shows how keeping teachers' intrinsic motivation might be an important aspect if we do not want them suffering from burn-out and dropping off.

The Status quo study also intends to provide an overview of teachers' attitudes towards international mobility as a means for teacher professional development through the application of a 5 items scale (Cronbach's α 0.87). Results show no significant differences between pre-service and in-service teachers in this respect with an average score of 21.15 and 21.05 respectively out of 25 maximum score, agreeing with the view of international mobility as a powerful opportunity to exchange inspiring experiences and acquiring useful knowledge and competences for the teaching career.

As a summary of the Status quo analysis, we can conclude that that pre-service teachers tend to be more motivated and have greater needs for professional development compared to in-service teachers, while both groups have similar views on internationalisation.

The pre-test, post-test analysis conducted before and after teachers' participation in the ICSE Academy activities provides a measure of the impact of the project on participants' motivation for the teacher career, attitudes towards internationalisation, teacher professional development needs related to the integration of the European priorities in STEM teaching and the knowledge and skills required to do so.

Results of the impact analysis show that motivation and internationalisation remain stable with no significant change after the project, while there is a significant increase in teacher professional development needs and the knowledge and skills required to integrate sustainability, digitalisation and diversity or inclusion in STEM teaching.

A closer look at these results reveals that participants scored high in motivation and attitudes towards international mobility in the pre-test and there was not much room for improvement. Nevertheless, those values did not become worst after the experience but remain stable, what might be considered a positive result.

Knowledge and skills to integrate the European priorities show the largest improvement, and the difference is highly significant, suggesting that the activities were effective in enhancing participants' perceived knowledge and skills.

Needs for teacher professional development show a significant increase, indicating that, even after the project, participants felt a stronger need for further teacher professional development in the field. In addition, 60% of participants stated that they would participate in similar activities in the future, suggesting the need to keep on funding these kinds of initiatives.

6. CONCLUSIONS AND RECOMMENDATIONS

In view of the main results from the Status quo and the pre and post study conducted, we can conclude that ICSE Academy project **has made an important contribution to STEM teachers' international mobility and professional development related to the European priorities** due to the following facts:

1. The Status quo analysis shows that 63.7% of pre-service and in-service teachers in the sample from 13 different European countries did not have international training experiences, even though they present positive attitudes to them. However, as a result of the project, hundreds of pre-service and in-service teachers from those countries have lived enriching international training experiences. Those experiences were related to their participation in international summer schools with teachers from different European countries and the interactive engagement in various series of workshops delivered in English by international experts. In those international training experiences teachers had the chance to analyse and discuss best practices, to exchange strategies and experiences with colleagues from different countries, and to co-create teaching and learning resources in communities.
2. Teachers participating in the ICSE Academy show high motivation for the teacher career and positive attitudes towards international mobility from the beginning till the end of the project, what is very well aligned with the aims of the call funding this project. Therefore, we conclude that this kind of actions contribute to maintaining teachers' motivation for the teaching career and due to their positive attitude towards international training experiences, more efforts should be made to increase teachers' mobility as a privileged means for professional development.
3. Both pre-service and in-service teachers participating in the Status quo study see the relevance of integrating sustainability, digitalisation and inclusive teaching in STEM teaching and state that they have important teacher professional development needs in this respect. These needs are higher in pre-service teachers than in in-service teachers. Based on teachers' positive attitudes towards the European priorities and their professional development needs in this line, we conclude that there are big opportunities to introduce the European priorities in teacher education.
4. In relation to teacher professional development needs related to the importance of integrating sustainability, digitalisation and inclusive teaching into STEM education, the Status quo study shows that 85.5 % of teachers exhibit high or very high needs, while 10.5% of them show moderate or low needs. Based on these results we conclude that the ICSE Academy has provided an interesting opportunity to satisfy these needs by providing teachers with the knowledge and competences required to integrate the European priorities into STEM teaching.
5. The innovative formats for teacher professional development provided by the ICSE Academy has had a significant positive impact on teachers' knowledge and skills to integrate sustainability, digitalisation and inclusive teaching in STEM education. These results along with the fact that they are referred to the successful implementation of those formats in 13 different countries prove them as accessible,

useful and transferable innovative formats for international mobility and teacher education.

6. No significant differences between the teachers' gain as a result of their participation either in the summer schools or in the international workshop series was detected, proving both of them as equally effective formats for teacher professional development. Therefore, we conclude that the different innovative formats and forms of international mobility tested (either physically and online) have been proving as effective for teacher professional development, with an emphasis on the European dimension.
7. Even after having experienced a significant improvement in the knowledge and skills required to integrate sustainability, digitalisation and inclusive teaching in STEM education, teachers' needs for further teacher professional development in this field increase after the project, showing that there is still much work to do in this line. In addition, over 60% of teachers express willingness to participate in more similar activities in the future, suggesting the need to keep on funding these kinds of initiatives. Therefore, we conclude that more efforts are required in this direction.

