

# **Analysis of the training and educational needs of Italian teachers of Mathematics and Science provided through the questionnaires**

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## **1. Introduction**

In the preliminary and preparation phases of the SMART (Science and Mathematics Advanced Research for good Teaching) project, the components of the international partnership (Italy, Germany, Hungary, the Netherlands and Sweden) agreed and elaborated a questionnaire format for the collection of Mathematics and Science teachers training needs.

Each project partner got electronic forms for the collection of the training and educational needs of teachers of Mathematics and Science; the educational needs of students would be obtained from the analysis of the results and collected in the report.

The collection of data, focused on local training needs, has allowed to obtain the following outputs:

1. development of a European database on training needs;
2. definition of common educational models and of one or more possible paths of intervention built on the basis of educational polycentricism.

Despite having already done the analysis on training needs at an international level, from which the project objectives have been derived, this analysis report has the aim to verify in details which the training and educational needs are, according to specific training needs that teachers have expressed to modernize and update an innovative didactic, in the contents, in the methodology and also in the instruments (ICT) which would be used in the OOC (Open Online Courses).

The aim of the questionnaire was to verify the status quo both of the perception that teachers have of their teaching practice, and of the quantity and quality of activities put in place in the last two years for their own professional development (First Part). Another aim (Second Part) was to investigate the areas of interest that the teachers have, among those which are the object of the SMART Project (acquisition of STEM - Science, Technology, Engineering, Mathematics - skills, teaching with e-learning activities).

## **2. Questionnaires in Italy**

The format adopted for the questionnaire has been prepared by MIUR (Italian Ministry for Education, University and Research) with the collaboration of the University of Torino.

The aim was to collect the training and educational needs of Italian teachers of Mathematics and Science subjects. In the first part the questionnaire investigates both on how they feel their teaching practice and on the quality and amount of the activities chosen in the last two years for their professional enhancement. In the second part the focus is oriented on the specific interests of the teachers within the areas covered by the

SMART project (acquisition of STEM - Science, Technology, Engineering, Mathematics - skills, teaching with e-learning activities).

The questionnaire has been administered with the aid of the ICT service of the University of Torino that provided an electronic form (toollimesurvey).

The outputs together with those of the other partners will be helpful in the two following tasks:

1. Development of a European database on training needs;
2. Definition of common educational models and of one or more possible paths of intervention built on the basis of educational polycentricism.

The questionnaire has been administered to 2800 teachers of the two National Projects PP&S (Problem Posing & Solving) and LSosa-Lab (Project of training in laboratory activities for teachers in Applied Sciences Scientific High Schools). This choice has been made to be sure to select teachers able to understand all questions because through the above mentioned Projects they have already been informed on the change from the old programs to National Guidelines for High Schools, Technical Schools and Vocational Organizations specified by the Ministry of Education (2010).

The period for filling in the questionnaire was from 2015-01-20 to 2015-01-27 (that is 8 days with a final remind on 2015-01-24).

A total number of 669 teachers answered the questionnaire.

### **GENERAL QUESTIONS- Information about the context**

The preliminary part of the questionnaire contained a series of general questions aimed at assessing the educational, scholastic and environmental background of the teachers that answered.

In particular, the questions concerned the following topics:

- The type of school they were teaching in

The Italian high school system at present is structured in three categories:

- Lycée system (Liceo)
  - Technical high schools (Istituti Tecnici)
  - Vocational high schools (Istituti Professionali)
- Whether they teach in a private or in a stateschool
  - The socio-economic area of theirschool

The classification of urban areas has been performed on the ground of a territorial classification based on welfare grade, education level, economic structure (source: [www.valuelab.it](http://www.valuelab.it)) finding out five socio-economic clusters :

- Group 1: Areas with a high welfare grade, higher levels of education, a well organized local economic system
- Group 2: Areas with a non-high welfare grade, low levels of education, a poorly developed local economic system mainly based on commercial activities

- Group 3: Areas with a high urbanization, a remarkable welfare grade, higher levels of education, characterized by local systems with advanced tertiary services
  - Group 4: Areas characterized by the presence of little villages with a distinctly craftworkers' organization of the production activities and a medium welfare level
  - Group 5: Areas characterized by a strong economic underdevelopment, a low welfare grade and poorly developed education
- The total number of students in their school
  - The total number of teachers in their school
  - The subject they are teaching
  - The teaching qualification obtained (in the Italian school system it is distinct depending on the subject one is going to teach and in which grade of instruction)
  - The degree obtained
  - The number of teaching years
  - The gender

### 3. Descriptive analysis of the general part

- **Private or state schools**

The distribution of the teachers among state or private schools was clearly deeply asymmetric, since less than 3% of them are teaching in private schools as is shown in Table 1 below.

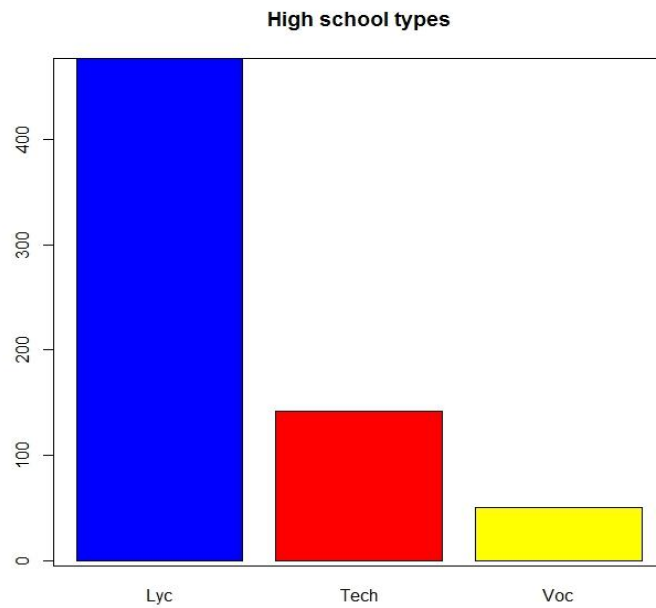
State schools	Private schools
651 (97.3%)	18 (2.7%)

**Table 1: School types by single categories**

- **Type of high schools**

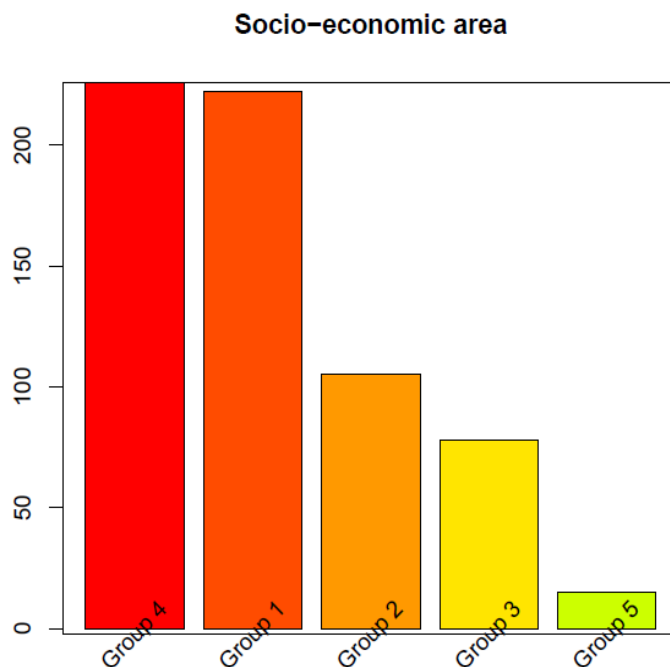
The sample of teachers that answered to the questionnaire was composed by a predominant proportion of teachers from Lycée (71.3%) and Technical schools (21.2%), while only the remaining 7.5% came from Vocational schools (see barplot in Figure 1). This subdivision does not fully reflect the general proportion among all the Italian high schools, where the disparity between the numbers of scientific subject teachers in Lycée and Technical high schools is not so evident. The reason is that, as explained before, the survey has

been conducted especially among teachers that already enrolled for the PP&S and for the LSosa-Lab programs, whose subdivision among the different types of high schools is similar to the one obtained here.



**Figure 1: Frequencies of high school types**

- **Socio-economic area of the school**

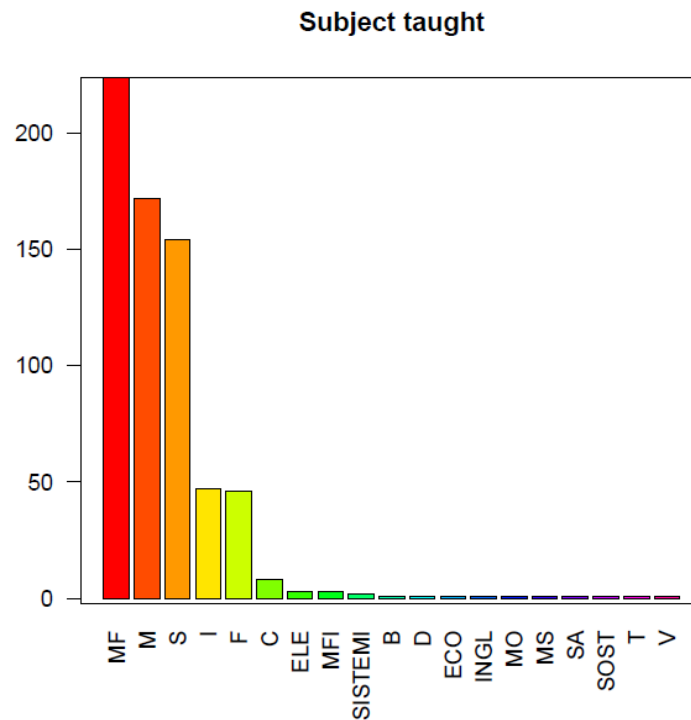


**Figure 2: Frequencies of socio-economic areas**

As it appears from Figure 2, the areas where the greatest number of schools were placed belong to Group 4 (Areas characterized by the presence of little villages with a distinctly craftworkers’

organization of the production activities and a medium welfare level) and to Group 1 (Areas with a high welfare grade, higher levels of education, a well organized local economic system). A particular attention will be given to the answers of teachers in Area 4 since it corresponds to the socio-economic context that is more typical for the Italian country.

- **Subject taught**



**Figure 3: Frequencies of the subjects taught**

Figure 3 clearly displays how the majority of teachers involved in the questionnaires were teaching Mathematics (M), Physics (F), Science (S), Computer Science (I) or Mathematics and Physics altogether (MF). Only a few of them teach Chemistry (C), Biology (B), Electronics (ELE) or Mathematics, Physics and Computer Science altogether (MFI) just to quote the most relevant among the other subjects.

It is important to note that the distribution of the teachers among the different teaching subjects corresponds to the national one.

- **Teaching qualification obtained**

Math&Phys	Science	Math	Comp.Sc.	Phys	Appl.Math
247 (37%)	142 (21%)	138 (21%)	38 (6%)	34 (5%)	14 (2%)

**Table 2: Teaching qualification**

In Table 2 the absolute frequencies and the percentages of the teaching qualifications obtained by the teachers involved are shown for the main areas of interest. Obviously they correspond to the distribution of the subjects taught since the qualifications in Mathematics and Physics, Mathematics and Science are the most represented.

- **Degree obtained**

<b>Math</b>	<b>Phys</b>	<b>Biology</b>	<b>Engineer.</b>	<b>Comp.Sc.</b>	<b>Nat.Sc.</b>
<b>262 (39%)</b>	<b>112 (17%)</b>	<b>91 (14%)</b>	<b>52 (8%)</b>	<b>34 (4%)</b>	<b>22 (3%)</b>

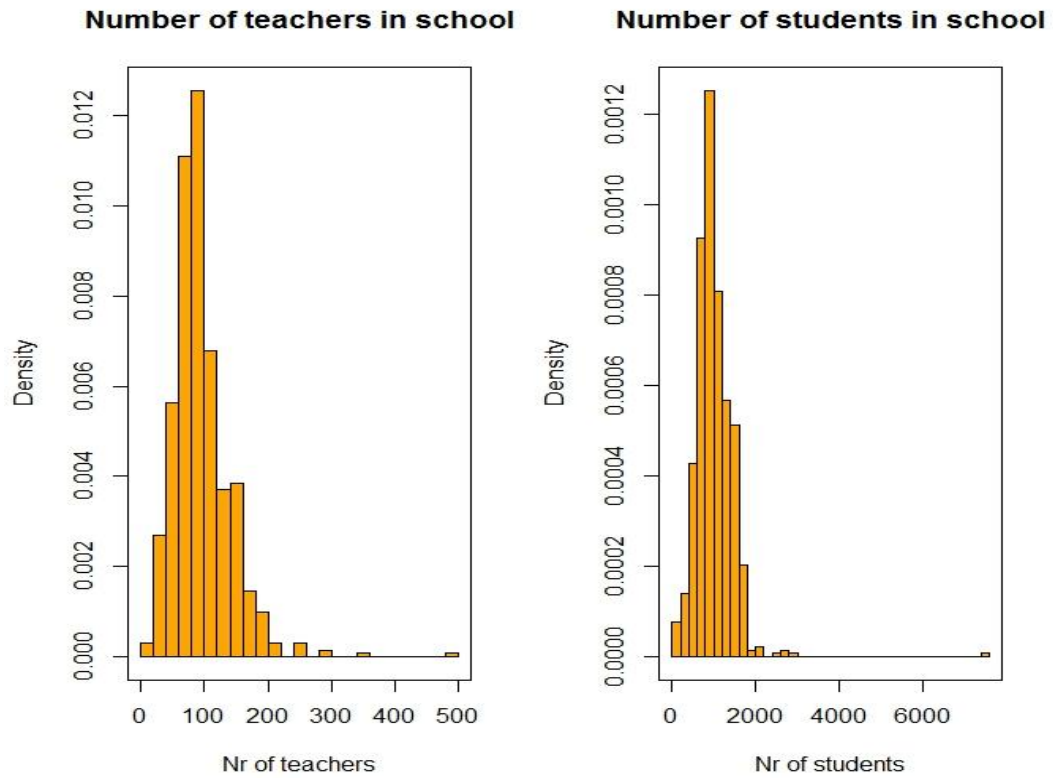
**Table 3: Degree obtained**

Table 3 above shows the absolute frequencies and the percentages for the degrees mostly obtained by the teachers involved. It is noticeable that 70% of them as a whole got a degree either in Mathematics, in Physics, in Engineering or in Computer Science while 17% of them graduated either in Natural Sciences or in Biology.

- **Number of teachers and of students in the school**

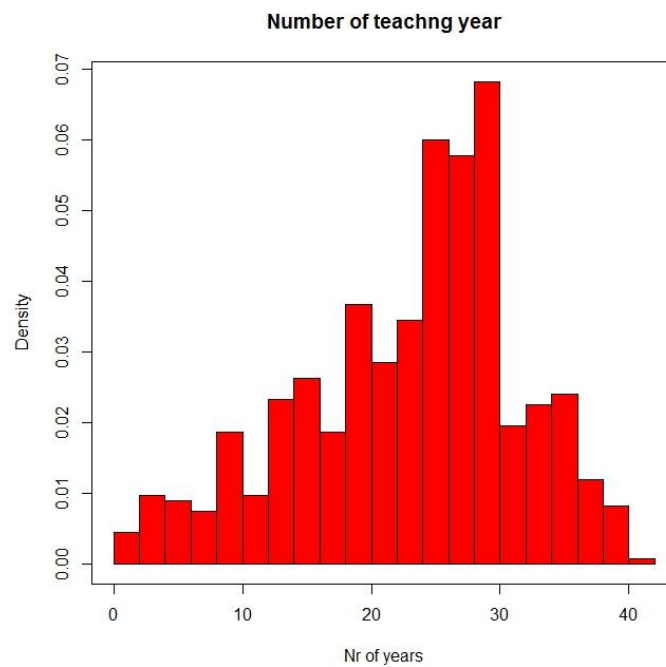
The number of teachers in the school went from 10 to around 500 with a median value of 98, while the number of students went from around 100 to around 7500 with a median value of 1000.

The histograms of the distributions of these two values are shown in Figure 4 (panel on the left: number of teachers, panel on the right number of students).



**Figure 4: Histograms of number of teachers and of students in the school**

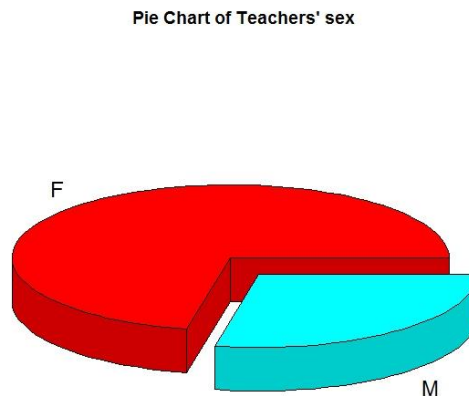
- **Number of teaching years**



**Figure 5: Histogram of number of teaching years**

The number of teaching years for the teachers that answered to the questionnaire ranged from less than one to 41 with a median value of 25. The corresponding histogram is shown in Figure 5.

- **Gender**



**Figure 6: Distribution of teachers' sex**

The distribution of teachers' sex (almost 78% of those who answered are women) reflects the trend in Italian education system, in which women cover a large majority of the working places in the educational field.

#### **4. Analysis of Part I: Perception of the teaching practice**

After the preliminary section of the questionnaire, the first part intended to verify the *status quo* both of the perception that teachers have of their teaching practice and of the quantity and quality of activities that they selected in the last two years to favor their own professional development.

- **Perception of the teaching practice**

- **Questions 1-9**

Questions from 1 to 9 were aimed at ascertaining the teachers' perception of their teaching practice and were organized as follows:

1. Does your teaching action produce significant changes in your students' attitudes ?
2. Are you able to let your most difficult and less motivated students improve?



3. How do you rate your use of time in the class work?
4. To what extent are your didactic choices coherent with your students' interest?
5. How do you perceive the classroom "climate"?
6. How efficient do you rate your practice of students' evaluation?
7. How updated do you consider your disciplinary preparation?
8. How updated do you consider your methodological preparation?
9. How much do you use the new technologies in your teaching action?

The teachers could choose for the answer to each question among five possible levels of a Likert scale, i.e. (from the lowest to the highest level) difficult, unsure, satisfactory, good, very good.

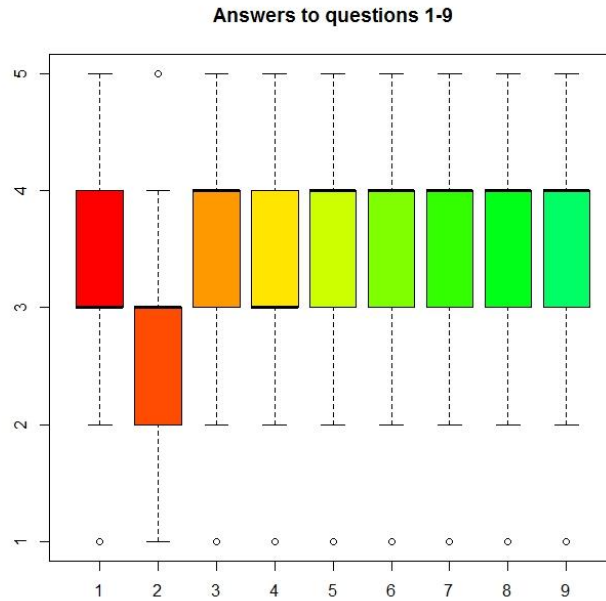
A Likert scale is a psychometric scale commonly involved in researches employing questionnaires, so that it is the most widely used approach to scaling responses in survey research. It is necessary to distinguish between a scale proper, which emerges from collective responses to a set of items (usually eight or more), and the format in which responses are scored along a range since, technically speaking, a Likert scale refers only to the former. When responding to a Likert questionnaire item, respondents specify their level of agreement or disagreement on a symmetric agree-disagree scale for a series of statements. Thus, the range captures the intensity of their feelings for a given item. A scale can be created as the simple sum of questionnaire responses over the full range of the scale. In so doing, Likert scaling assumes that distances on each item are equal. Hence a *Likert scale* is the sum of responses on several *Likert items*, while a *Likert item* is a statement that the respondent is asked to evaluate by giving it a quantitative value on any kind of subjective or objective dimension, with level of agreement or disagreement being the dimension most commonly used.

Here we used both Likert items (each question) and a true Likert scale for considering the responders' attitude towards teaching practice as examined in the first nine questions as a whole.

While in the first instance the analysis has to be done employing non parametrical techniques, when considering sums of scores it is possible to consider them as normally distributed and hence to use parametric statistical techniques. In both cases the responses to each question are converted from nominal values to numeric ones, ranging from 1 (the lowest, difficult) to 5 (the highest, very good).

As far as the single items are concerned, we show in Figure 7 the boxplots for the distributions of the answers to questions from 1 to 9.

The median values correspond to the thick black lines while the box height is the interquartile range. The answer whose scoredistribution shows the lowest values is the second, concerning the self-rating of the ability to let most difficult and less motivated students improve. All the medians are assessed on level 4 except for the answers to questions 2, 1 and 3 (these last two ones concerning the evaluation of changes in students' attitudes and the use of time in class work), that have median level 3.

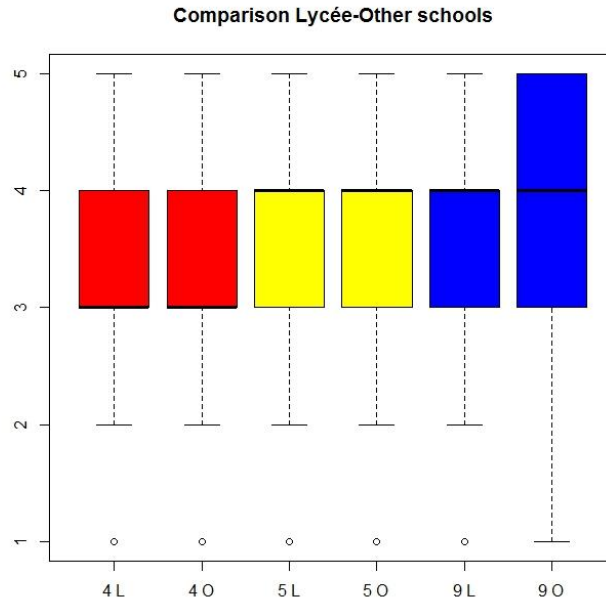


**Figure 7: Boxplots for answers to Questions 1-9**

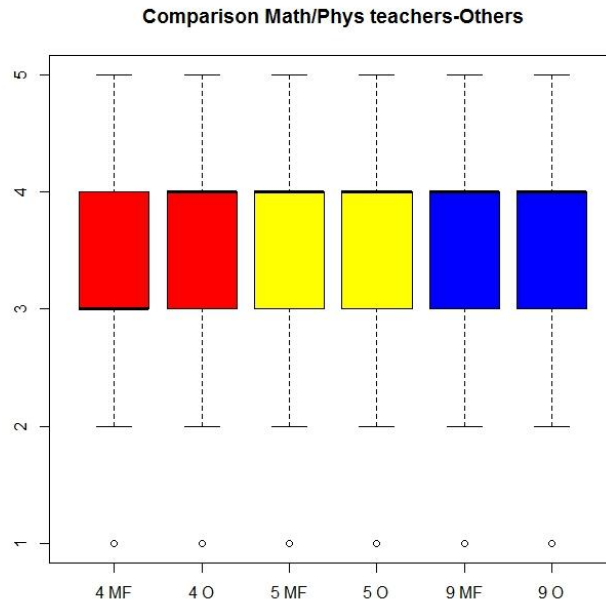
We have then analyzed in more details the answers to questions 4, 5 and 9 concerning the coherence of teaching choices with students' interest, the perception of the classroom "climate" and the use of new technologies in the teaching action.

In Figure 8 the distributions of the answers to such questions are shown in pairs regarding teachers in Lycée and in other schools respectively. The most relevant feature that appears is the broadening of the interquartile range for teachers in schools other than Lycée as far as the use of new technologies in the teaching is concerned (question 9). The Kruskal-Wallis test performed on the scores to question 9 with respect to the type of school was significant ( $p=0.0443$ ) as well as the Wilcoxon test to compare the median scores between teachers of Lycée and of other schools for the same question ( $p=0.0198$ ).

When the distributions of the answers to questions 4, 5 and 9 are compared with respect to the teaching subject, some differences arise between teachers of Mathematics (M) and of Mathematics and Physics (MF) and teachers of all the other subjects. The corresponding boxplots are shown in Figure 9. The Kruskal-Wallis tests performed on the scores to question 4 and 9 with respect to teaching subject were significant ( $p=0.0349$  and  $p<0.0001$  respectively) as well as the Wilcoxon tests to compare the median scores between the two groups ( $p=0.0003$  and  $p=0.0091$  respectively).



**Figure 8: Boxplots for answers to Questions 4, 5 and 9; Lycée vs other schools**

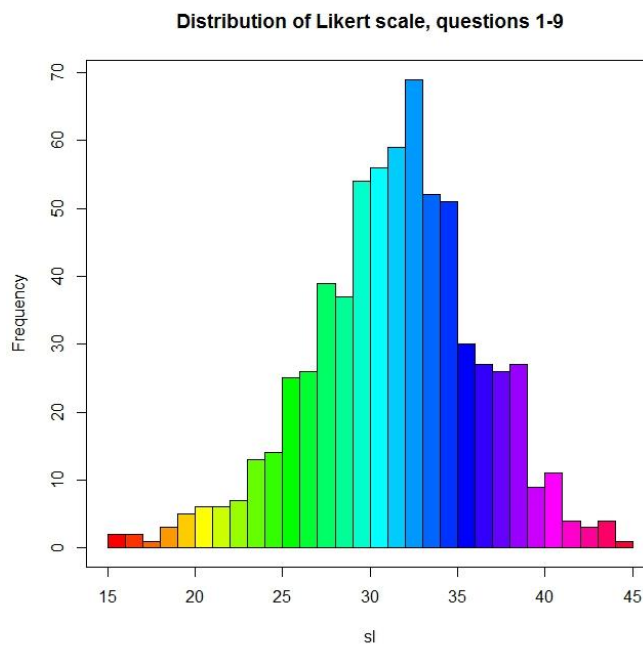


**Figure 9: Boxplots for answers to Questions 4, 5 and 9; M and MF teachers vs others**

If we perform a similar analysis of the answers to questions 4, 5 and 9 by socio-economic zone, a slight difference in the median answer score arises only for question 5, where the median (3) for zone 5 is significantly lower than the others that are all equal to 4.

The analysis of the Likert scale, i.e. of the sum of the scores assigned to each answer, allowed to obtain a mean of 31.92825 and a standard deviation of 4.857637. The ANOVA test performed with respect to the teaching subjects was significant ( $p=0.0085$ ), while no difference was detected in the mean scales with respect either to the type of school or to the socio-economic zone. In particular, teachers of Mathematics and of Physics were characterized by slightly lower scales with respect to teachers of Science, Computer Science and Mathematics and Physics.

Figure 10 shows the histogram of the overall scale distribution.



**Figure 10: Histogram of scale distribution for questions 1-9**

### ➤ Questions 10-11

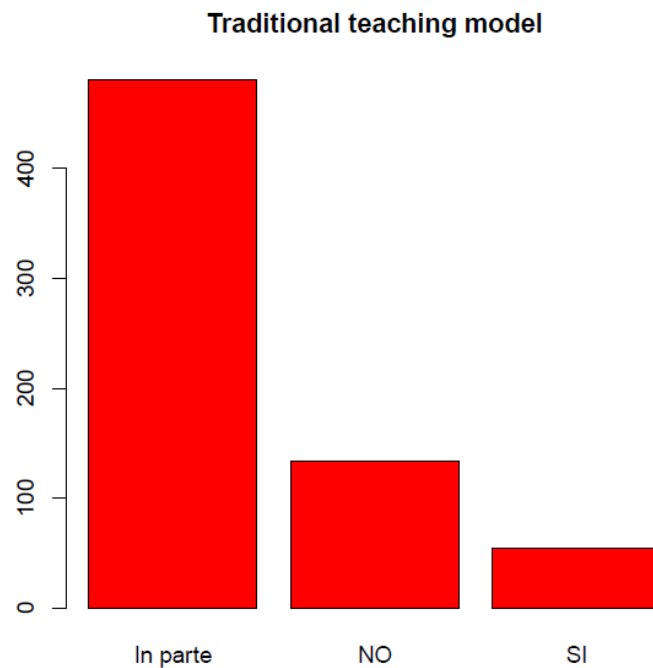
Questions 10 and 11 went on in ascertaining the teachers' perception of their teaching practice by considering teaching models and methodologies in the following way:

10. Do you consider your teaching practice referable to a traditional teaching model of transmissive type?

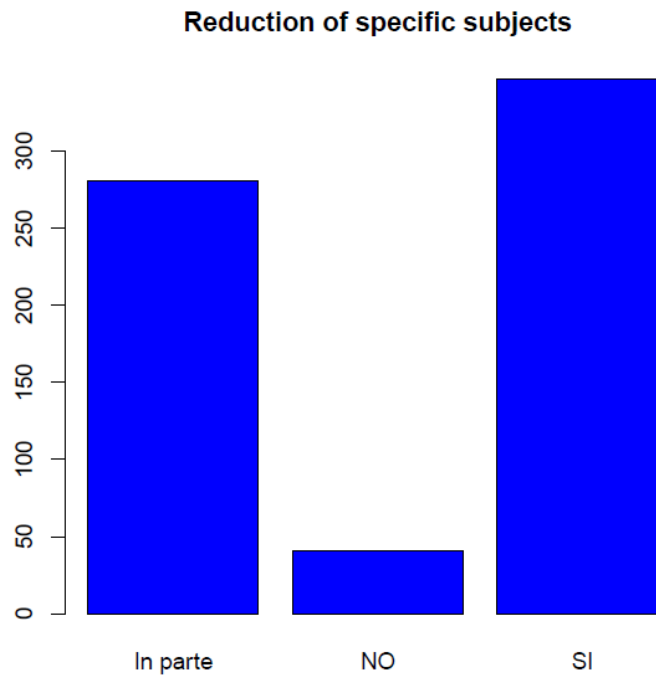
11. Do you agree with the choice of reducing the quantity of specific Mathematical topics in the Curriculum in favor of cross-curricular links, problem solving and application of knowledge?