Based on the previous conclusions, we suggest the following recommendations to improve teachers' education and international mobility:

1. Increase the number of opportunities for international teacher professional development, combining training experiences abroad with other ways of international exchange, such as online interactive workshops that facilitate the exchange of teaching strategies and resources with experts and colleagues from different countries.
2. Disseminate and exploit best practices related to teacher professional development in international contexts, making visible the wide range of benefits derived from being part of an international community of teaching practice, such as the maintenance of the motivation for the teaching career or the improvement of relevant knowledge and skills to address the European priorities.
3. Provide teacher professional development activities that engage teachers in the critical discussion of different pedagogies and resources with other colleagues and in the co-creation of innovative resources.
4. Deliver more teacher professional development actions aimed at supporting teachers in the integration of digitalisation, sustainability and inclusive teaching in STEM education.

7. BIBLIOGRAPHY AND REFERENCES

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8. APPENDIX I. TABLES FROM THE METHODOLOGY SECTION

Table 2. Demographic variables and corresponding codes

Description	CODE
Gender (Female/Male)	GEN
Initial Orientation to teaching (Yes/No)	ORI
Previous experiences in mobility (Yes/No)	MOB
Range of Age (years)	AGE
Range years of teaching experience	AGET
Initial Background (STEM subjects and others)	BCK
Need for additional professional development	TPD+

Table 3. Exploratory Factor analysis (with three scales). Factorization Statistics

KMO 0.870

Bartlett sphericity

Chi-square = 1888.672

$p < 0.001$

Total variance explained: 59.8%

	Items retained	Cronbach α
Teacher Professional Development Needs*	5	.777(a); .783(b); .762(c)
Internationalisation*	5	.865(a); .892(b); .830(c)
Motivation	4	.614(a); .566(b); .632(c)
Motivation (Extrinsic)	2	.426(a); .320(b); .570(c)
Motivation (Intrinsic)	2	.689(a); .656(b); .734(c)

a. Whole sample

b. Inservice Teachers

c. Pre-service Teachers

Scales mark with * in this table were later on reduced to 4 items in the pre-test post-test questionnaire and analysis were repetitively consistent.

Perceived relevance for EU priorities, was also explored: .677(a); .667(b); .665(c)

Motivation scale was improved in the final version of the questionnaire used as pre/post (see table 4)

Table 4. Reliability test (Cronbach's α) for the motivation (MOT), professional development needs (TPD-NEEDS), internationalisation (INT) and knowledge (KNW) dimensions analysed.

Scale	Cronbach's α
Motivation (MOT) [A]	0.825
Teacher Professional Development Needs (TPD-NEEDS) [B]	0.843
Internationalisation (INT) [C]	0.852
Knowledge (KNW) [D]	0.899

Brief Description:

[A] Motivation for the teaching career. This includes Intrinsic and extrinsic Motivation

[B] Interest, as part of teacher professional development, in European Priorities.

[C] Beliefs and attitudes toward international mobility and exchanges/collaboration

[D] Knowledge/Skills about how to teach in relation to the European priorities

9. APPENDIX II. CLUSTERING FIGURES

Notes on Clustering: the DBSSCAN technique was used to recode ordinal or categorical variables, such as gender, age, professional experience, professional mobility, perceived professional needs, type of teacher, and initial orientation toward the teaching career. Method application without restrictions or fit parameters identified more than 20 clusters, indicating the great diversity of teachers in the study. Figure 14 show the identified clusters after fixing some parameters (Cluster I, II and III are describe in the corresponding section “Clustering analysis”).

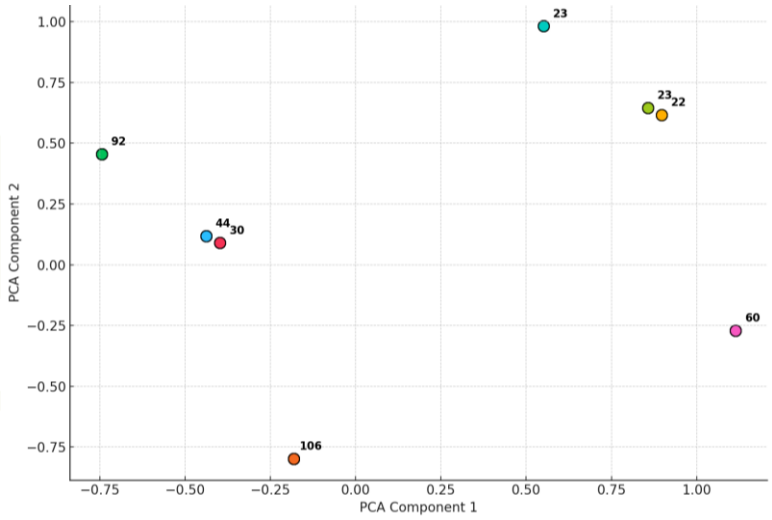

Figure 14. Status quo sample through the analysis of clusters (excluding type of teachers; for clarity of visualization, it has been reduced at 2 components)

10. APPENDIX III. TABLES DESCRIPTION OF SAMPLE IN PRE-POST STUDY

Table 5. Number of participants responding to the pre-test and post-test questionnaires.