The possible answers were in both cases “Partly” (in parte), “No” and “Yes” (SI).

As can be clearly seen from Figure 11, most teachers (72%) involved in the questionnaires judged their teaching practice only partially referable to a traditional teaching model of transmissive type. Only 8% of them agreed with that statement.



**Figure 11: Frequencies of the answers to question 10**



**Figure 12: Frequencies of the answers to question 11**

As opposite, more than a half of the teachers (52%) agreed with the possible choice of reducing the quantity of specific Mathematical topics in the Curriculum in favor of cross-curricular links, problem solving and application of knowledge. Moreover, the proportion was almost the same if computed separately for the teachers of Mathematics, Physics, Mathematics and Physics and Science. Only 6% among all teachers did not agree while the remaining proportion (42%) was only partially convinced of this choice (Figure 12).

To ascertain the existence of a possible association between the answers to questions 10 and 11 we employed the Goodman Kruskal Gamma coefficient. In statistics, such coefficient is a measure of rank correlation, i.e. of the similarity of the orderings of the data when ranked by each of the quantities. It measures the strength of association of the cross tabulated data when both variables are measured at the ordinal level while it makes no adjustment for either table size or ties. Values range from  $-1$  (100% negative association, or perfect inversion) to  $+1$  (100% positive association, or perfect agreement) while a value of zero denotes the absence of association.

The association coefficient between the answers to questions 10 (traditional teaching method) and 11 (reduction in the number of specific subjects) was low:

$$\text{Goodman Kruskal Gamma} = 0.240 \text{ (CI [0.095,0.385])}$$

This could be a hint for the hypothesis that those teachers that are more keen to traditional teaching methods could be less determined to introduce new teaching methodologies or orientations requiring maybe also a reduction in the number of specific subjects to favor other aspects, and viceversa.

➤ **Question12, sections 1-4**

Questions 12, sections 1-4 were dedicated to the activities that teachers underwent in the last two years for their professional development. The answers were of the type “Yes”/”No” for all the items in each section. Teachers could of course answer positively to more than one item. We will consider them one at a time.

➤ **Question 12.1: activities of professional development in the last two years**

- 1 training courses/seminars
- 2 National/regional programmes of requalification
- 3 observation visits to other schools
- 4 individual research
- 5 online courses
- 6 tutoring experiences
- 7 training practice with other colleagues
- 8 participation to teachers networks
- 9 participation to online communities of practice

The proportions of positive answers with respect to the total are plotted for all the 9 items in Figure 13. The great majority of teachers (around 90%) followed training courses or seminars for their professional development, while less than 10% were involved in observation visits to other schools. It is also interesting to note that quite a conspicuous proportion of the teachers were also interested in individual research (around 75%).

Some teachers declared to have followed other ways for their professional development, among them:

- PP&S or LSosa projects
- Seminars or congresses
- Masters for teaching trainers
- English courses, some of them specific for teaching in that language (CLIL courses)

➤ **Question 12.2: How many days did you dedicate to your professional development activities in the last two years?**

More than 65% of the teachers involved declared to have dedicated from 5 to 20 days in the last two years to their professional development, while only around 4% dedicated a number of days less than 5. The distribution of the answers can be seen in Figure 14.

Activities of professional development in last 2 years  
Percentage of teachers

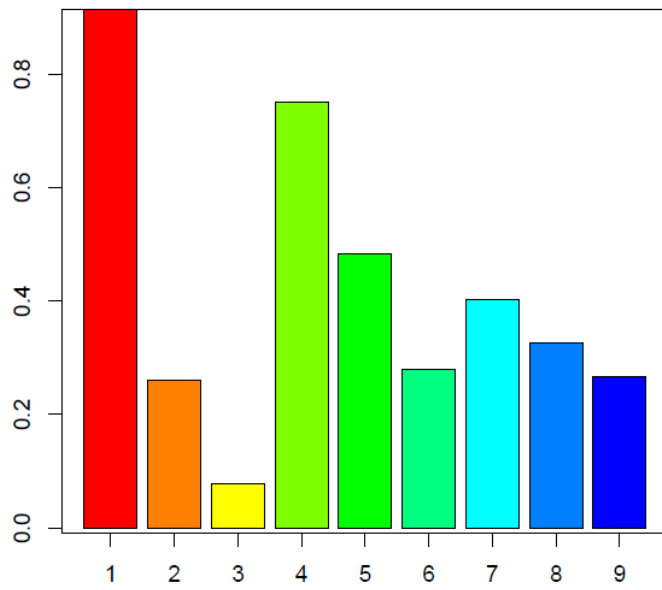


Figure 13: Proportions of positive answers to items in question 12.1

Days for professional development activities  
in the last 2 years

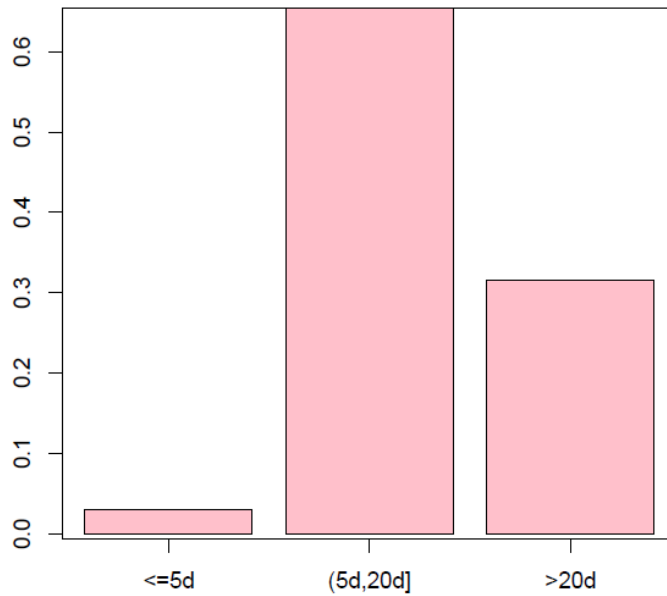
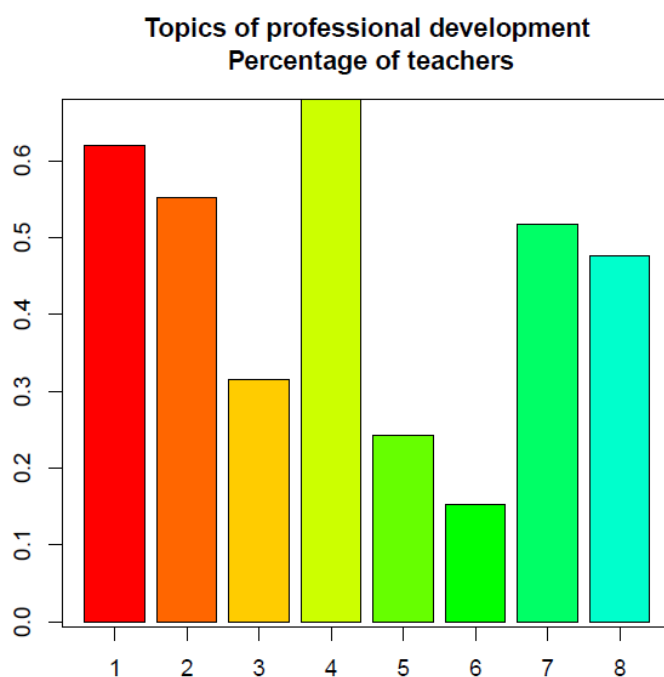


Figure 14: Proportions of answers to question 12.2



➤ **Question 12.3: Which of the following topics were the object of your professional development?**

- 1 disciplinary contents
- 2 use of ICT
- 3 use of professional SW
- 4 use of innovative methodologies
- 5 teaching to students with special needs
- 6 evaluation practices
- 7 production of multimedia and online didactic materials
- 8 didactic planning



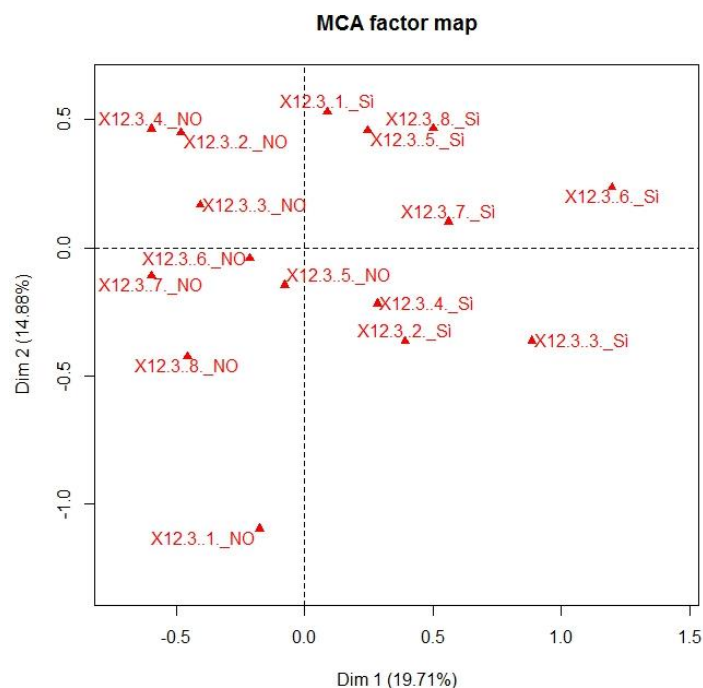
**Figure 15: Proportions of positive answers to question 12.3**

As can be seen from Figure 15, the use of innovative methodologies was the topic that obtained the higher proportion of preferences among the objects of professional development (almost 70%). Also the disciplinary contents and the use of ICT were preferred by a good amount of teachers (around 60% and 55% respectively).

A chi-square test was executed to establish whether the use of ICT was the object of a significant ( $p\text{-value} < 0.0001$ ). In particular, 74% of teachers in other schools and only 53% of teachers in Lycée declared to have included the use of ICT among the subjects of their professional development.

To perform a more sophisticated analysis on the pattern of answers to questions 12.3 we employed multiple correspondence analysis (MCA), which is a multivariate method allowing us to analyze the systematic patterns of variations with categorical data. Indeed MCA applies to tables in which the observations are described by a set of qualitative (i.e. categorical) variables. Associations among the variables considered are represented graphically as "maps", which eases the interpretation of the structures in the data. Oppositions are maximized in order to uncover the underlying dimensions best able to describe the central tendency in the data. Generally this results in a two dimensional plot whose axes are the new first two variables that together better describe associations and oppositions in the original data.

In Figure 16 we show the factor plot resulting from the application of MCA to the answers to questions 12.3.



**Figure 16: Factor map for answers to question 12.3**

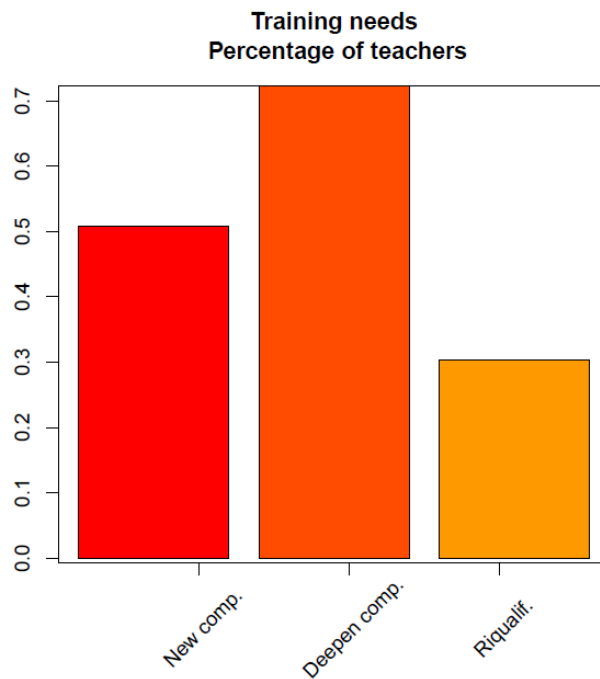
The horseshoe shape, somewhat similar to a parabolic crescent, is known in the literature as Guttman effect and it is rather common in correspondence analysis. This happens when there is a sort of intrinsic subdivision in the levels of the variables involved and hence the greatest part of the levels lie near the barycentre of the factor map, while some points are very far from it and hence express some peculiar behavior of the association among variables. This happens here for the positive answers concerning evaluation practice and use of professional SW and for the negative answer concerning disciplinary contents.

Some teachers declared to have chosen other topics of professional development, among them:

- English and English for teaching
- Laboratories
- Scientific festivals

- Physics Olympic Games
- Vocational guidance for students

➤ **Question 12.4: Which training needs were at the basis of your participation to the training activities?**



**Figure 17: Proportions of answers to question 12.4**

More than 70% of the teachers declared that the deepening of the competences already acquired in their subject was at the basis of their participation to the training activities analyzed in the previous questions. At the same time, a half of them was also interested in the acquisition of new competences in new sectors, while only slightly more than a quarter underwent professional development activities for requalification opportunities (see Figure 17).

Some teachers indicated also other training needs that were at the basis of their participation to training activities, among which:

- Personal interest
- The new secondary school-leaving examination
- Search for methods to better the teaching practice from the point of view of classroom climate, work and techniques

- Interest in knowing and comparing teaching experiences in international contexts.

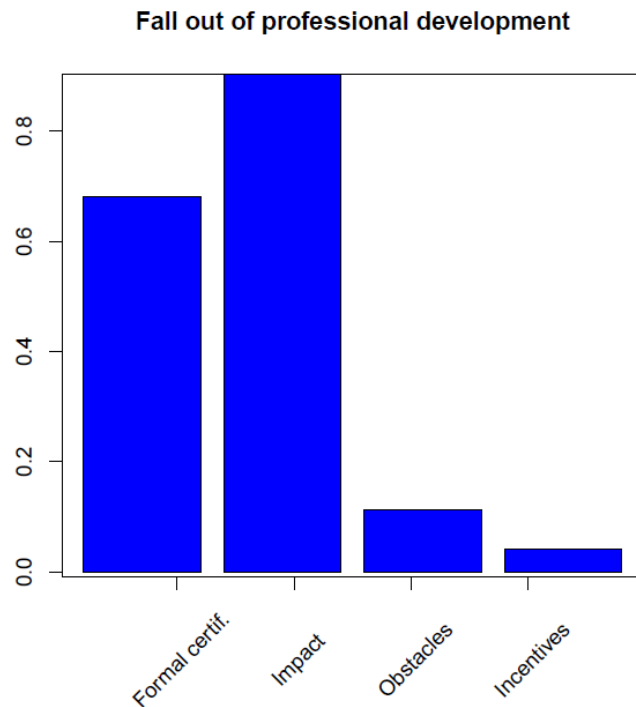
➤ **Questions 12.5 – 12.8: Certification, impact, obstacles and incentives of professional development activities**

12.5. Did you get a formal certification at the end of the professional development activities?

12.6. Did the professional development activities have an impact on your teaching practice?

12.7. Were there any obstacles in the participation to the activities?

12.8. Were there any incentives for the participation to the activities?



**Figure 18: Proportions of positive answers to questions 12.5-12.8**

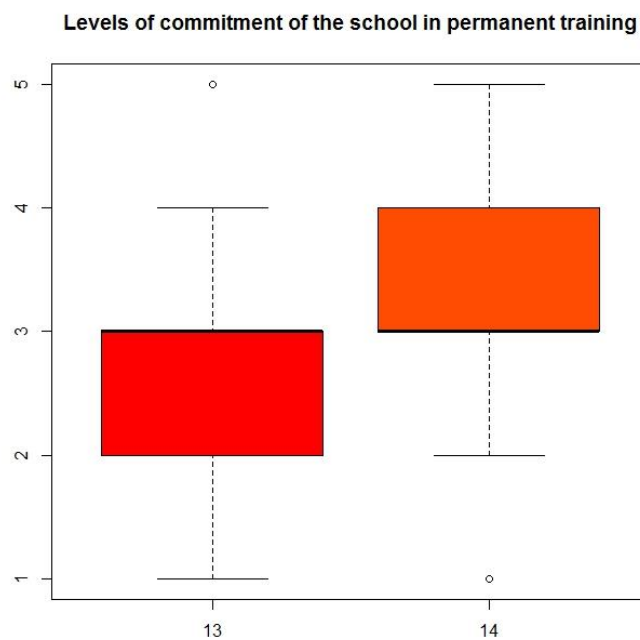
More than 60% of the teachers declared to have obtained a formal certification at the end of the professional development activities. An impact on their teaching practice arising from the professional development was recognized by 85% of them, while 10% revealed to have encountered obstacles in the participation to the activities and for less than 5% there were incentives for the participation to the activities (see Figure 18).

➤ **Questions 13 and 14: Level of commitment of the school in the permanent training and, if positive, added value of permanent training**

➤ 13. What was the level of commitment of your school in the permanent training?

- 14. How do you rate the added value of permanent training implemented by your school in the last two years for your personal activity? (please answer only if you rated question number 13 Very good/Good/Satisfactory)

These two questions concerned the level of commitment of the schools in permanent teachers' training. They were Likert items with score (in ascending order) insignificant, poor, satisfactory, good, very good. The level of commitment of the schools did not reach as a whole very high scores, while the added value of permanent training, if any, implemented by the teachers' school in the last two years for their personal activity was on the average higher. The boxplots of the distributions of the answers to the two questions are shown in Figure 19.



**Figure 19: Boxplot of the answers to questions 13 and 14**

## 5. Analysis of Part II: Training needs

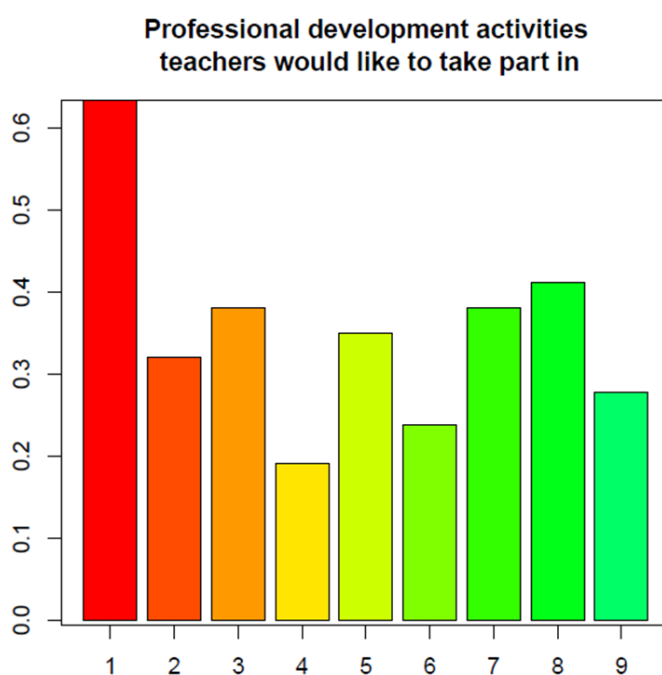
The second part of the questionnaire was oriented on the specific interests of the teachers within the areas covered by the SMART project (acquisition of STEM - Science, Technology, Engineering, Mathematics - skills, teaching with e-learning activities). It was then intended to investigate on which activities and subjects the teachers judge relevant for their future professional development and to provide thus a hint into the possible actions to be scheduled.

Questions 15.1 and 15.2 concerned specifically the activities and the subjects for professional development, and were divided in several topics, while in the last section of the questionnaire teachers were asked to chose between a series of possible subjects they could be interested in for deepening their competences.

➤ **Question 15.1: Desired future professional development activities**

- 1 Training courses / seminars
- 2 National/regional programmes of requalification
- 3 observation visits to other schools
- 4 individual research
- 5 online courses
- 6 tutoring experiences
- 7 training practice with other colleagues
- 8 participation to teachers networks
- 9 participation to online communities of practice

The possible answers for each topic were “Yes” or “No”. The proportions of positive answers to the nine topics are shown altogether in Figure 20.



**Figure 20: Proportions of positive answers for questions 15.1**

Topic 1, the attendance to training courses or seminars, is the most preferred with a proportion of positive answers of more than 60% , while topic 4, individual research, is the least preferred having been selected by less than 20% of the teachers.

The teachers' preferences have then been analyzed by socio-economic area, by type of school, by teaching subject and by degree obtained. In this last case only the subjects Mathematics, Physics, Mathematics and Physics, Science and Computer Science have been taken into consideration.

The proportions of teachers expressing a positive preference were significantly different with respect to socio-economic areas only for topic 1, regarding the attendance to training courses or seminars (chi-square test  $p=0.002046$ ). Indeed the proportions of positive answers in area 1 (0.72) and in area 4 (0.65) were consistently higher than those in the remaining areas.

As far as the type of school is concerned, the proportions of positive answers were significantly different only for question 9, regarding the participation to online communities of practice (chi-square test  $p=0.0063$ ). The proportions in the three types of school were as in the following Table:

Lycée	Technical	Vocational
24%	36%	38%

**Table 4: Percentages of positive answers to topic 15.1.9**

The chi-square test performed after dividing the answers from teachers in Lycée from all the others was significant ( $p=0.0021$ ), revealing that there is a difference in the participation to online communities of practice between these two categories (it is lower for the first one).

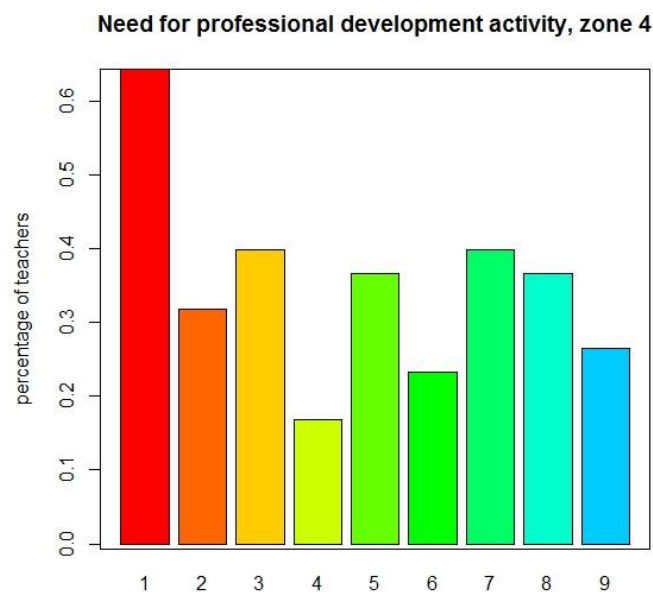
When the teaching subject has been taken into consideration, the proportions of positive answers to question 5, concerning the attendance to online courses, and to question 9 already considered above resulted significantly different across the categories (chi-square test  $p=0.0121$  and  $p=0.0214$  respectively). In particular, the proportions of Mathematics teachers was significantly different with respect to that of all the others considered in both cases:

- Question 5: chi-square  $p=0.0036$   
proportion of Mathematics teachers 0.44; proportions of other subjects teachers 0.31
- Question 9: chi-square  $p=0.0015$   
proportion of Mathematics teachers 0.37; proportions of other subjects teachers 0.24

As far as the analysis based on the degree obtained is concerned, only the degrees in Mathematics, Physics, Chemistry, Biological and Natural sciences and Geological sciences have been considered. The proportions of positive answers to question 4 concerning individual research and to question 5 concerning online courses resulted significantly different across the categories (chi-square test  $p=0.03248$  and  $p=0.01607$  respectively). In particular, in the second case the proportion of teachers

with a degree in Mathematics was higher than all the others (0.42 with respect to values ranging from 0.20 to 0.30).

The answers to questions 15.1 have been finally analyzed considering separately teachers in socio-economic area 4, that as stated at the beginning is particularly relevant in the Italian society, with teachers in all the other areas. The aim was to ascertain whether there could be a difference in the possible professional development activities in that area with respect to the others, thus finding out an indication for the future guidelines. The proportions of positive answers to all the nine topics for teachers in socio-economic area 4 are shown altogether in Figure 21.

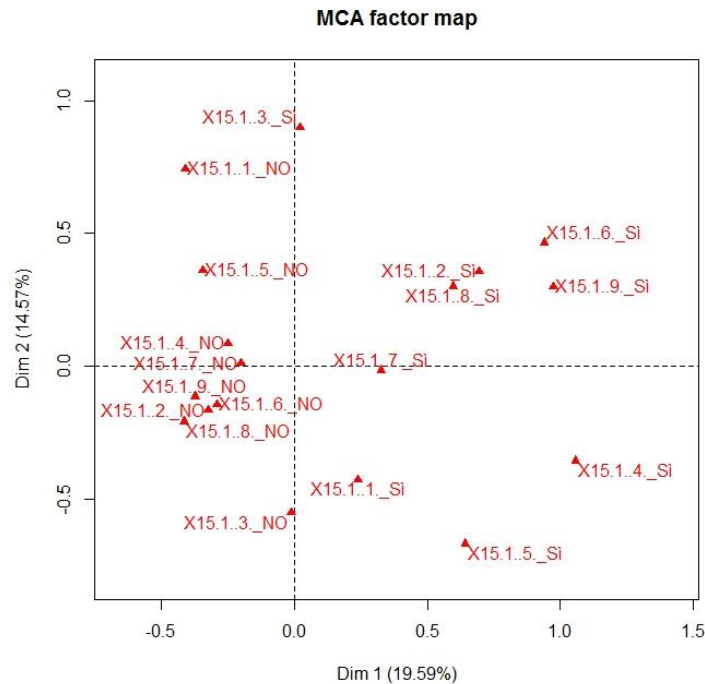


**Figure 21: Proportions of positive answers for questions 15.1 for area 4**

As can be easily seen from the comparison with Figure 19, there seems to be no relevant discrepancy with respect to the behavior of the teachers as a whole. Indeed the chi-square tests performed on the two groups of answers for each single topic did not reveal any significant difference between the choices.

The multiple correspondence analysis has been applied to the answers to questions 15.1 to find out possible intrinsic associations or dissociations among the various topics involved. The resulting factor plot is shown in Figure 22.





**Figure 22: Factor map for questions 15.1**

The ellipsoidal shape of the factor map is the most common in correspondence analysis; the major axis expresses the greatest part of the information and hence represents the most important factor. The two factors are bipolar since there are two opposite groups of levels for the variables that describe each factor, the extreme points of the barycentre. In this case the topics that mainly characterize the major axis are individual research and training practice with colleagues, while the distinction along the other axis is led by the answers on training courses and seminars and on observation visits in other schools.

Some teachers expressed also other desired future professional development activities, among them:

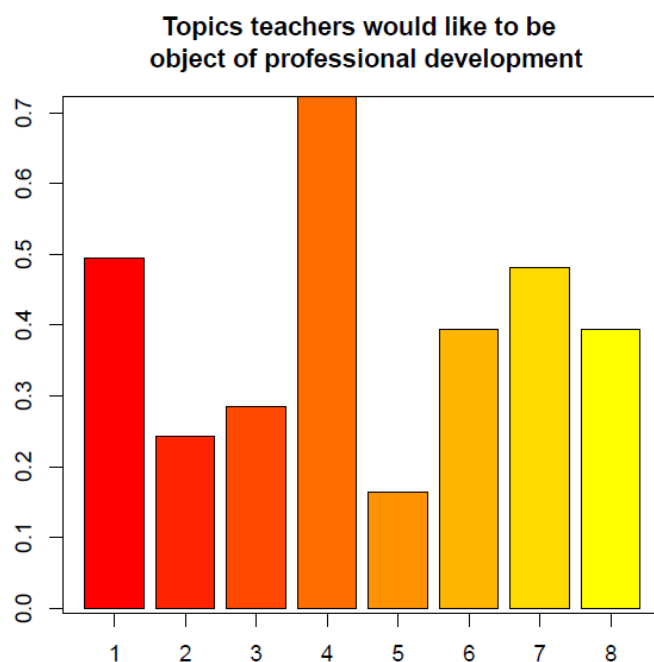
- English courses
- Training seminars at the University
- Observational experiences abroad
- Organization of scientific festivals
- Meetings with Italian and foreign teachers
- Experiences in European type schools
- CLIL methodologies
- Involvement in school system reorganization
- Experiences abroad

- Training role in good practices
- Involvement in the standardization of curricula
- Observation of one's teaching practice by other teachers

➤ **Question 15.2: Topics teachers would like to be the object of professional development**

- 1 disciplinary contents
- 2 use of ICT
- 3 use of professional SW
- 4 use of innovative methodologies
- 5 teaching to students with special needs
- 6 evaluation practices
- 7 production of multimedia and online teaching materials
- 8 teaching planning

Also for this questions the possible answers for each topic were “Yes” or “No”. The proportions of positive answers to the eight topics are shown altogether in Figure 23.



**Figure 23: Proportions of positive answers for questions 15.2**

Topic 4, the use of innovative technologies, is the most preferred with a proportion of positive answers of more than 70%, while topic 5, teaching to students with special needs, is the least preferred having been selected by only around 15% of the teachers.

The teachers' preferences about the topics they would like to appear in their professional development have been analyzed also in this case by socio-economic area, by type of school, by teaching subject, considering here again Mathematics, Physics, Mathematics and Physics, Science and Computer Science, and by degree obtained, considering the same degrees as for question 15.1

The proportions of teachers expressing a positive preference were significantly different with respect to socio-economic areas for topic 4, regarding use of innovative methodologies (chi-square test  $p=0.0081$ ) and for topic 6, regarding the evaluation practices (chi-square test  $p=0.0389$ ). Indeed the proportion of positive answers to question 4 in area 2 (0.85) was consistently higher than those in the remaining areas and the proportions of positive answers to question 6 in area 2 (0.43) and in area 4 (0.46) were higher than in the other areas.