	Pre-test	Post-test	Paired
N	295	212	153
% Female	74.6	71.7	75.2
% Male	25.1	21.8	24.8

Table 6. Overview of the proportion of responses to the "Main field of educational background" question considering all the pre-test questionnaires.

Discipline	% Responses
Mathematics (and others)	25.8 % (20.6 %)
Sciences (and others*)	14.4 % (21.6 % *)
Biology (and others*)	0.0 % (1.3 % *)
Chemistry (and others*)	6.4 % (4.4 % *)
Physics (and others*)	4.1 % (4.7 % *)
Technology	5.4 % (1 %)
Others	21.0 %

* Not include in "Other" (21.0%) as discipline

Table 7. Overview of responses frequencies for the initial career orientation (ORI), the previous experience in mobility (MOB) and the range of ages (AGE) questions.

Question	Responses
Was teaching your first career choice?	Yes: 68 % No: 32 %
I have been abroad for training reasons	Yes: 67 % No: 33 %

Table 8. Analysis of frequencies for items of professional development additional needs

Question	Frequencies of responses
I am willing to participate in international summer schools for teachers in the next future.	Disagreement: 14.7% Neutral: 20.8% Agreement 64.4%
I am willing to participate in international workshops for teachers in the next future	Disagreement: 10.8% Neutral: 16.0% Agreement 73.2%

11. APPENDIX IV. RESULTS ITEMS ANALYS FOR STATUS QUO STUDY

Table 9. Item and statistics for attitudes towards change

Items: Attitudes towards Change	Overall sample	In-service	Pre-service
	Median; Mode	Median; Mode	Median; Mode
Q6. I am ready to learn new things.	5; 3	5; 5	5; 5
Q7. My personal/family situation favours my international mobility.	3; 3	4; 4	3; 3
Q10. I am able to adapt to new environments/contexts/situations.	4; 4	4; 4	4; 4
Q12. I feel confident speaking a foreign language.	4; 4	4; 4	4; 3
Q21. I feel confident addressing new situations.	4; 4	4; 4	4; 4

Table 10. Item and statistics for the dimension of teachers' perceptions in relation to relevance regarding European priorities

Items for Perception of Relevance	Overall sample	In-service	Pre-service
	Median; Mode	Median; Mode	Median; Mode
Q8. Learning about how to use digital tools to enhance learning is relevant for me	5; 5	4; 5	5; 5
Q14. Learning how to engage students with different backgrounds and capacities is relevant for me	5; 5	4; 5	5; 5
Q20. Learning about how to improve my teaching is relevant for me	5; 5	5; 5	5; 5
Q27. Learning how to teach maths and/or science in relation to sustainability problems (reducing waste, recycling) is relevant for me.	4; 4	4; 4	4; 4
Q30. Learning about how to support girls and boys equally in my classes is relevant for me	4; 4	4; 4	4; 5

Table 11. Item and statistics for the dimension of teachers' perceptions in relation to motivational dimension, considering both intrinsic and extrinsic aspects.

Items for Motivation	Overall sample	In-service	Pre-service
	Median, mode	Median, mode	Median, mode
Q5. I consider that the teaching profession is important for society. (EXTRINSIC)	5; 5	5; 4	5; 5
Q9. I feel that teaching is a crucial tool to help people learn (EXTRINSIC)	5; 5	5; 5	5; 5
Q25. I find the teaching career attractive (INTRINSIC)	4; 4	4; 4	4; 5
Q26. I feel passionate about the teaching career (INTRINSIC)	4; 4	4; 4	4; 5

Table 12. Item and statistics for the dimension of teachers' perceptions in relation to internationalisation aspects.