As far as the type of school is concerned, the proportions of positive answers were significantly different for question 1, regarding the disciplinary contents (chi-square test  $p=0.0072$ ) and for question 5, regarding teaching to students with special needs (chi-square test  $p=0.0365$ ). In both cases there was a significant difference in the proportions of positive answers between teachers in Lycée and in other schools, with  $p=0.0028$  and  $p=0.0220$  respectively. The proportions for the two topics are shown in the following table.

Lycéeqst. 1	Other qst. 1	Lycéeqst. 5	Other qst. 5
53%	40%	14%	22%

**Table 5: Proportions of positive answers for questions 15.2.1 and 15.2.5**

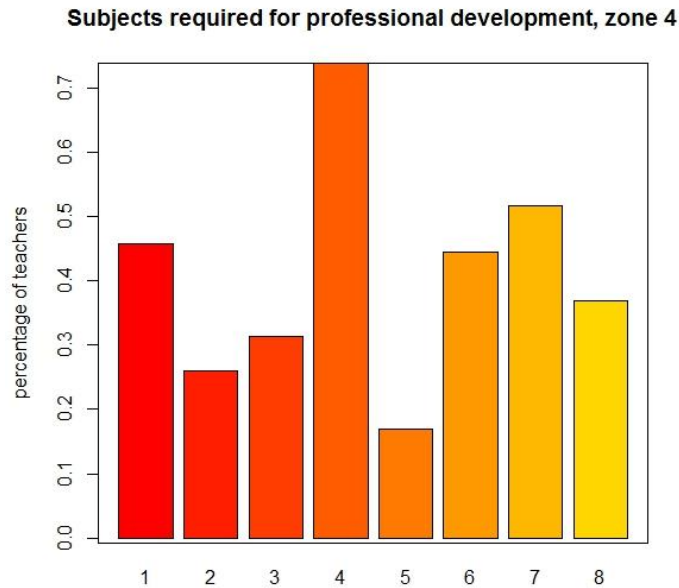
It appears that, while teachers in Lycée are more interested in professional developments concerning disciplinary contests with respects to teachers in other types of schools, they are less interested in professional activities regarding teaching to students with special needs.

When the teaching subject has been taken into consideration, the proportions of positive answers to question 1, concerning disciplinary contents, to question 3 concerning use of professional SW and to question 7 concerning production of multimedia and online teaching materials resulted significantly different across the categories (chi-square test  $p=0.0223$ ,  $p<0.0001$  and  $p=0.0103$  respectively). In particular, the following distinctions between teachers of one specific subjects and all the others have been detected:

- Question 1  
proportion of Mathematics and Physics teachers 0.56; overall proportion of other subjects teachers 0.46  
chi-square  $p=0.0257$
- Question 3  
proportion of Science teachers 0.11; overall proportion of other subjects teachers 0.34  
chi-square  $p<0.0001$
- Question 7  
proportion of Computer Science teachers 0.32; overall proportion of other subjects teachers 0.49  
chi-square  $p=0.0315$

As far as the degree obtained is concerned, only the proportions of positive answers to question 4, concerning use of innovative methodologies, resulted significantly different across the categories (chi-square test  $p=0.0187$ ). The proportion of teachers with a degree in Physics that were interested in the topic was higher than all the others (0.63 with respect to values ranging from 0.35 to 0.55).

Also in this case the answers have been finally analyzed comparing teachers in socio-economic area 4 with teachers in all the other area to find out possible differences in the choices for professional development topics in that area with respect to the others. The proportions of positive answers of teachers from socio-economic area 4 to all the eight topics are shown altogether in Figure 24.



**Figure 24: Proportions of positive answers for questions 15.2 for area 4**

In particular, socio-economic area 4 was different in the proportion of positive answers for topic 6, concerning the evaluation practices, from all the others (chi-square  $p=0.0096$ ). The proportions for the groups are shown in the following table.

Socio-economic area 4	Other socio-economic areas
45%	35%

**Table 6: Percentages of positive answers for question 15.2.6**

As a last analysis, the Goodman Kruskal association coefficient has been computed for some pairs of answers to find out possible associations between past and desired professional development activities for the teachers involved.

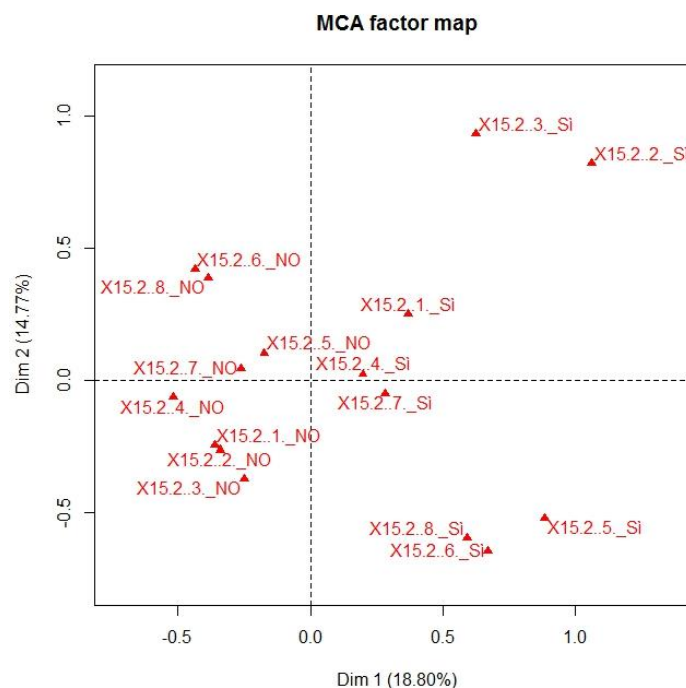
In particular we considered the following subjects that are directly related to the topics of the study:

- Use of ICT  
Goodman Kruskal Gamma 0.612 (CI [0.482,0.742])
- Use of professional SW  
Goodman Kruskal Gamma 0.689 (CI [0.593,0.784])

- Use of innovative methodologies  
Goodman Kruskal Gamma 0.257(CI [0.092,0.422])
- Production of multimedia and online didactic materials  
Goodman Kruskal Gamma 0.207 (CI [0.061,0.353])

In the first two cases there was a good association between past and desired choices for professional development activities, showing that those teachers that have already deepened their skills in the use of CT and/or in the use of professional SW would be interested in other similar experiences. On the contrary, teachers that had already experienced the use of innovative methodologies and the production of multimedia and online didactic materials did not revealed a strongly associated interest to choose the same teaching development topics.

The MCA has been applied also to questions 15.2, obtaining as a final result the factor map shown in Figure 25.



**Figure 25: Factor map for questions 15.2**

In this case the shape seems to be more similar to a horseshoe than to an ellipse; most levels of the variables are close to the barycentre and only some points lie rather far from it, in particular those concerning positive answers to questions concerning use of professional SW and of ICT and teaching to students with special needs.

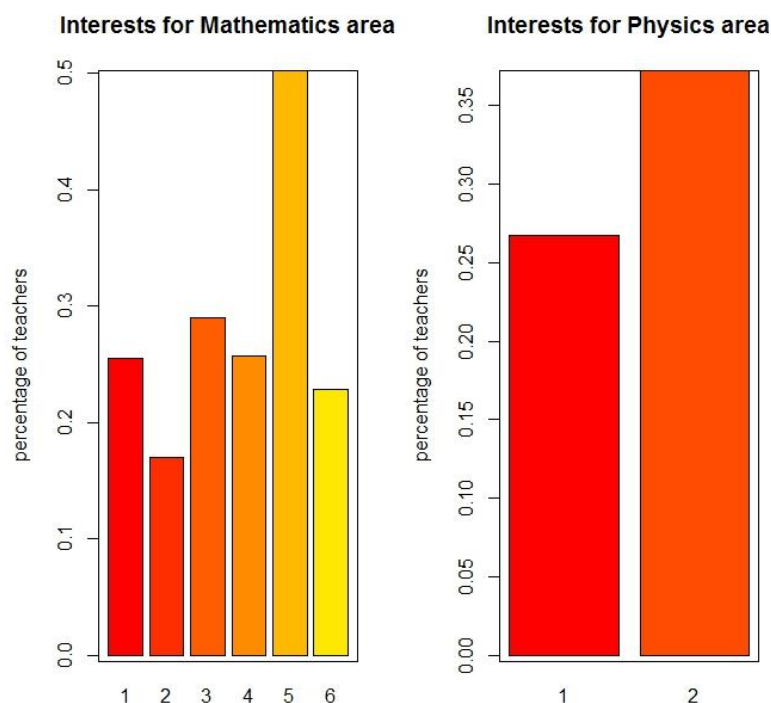
Some teachers indicated also other topics as the object of professional development, among them:

- CLIL
- Sharing of teaching models
- Experiences in new teaching models
- Teachers' training
- Laboratory teaching

➤ **Last questions: Training actions of interest by training area**

In the last part of the questionnaire on the training needs teachers were asked to express their possible interest in a series of specific training actions subdivided on the basis of five training areas: Mathematics, Physics, Science, ICT and Cross-curricular area.

In Figure 26 the proportions of teachers that were interested in the training actions for the Mathematics area and for the Physics area are shown.



**Figure 26: Proportions of positive answers for Mathematics and Physics areas**

The specific topics for the Mathematics area were the following:

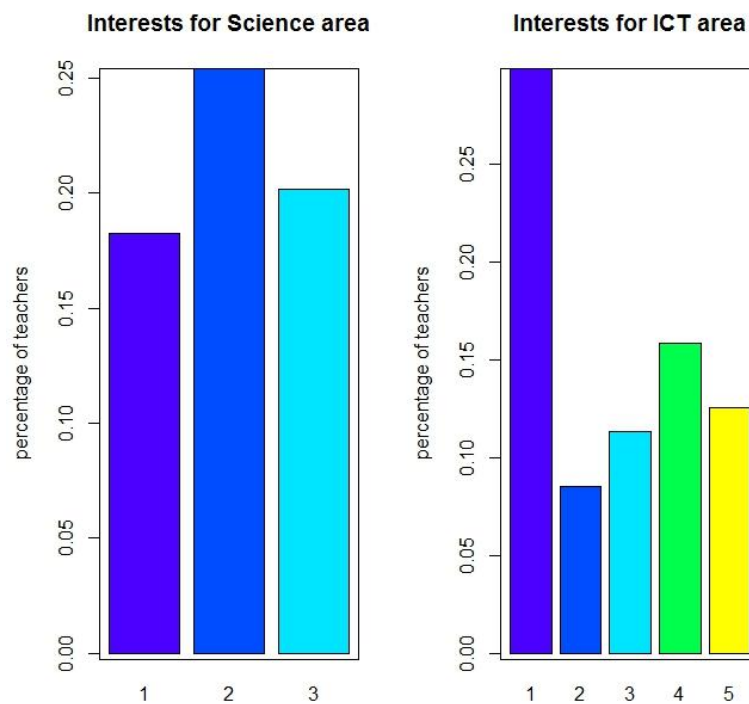
1. Use of advanced computing environments
2. Use of SW of numerical calculation
3. Use of SW of graphical representation
4. Modelling
5. Problem Posing and Solving
6. Specific contents

while for the Physics area they were the following:

1. Modelling
2. Modern Physics.

Teachers showed a clear preference for the training action “Problem Posing and Solving” within the Mathematics area (half of positive answers) while they appeared to be not so interested in the actions proposed within the Physics area.

In Figure 27 the proportions of teachers that were interested in the training actions for the Science area and for the ICT areas are shown.



**Figure 27: Proportions of positive answers for Science and ICT areas**

The topics for the Science area were the following:

1. Integrated sciences
2. Laboratory methodology
3. Poor laboratory



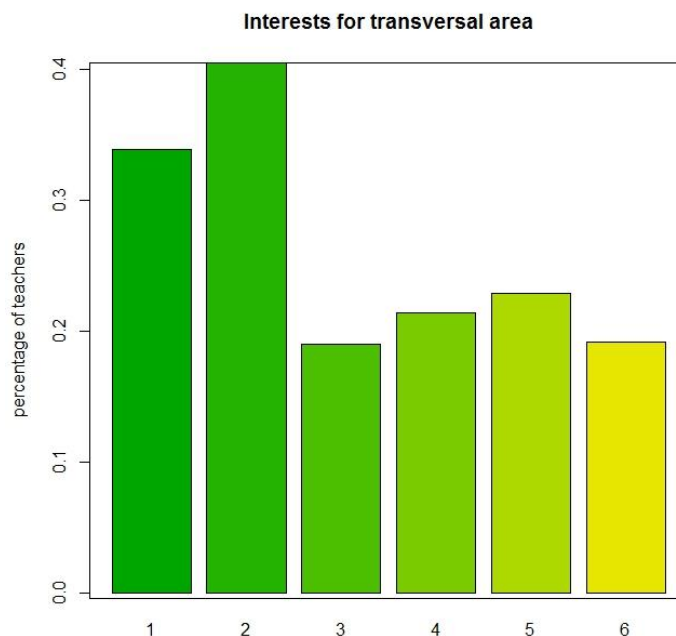
while for the ICT area the following training actions of interest were proposed:

1. Use of e-learning platforms
2. Information security
3. Algorithmic computation
4. Programming languages
5. Management of IT applications.

Laboratory methodology was chosen as interesting by around 26% of the teachers involved, while a little less than 20% chose the action concerning integrated sciences and around 20% poor laboratory.

Use of e-learning platform arouse the interest of almost 30% of the teachers, while only less than 10% showed interest towards information security and slightly more than 15% chose the action in programming languages.

In Figure 28 we show the proportions of teachers that were interested in the training actions for the Cross-curricular area.



**Figure 28: Proportions of positive answers for Cross-curricular area**

Here the topics were the following:

1. Creativity and innovation
2. Competence evaluation and assessment
3. Development of relational competences
4. Project management techniques
5. Constructivist learning
6. Teaching for students with special needs

The most selected training actions of interest were in this case the actions on competence evaluation and assessment (40% of positive answers) and on creativity and innovation (around 33% of positive answers). Less considered were the actions on development of relational competences and on teaching for students with special needs, that were chosen by slightly less than 20% of the teachers.

The Goodman Kruskal association coefficient has been computed for the answers to some pairs of topics to find out possible associations between interest in different training actions.

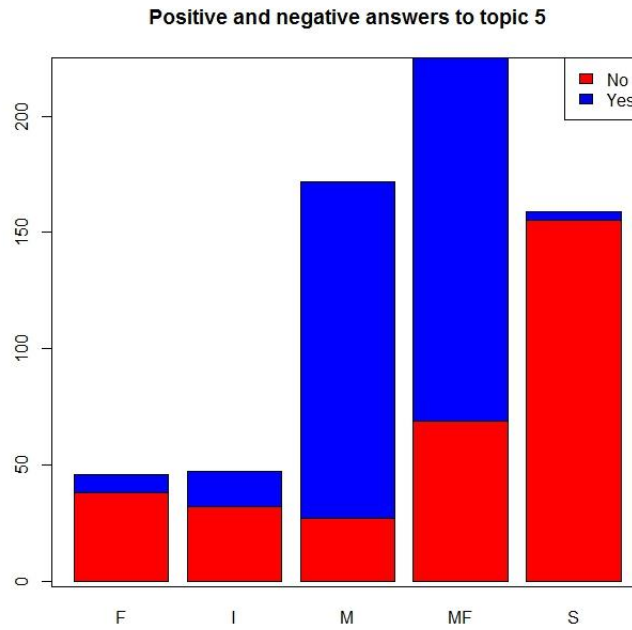
In particular we considered the following pairs of topics:

- Use of SW of numerical calculation (Mathematics area) and Programming languages (ICT area)  
Goodman Kruskal Gamma 0.458 (CI [0.271,0.645])
- Modelling (Mathematics area) and Modelling (Physics area)  
Goodman Kruskal Gamma 0.637 (CI [0.525,0.748])
- Use of advanced computing environments and Use of e-learning platforms  
Goodman Kruskal Gamma 0.325 (CI [0.162,0.488])

A good association could then be found only between the interest in modelling both from a mathematical and from a physical point of view, while the association between interest in the use of SW for numerical computation and in programming languages and the association between interest in the use of advanced computing environments and of e-learning platforms were only moderate.

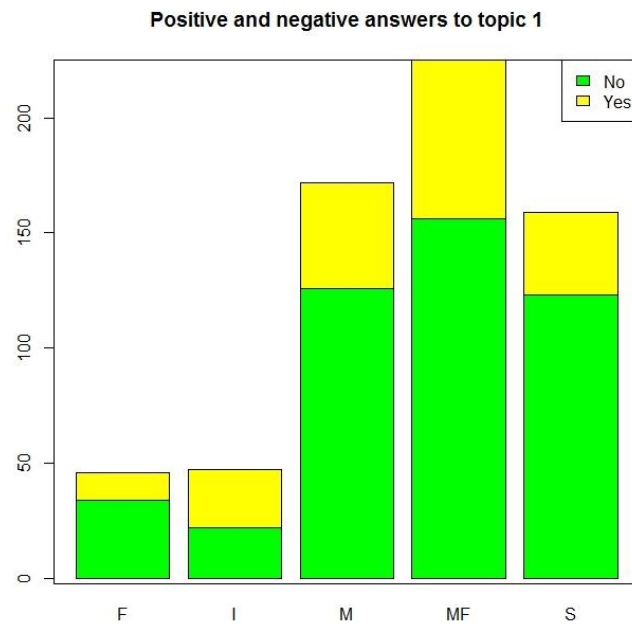
We finally considered if there was a possible differentiation in the interest for the teaching actions that are more connected with the SMART project with respect either to the school or to the subject taught. We analyzed then topic 5 for the Mathematics area (Problem posing and solving), topic 1 for the ICT area (Use of e-learning platforms) and topic 1 for the cross-curricular area (Creativity and innovation).

There was a significant difference in the interest for Problem posing and solving with respect to the teaching subjects (chi-square  $p < 0.0001$ ). Mathematics and Mathematics and Physics teachers were far more interested of their colleagues in Science, Computer Science or Physics in this topic, as can be read from the frequencies of “Yes” and “No” answers showed in Figure 29.



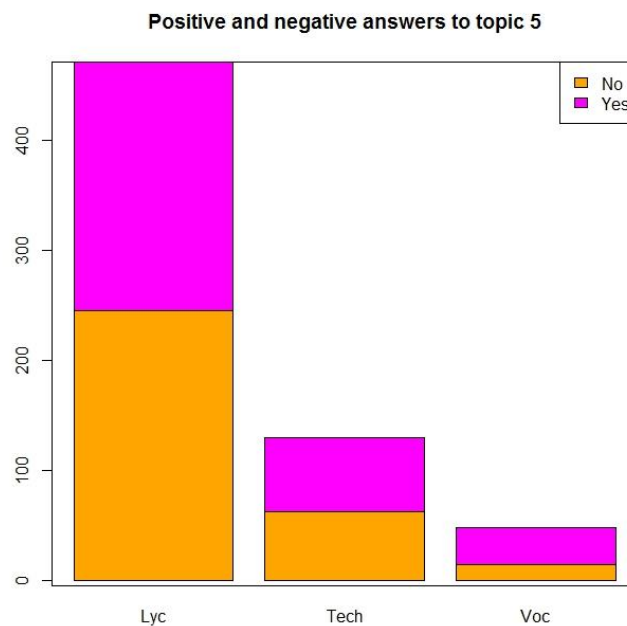
**Figure 29: Frequencies of answers for topic 5 Mathematics**

A significant difference was also detected among the interest shown for topic 1 of the ICT area, Use of e-learning platforms (chi-square test=0.0016). The absolute frequencies of positive and negative answers are plotted in Figure 30, where it can be noticed that a higher interest is shown by the teachers of Computer Science with respect to the other subjects.



**Figure 30: Frequencies of answers for topic 1 ICT**

Finally, there was a significant difference in the interest for Problem posing and solving with respect to the school (chi-square  $p=0.0096$ ). The absolute frequencies of positive and negative answers are shown in Figure 31.



**Figure 31: Frequencies of answers for topic 5 Mathematics**

A predominance of positive choices is exhibited here only by teachers in vocational schools, while for Lycée and Technical schools there is no evident difference between the proportions of positive and of negative opinions.

Some teachers indicated also other training actions of interest, among them:

- Other Mathematics topics for different subjects
- Theoretical research
- Cross-curricular activities
- Problem solving for subjects different with respect to Mathematics
- Comparison with abroad way of teaching
- Training
- Standardization of curricula
- Software for middle school
- Vocational activities for students.

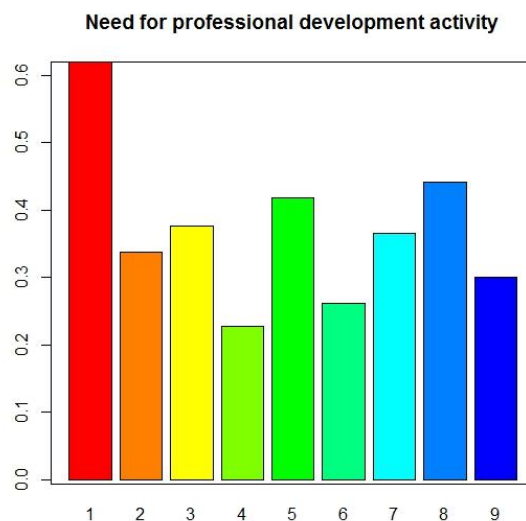
## 6. Training needs depending on teachers' degree

To get a deeper insight into the training needs expressed by the teachers that filled the questionnaire we performed a detailed analysis of Questions 15 and 16 splitting the teachers on the basis of their degree. We focused in particular on the degrees in Mathematics, Physics, Biological or Natural Sciences, Chemistry and Geological Sciences though in the last two cases sample sizes were rather small.

### 8.1 Training needs for teachers with a degree in Mathematics

#### ➤ Question 15.1: Desired future professional development activities

The proportions of positive answers to all the nine topics are shown altogether in Figure 32.

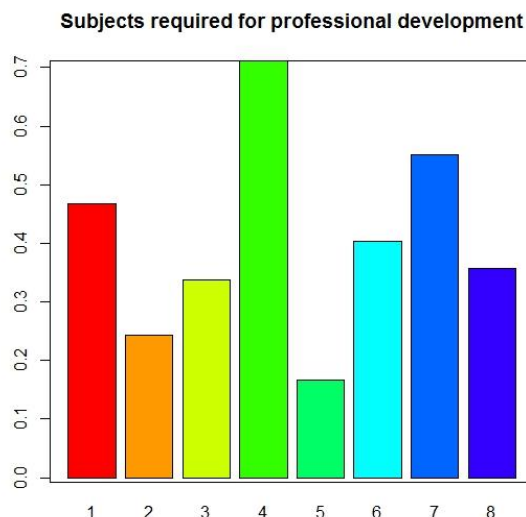


**Figure 32: Proportions of positive answers for questions 15.1**

The proportions do not present relevant differences with respect to the overall distributions concerning the teachers that answered to the questionnaire.

#### ➤ Question 15.2: Topics teachers would like to be the object of professional development

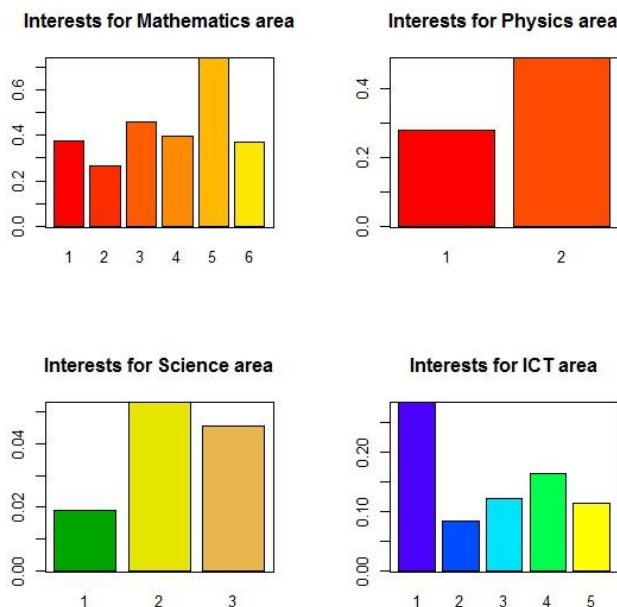
The proportions of positive answers to all the eight topics are shown altogether in Figure 33.



**Figure 33: Proportions of positive answers for questions 15.2**

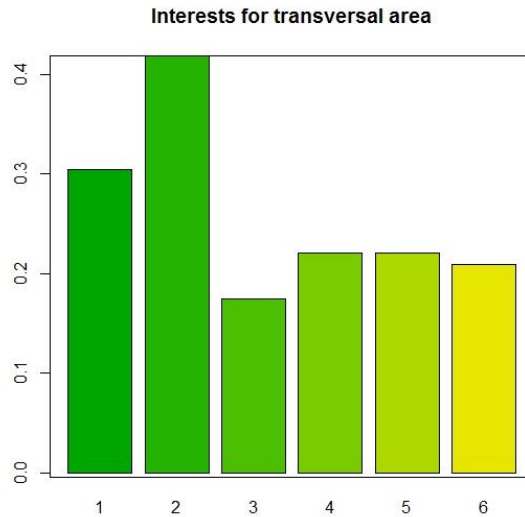
Also in this case there seems to be a non-relevant difference with respect to the global case except for question 7, regarding the production of multimedia and online teaching materials, for which the proportion of positive answers is slightly greater for teachers with a degree in Mathematics.

In Figure 34 the proportions of teachers that were interested in the training actions for the Mathematics, Physics, Science and ICT areas are shown.



**Figure 34: Proportions of positive answers for questions 16 – first four subjects**

The only relevant difference with respect to the global behavior is that the interest for Science area, though maintaining the same ratio between the items, is highly reduced.



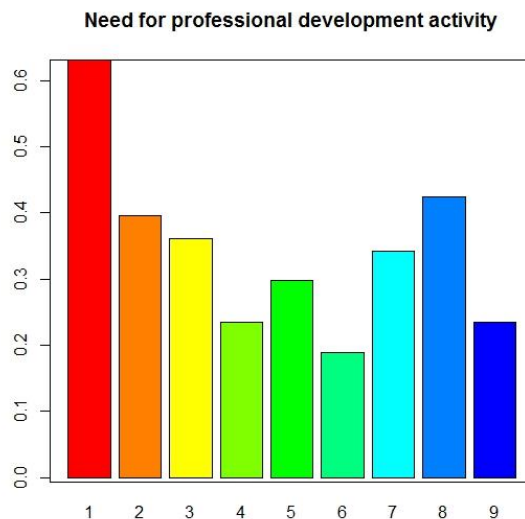
**Figure 35: Proportions of positive answers for Cross-curricular area**

In Figure 35 we show the proportions of teachers that were interested in the training actions for the Cross-curricular area, again very similar to the overall ones.

## 8.2 Training needs for teachers with a degree in Physics

### ➤ Question 15.1: Desired future professional development activities

The proportions of positive answers to all the nine topics are shown altogether in Figure 36.

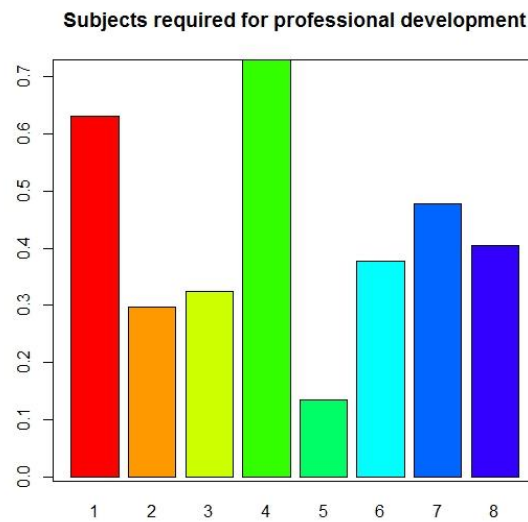


**Figure 36: Proportions of positive answers for questions 15.1**

The proportions are somehow higher with respect to the global case for answers 2 and 4, concerning National and regional programmes of requalifications and individual research respectively.

### ➤ Question 15.2: Topics teachers would like to be the object of professional development

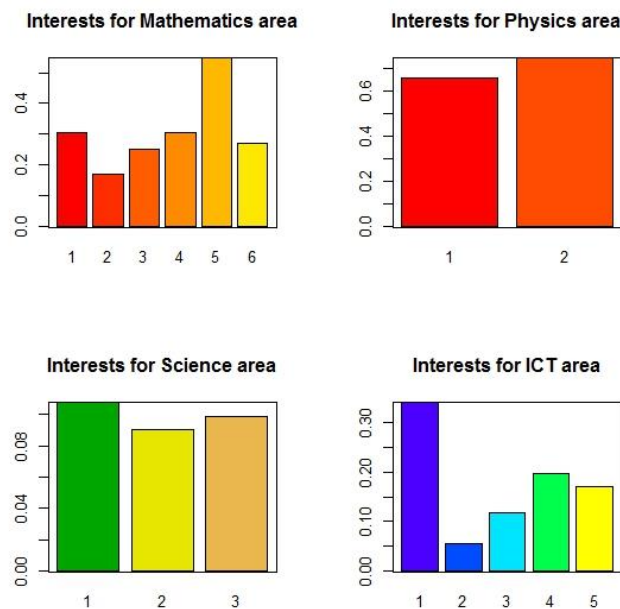
The proportions of positive answers to all the eight topics are shown altogether in Figure 37.



**Figure 37: Proportions of positive answers for questions 15.2**

Teachers with a degree in Physics appear to be more interested in disciplinary contents with respect to the global behavior (the proportion are more than 0.6 and less than 0.5 respectively).