Items for Internationalisation	Overall sample	In-service	Pre-service
	Median; Mode	Median; Mode	Median; Mode
Q4. The exchange of experiences with teachers from other countries makes me grow professionally	5; 5	5; 5	5; 5
Q15. The international mobility helps me developing teaching competences.	4; 4	4; 4	4; 4
Q19. International mobility increases useful knowledge for my teaching profession	4; 4	4; 4	4; 4
Q29. The exchange of experiences with teachers from other countries is interesting for my teaching career.	4; 4	4; 4	4; 4
Q31. The exchange of experiences with teachers from other countries helps me developing teaching competences.	4; 4	4; 4	4; 4

Table 13. Items and statistics for the dimension on perceived Teacher Professional Needs

Items for Teacher professional development needs scale	Overall sample Median; Mode	In-service Median; Mode	Pre-service Median; Mode
Q2. I need professional development to improve students' learning in my classes.	4; 4	4; 4	5; 5
Q17. I need professional development to engage students with different backgrounds and capacities.	4; 4	4; 4	4; 4
Q22. I need professional development to use digital tools to enhance learning.	4; 4	4; 4	4; 4
Q23. I need professional development to integrate sustainability education in my daily teaching.	4; 4	4; 4	4; 4
Q24.I need professional development to support girls and boys equally in my classes.	4; 4	3; 4	4; 5
Q27. Learning how to teach maths and/or science in relation to sustainability problems is relevant for me.	4; 4	4; 4	4; 4

Although the values for central tendency and standard deviations were analysed for all the items included in the dimension, finally the Q27 item was not retained due to its lower association with the rest of items.

Notes on items for this scale: The correlation analysis (Spearman method) for the whole sample considering all the items, yielded significant relationships between several pairs of items. The strongest correlations were observed between items Q22 and Q23 (r = 0.66), as well as between Q23 and Q24 (r = 0.50), indicating a moderate-high relationship between these. On the other hand, the weakest correlations were presented between Q27 and the other items, with r values below 0.3 except for the case of Q23 (r = 0.36). As both Q23 and Q27 items were related to sustainability, we decided to retain Q23 and not Q27 to keep an item addressing this issue while increasing the internal consistency of the whole scale. This greater coherence in items Q22, Q23 and Q24 reflect a common underlying sub-scale in the dimension measuring perceived needs for professional development. In contrast, item Q27 shows a lower association with the rest, which could indicate that the aspect in which it focused is less related to the whole dimension. The same analysis by the disaggregated sample in in-service teachers and pre-service teachers maintains these significant correlations. For pre-service teachers the correlation Q22-Q23 is even greater (r = 0.77) than for in-service ones. The analysis suggests that the scale formed by the complete set of items presents an adequate consistency for the global sample (Cronbach's α = 0.75). When analysed by type of teacher, the alpha values are similar, and equal to 0.75 for the in-service and pre-service groups, indicating a coherent internal structure in both groups.

12. APPENDIX V. RESULTS FOR THE PRE-POST STUDY

Table 14. Mean and standard deviation of non-paired pre-test and post-test.

	Implementation	
	Pre-test (n = 275)	Post-test (n = 192)
MOT	4.47 (.59)	4.49 (.51)
TPD-NEEDS	4.38 (.60)	4.45 (.51)
INT	4.31 (.68)	4.29 (.69)
KNW	3.49 (.70)	3.81 (.69)*

* Significant at level p <0.001

Table 15. Mean and standard deviation of non-paired pre-test and post-test compared with the Status quo sample

	Status quo		**Pre-test post-test study**	
	in-service (n = 218)	pre-service (n = 182)	Pre-test (n = 275)	Post-test (n = 192)
MOT	4.36 (.51)	4.45 (.53)	4.47 (.59)	4.49 (.51)
TPD-NEEDS	3.87 (.61)	4.11 (.63)	4.38 (.60)	4.45 (.51)
INT	4.21 (.59)	4.23 (.56)	4.31 (.68)	4.29 (.69)
KNW	-	-	3.49 (.70)	3.81 (.69)*

* Significant at level p <0.001

Table 16. Mean and standard deviation values for paired pre-test and post-test

	Pre-test (n = 133)	Post-test (n = 133)
MOT	4.46 (.54)	4.53 (.50)
TPD-NEEDS	4.36 (.54)	4.48 (.49)*
INT	4.29 (.64)	4.30 (.70)
KNW	3.36 (.64)	3.83 (.69)**

* Significant at level p<0.05
** Significant at level p <0.001

Table 17. Mean and standard deviation values for paired pre-test and post-test in Summer School I sample

	Pre-test (n = 45)	Post-test (n = 45)
MOT	4.61 (.45)	4.63 (.33)
TPD-NEEDS	4.51 (.48)	4.62 (.43) *
INT	4.45 (.54)	4.55 (.61)
KNW	3.45 (.69)	3.98 (.59) **

* Significant at level $p < 0.05$ ($p = 0.035$)

** Significant at level $p < 0.001$.

Table 18. Mean and standard deviation values for paired pre-test and post-test in Workshop Series II sample

	Pre-test (n = 74)	Post-test (n = 74)
MOT	4.38 (.56)	4.44 (.54)
TPD-NEEDS	4.25 (.59)	4.35 (.50)
INT	4.15 (.68)	4.08 (.71)
KNW	3.25 (.61)	3.67 (.71) **

** Significant at level $p < 0.001$