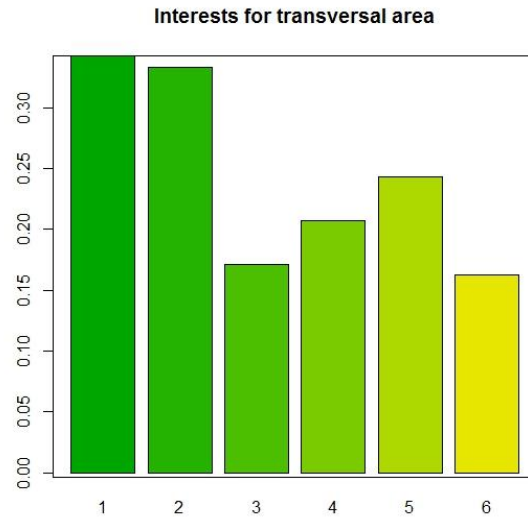
In Figure 38 the proportions of teachers that were interested in the training actions for the Mathematics, Physics, Science and ICT areas are shown.



**Figure 38: Proportions of positive answers for questions 16 – first four subjects**

The most relevant peculiarities concern an obvious greater interest with respect to Physics area topics and a far smaller interest in Science; furthermore, also a somehow higher interest in the use of e-learning platforms can be detected.





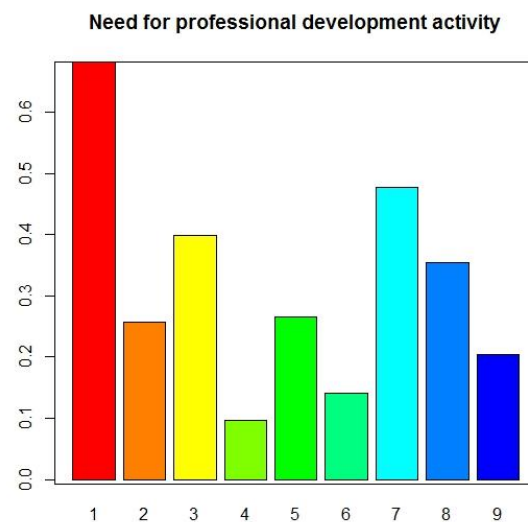
**Figure 39: Proportions of positive answers for Cross-curricular area**

In Figure 39 we show the proportions of teachers that were interested in the training actions for the Cross-curricular area, again very similar to the overall ones. Only the interest in competence evaluation and assessment is lower than in general.

### 8.3 Training needs for teachers with a degree in Biological or Natural Sciences

➤ **Question 15.1: Desired future professional development activities**

The proportions of positive answers to all the nine topics are shown altogether in Figure 40.

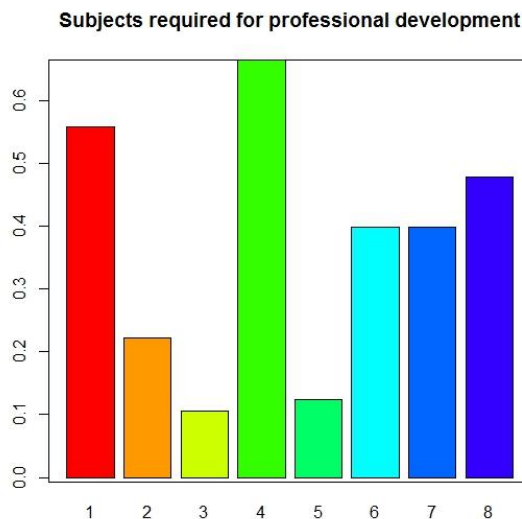


**Figure 40: Proportions of positive answers for questions 15.1**

For teachers with a degree in these subjects the proportions of positive answers is lower for questions 2, 4 and 9, concerning programmes of requalification, individual research and participation to online communities of practice.

➤ **Question 15.2: Topics teachers would like to be the object of professional development**

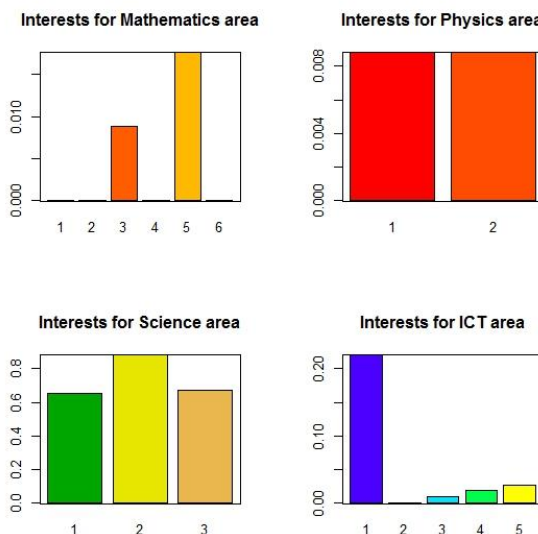
The proportions of positive answers to all the eight topics are shown altogether in Figure 41.



**Figure 41: Proportions of positive answers for questions 15.2**

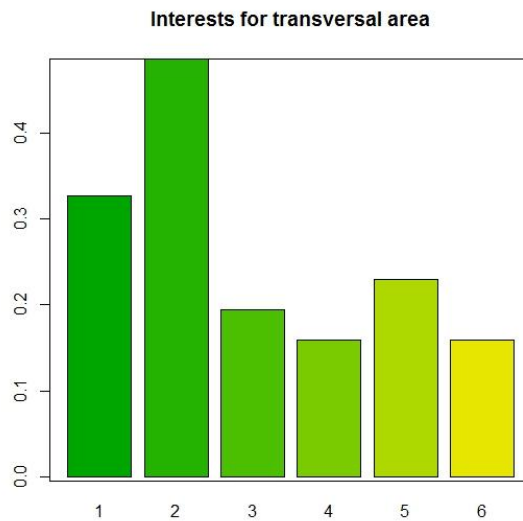
Questions 1 and 8 have a higher proportion of positive answers with respect to the total, while on the contrary these teachers are less interested in the use of professional SW.

In Figure 42 the proportions of teachers that were interested in the training actions for the Mathematics, Physics, Science and ICT areas are shown.



**Figure 42: Proportions of positive answers for questions 16 – first four subjects**

There is a clear preference for the topics concerning Science area and a lack of interest in the others.



**Figure 43: Proportions of positive answers for Cross-curricular area**

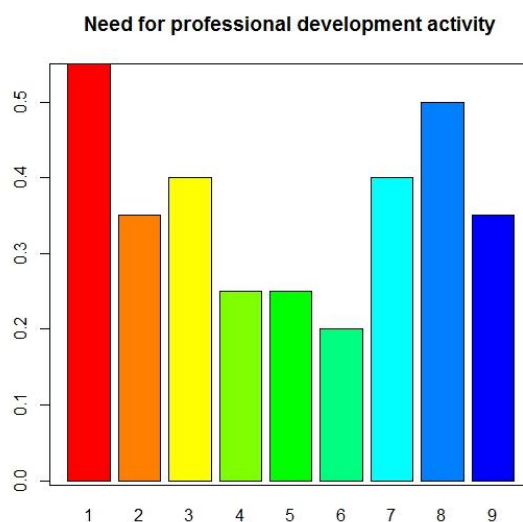
The only difference with respect to the global situation is a smaller interest in project management techniques.

#### 8.4 Training needs for teachers with a degree in Chemistry

It must be underlined that the sample size is rather small (20 cases), thus clearly reducing the effectiveness of the analysis.

➤ **Question 15.1: Desired future professional development activities**

The proportions of positive answers to all the nine topics are shown altogether in Figure 44.

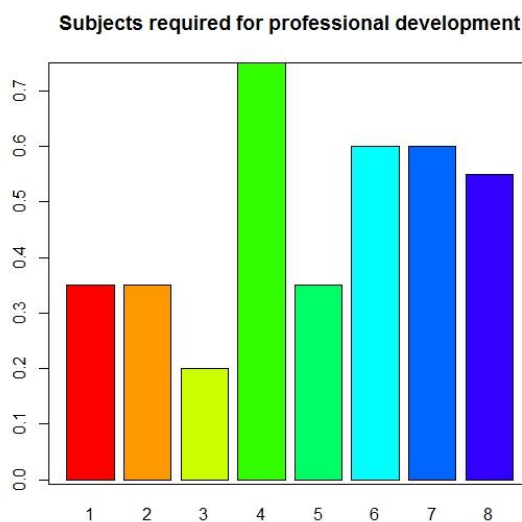


**Figure 44: Proportions of positive answers for questions 15.1**

Topics 4 and 5 are judged less interesting, while topic 8 is far more appreciated than the global case.

➤ **Question 15.2: Topics teachers would like to be the object of professional development**

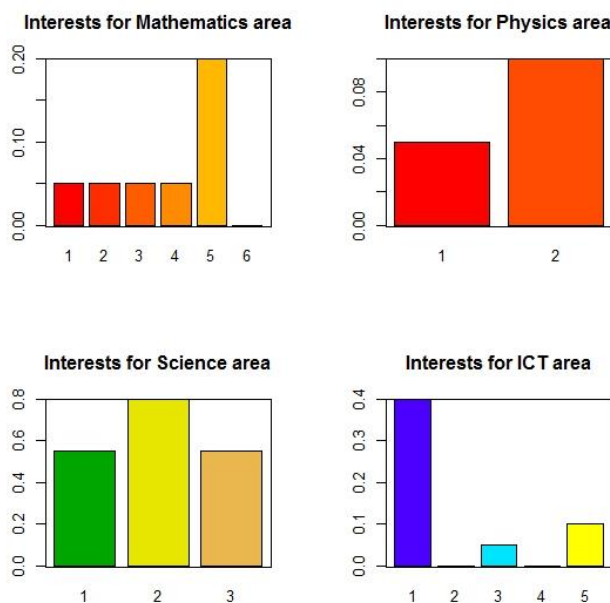
The proportions of positive answers to all the eight topics are shown altogether in Figure 45.



**Figure 45: Proportions of positive answers for questions 15.2**

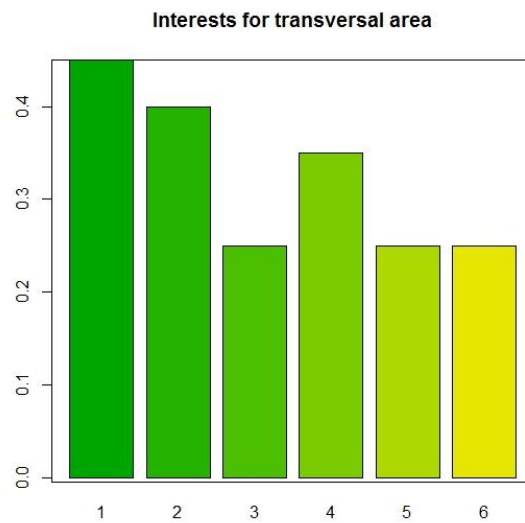
Questions 2, 6, 7 and 8 have a higher proportion of positive answers, while these teachers are less interested in training on the use of ICT and on teaching to students with special needs.

In Figure 46 the proportions of teachers that were interested in the training actions for the Mathematics, Physics, Science and ICT areas are shown.



**Figure 46: Proportions of positive answers for questions 16 – first four subjects**

There is a clear preference for the topics concerning Science area and also a clear interest in the use of e-learning platform.



**Figure 47: Proportions of positive answers for Cross-curricular area**

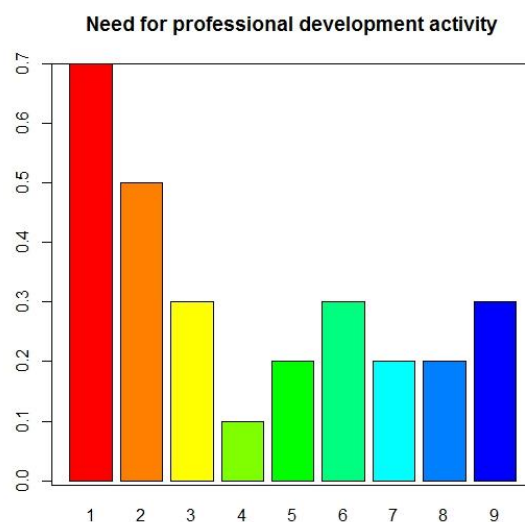
These teachers prefer topics related to creativity and innovation and to project management techniques.

### 8.5 Training needs for teachers with a degree in Geological Sciences

This analysis is purely descriptive since the sample size is limited to 10 cases.

#### ➤ Question 15.1: Desired future professional development activities

The proportions of positive answers to all the nine topics are shown altogether in Figure 48.

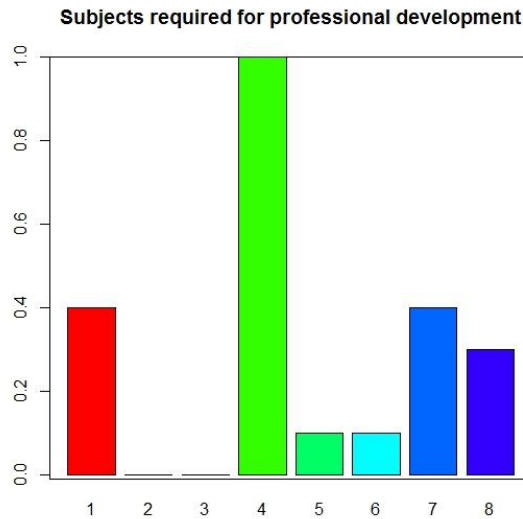


**Figure 48: Proportions of positive answers for questions 15.1**

The topic in which these teachers are most interested is individual research, while only one of them is interested in observation visits in other schools.

➤ **Question 15.2: Topics teachers would like to be the object of professional development**

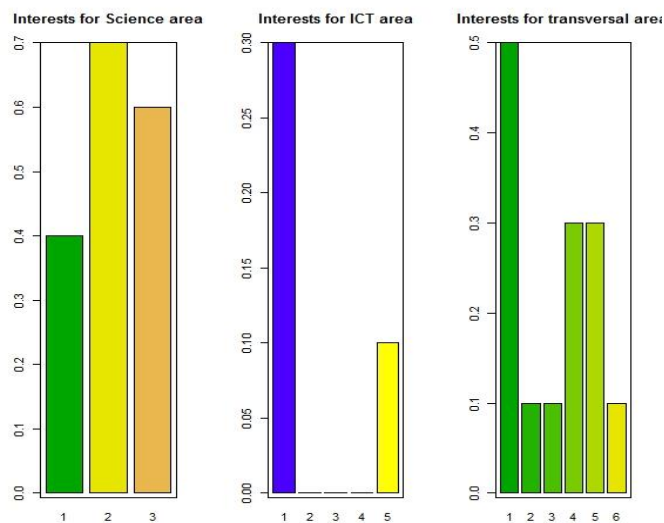
The proportions of positive answers to all the eight topics are shown altogether in Figure 49.



**Figure 49: Proportions of positive answers for questions 15.2**

All these teachers show an interest in the use of innovative technologies while they are not interested in the use of professional SW and of ICT.

In Figure 50 the proportions of teachers that were interested in the training actions for the Mathematics, Physics, Science and ICT areas are shown.



**Figure 50: Proportions of positive answers for questions 16**

No one was interested in Mathematics and Physics area as well as in some of the ICT topics proposed.

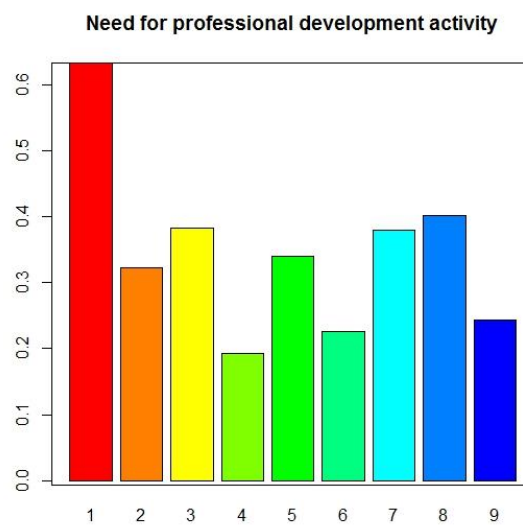
## 7. Training needs depending on the type of school

A last analysis concerns the answers to Questions 15 and 16 splitting the teachers on the basis of the type of school to ascertain whether this factor can produce relevant discrepancies in their training needs.

### 9.1 Training needs for teachers in Lycée

#### ➤ Question 15.1: Desired future professional development activities

The proportions of positive answers to all the nine topics are shown altogether in Figure 52.

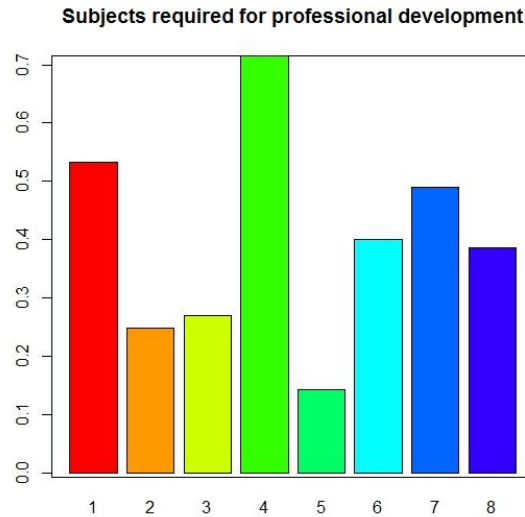


**Figure 52: Proportions of positive answers for questions 15.1**

There is no relevant difference with respect to the overall behavior.

#### ➤ Question 15.2: Topics teachers would like to be the object of professional development

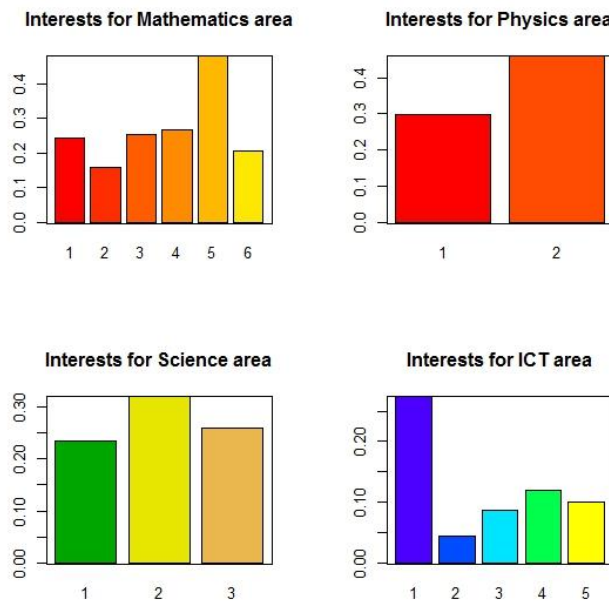
The proportions of positive answers to all the eight topics are shown altogether in Figure 53.



**Figure 53: Proportions of positive answers for questions 15.2**

The behavior is analogous to the overall case also for this set of questions.

In Figure 54 the proportions of teachers that were interested in the training actions for the Mathematics, Physics, Science and ICT areas are shown.

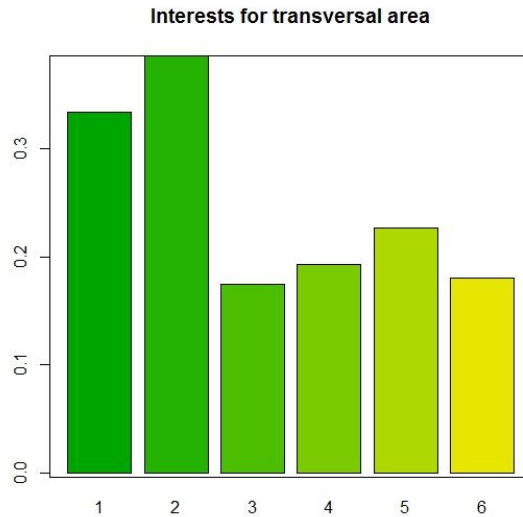


**Figure 54: Proportions of positive answers for questions 16 – first four subjects**

There is a slightly lower interest in the use of SW of graphical representation, a higher interest for problem posing and solving and for Science area and a lower one for ICT area.

In figure 55 the proportions of positive answers concerning cross-sectional area topics are shown.





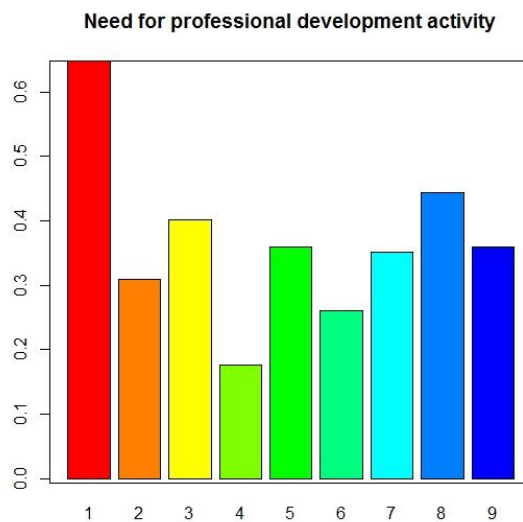
**Figure 55: Proportions of positive answers for Cross-curricular area**

Here again there is no relevant difference with respect to the global case,

## 9.2 Training needs for teachers in Technical high schools

### ➤ Question 15.1: Desired future professional development activities

The proportions of positive answers to all the nine topics are shown altogether in Figure 56.

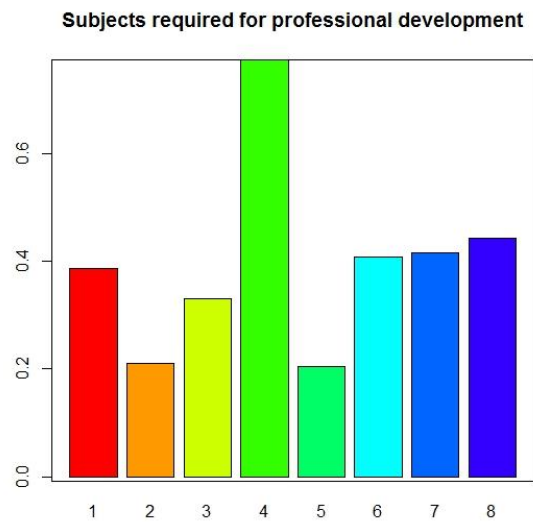


**Figure 56: Frequencies of positive answers for questions 15.1**

The distribution of positive answers is quite similar to the general one.

### ➤ Question 15.2: Topics teachers would like to be the object of professional development

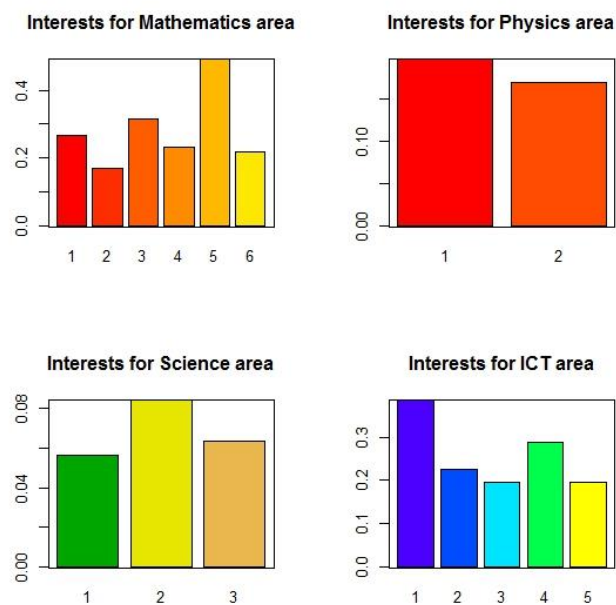
The proportions of positive answers to all the eight topics are shown altogether in Figure 57.



**Figure 57: Proportions of positive answers for questions 15.2**

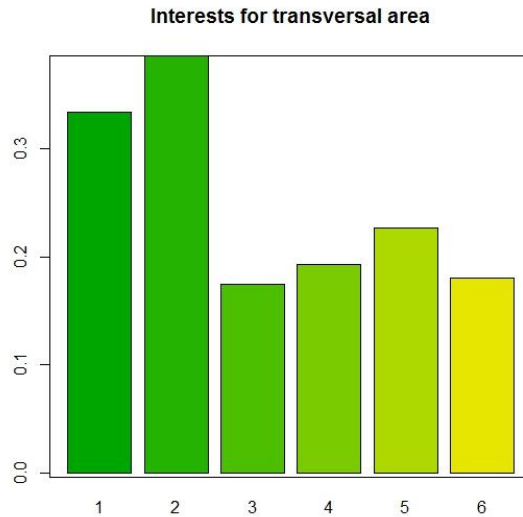
Only the proportion of positive answers to question 7, concerning the production of multimedia and online teaching materials, is less relevant.

In Figure 58 the proportions of teachers that were interested in the training actions for the Mathematics, Physics, Science and ICT areas are shown.



**Figure 58: Proportions of positive answers for questions 16 – first four subjects**

It appears that teachers are less interested in topics concerning problem posing and solving (question 5 in Mathematics area).



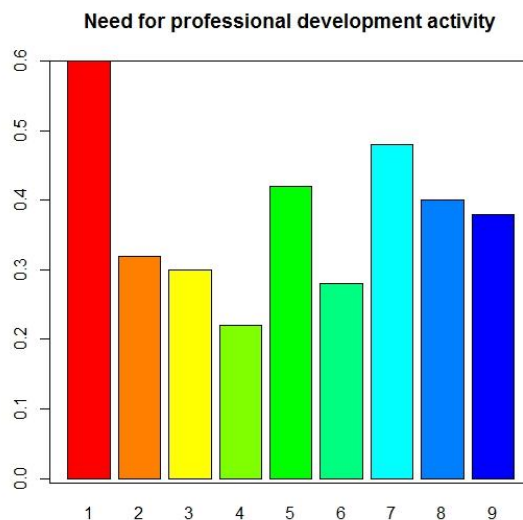
**Figure 59: Proportions of positive answers for Cross-curricular area**

The interest in topics for the area is not different with respect to the global case.

### 9.3 Training needs for teachers in vocational high schools

#### ➤ Question 15.1: Desired future professional development activities

The proportions of positive answers to all the nine topics are shown altogether in Figure 60.

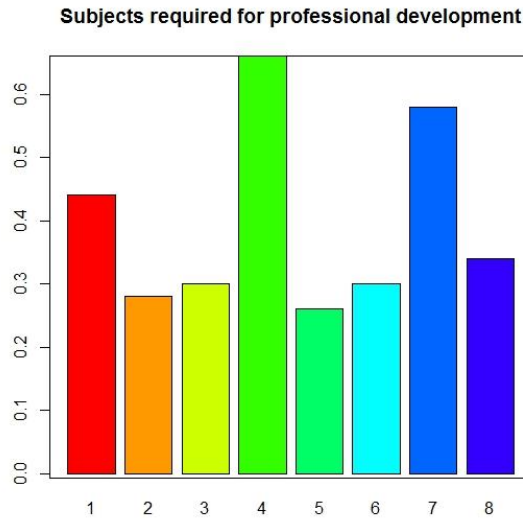


**Figure 60: Proportions of positive answers for questions 15.1**

Topics 3, 5 and 7 seem to be more preferred; they concern observation visits to other schools, online courses and training practice with other colleagues.

➤ **Question 15.2: Topics teachers would like to be the object of professional development**

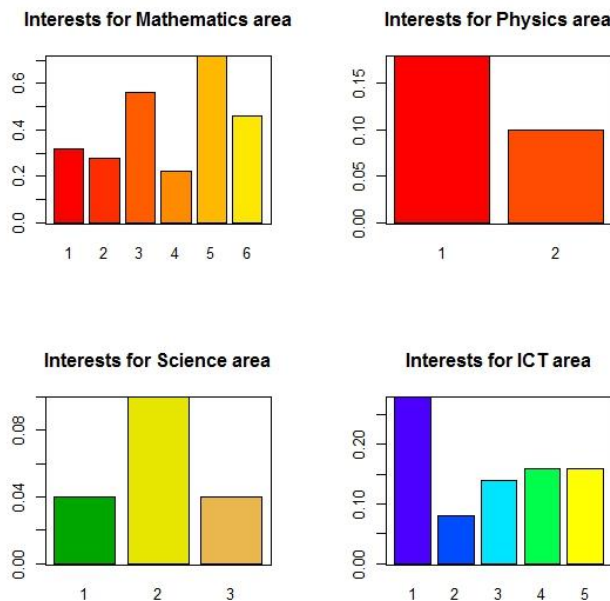
The proportions of positive answers to all the eight topics are shown altogether in Figure 61.



**Figure 61: Proportions of positive answers for questions 15.2**

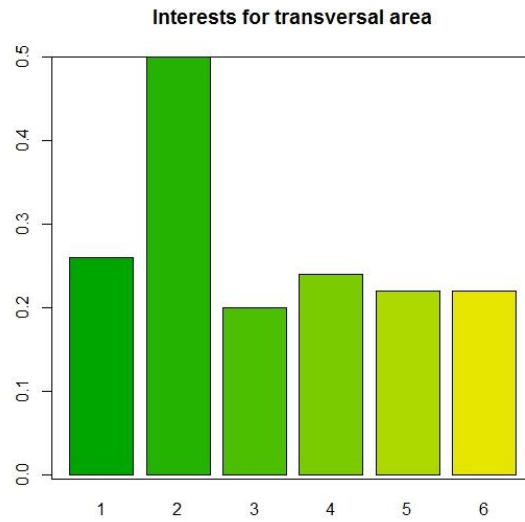
The proportions are somehow different with respect to the global case, especially for topics 6 for which the proportion is reduced and for topics 5 and 7 where it is enhanced.

In Figure 62 the proportions of teachers that were interested in the training actions for the Mathematics, Physics, Science and ICT areas are shown.



**Figure 62: Proportions of positive answers for questions 16 – first four subjects**

The interest for topics 3, 5 and 6 in the Mathematics area is greater while the interest for Physics and Science area is highly reduced.



**Figure 63: Proportions of positive answers for Cross-curricular area**

The only difference with respect to the global situation is a greater interest in competence evaluation and assessment.