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National "Draw a Person Doing Science" survey: Development perspectives

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Summary. — The perception of science and scientists plays a crucial role in shaping attitudes toward STEM disciplines. In particular, prospective primary school teachers' views on science can significantly influence how they introduce scientific concepts to primary school pupils, either fostering interest or reinforcing stereotypes. This study, conducted within the AgoràLAB project and through the collaboration of three research groups in physics education from the Universities of Calabria, Naples, and Palermo, investigates the mental representations of scientists among students enrolled in the Italian *Primary Education Sciences* program. In this paper, we present a preliminary analysis of 290 drawings. The first preliminary results highlight the persistence of several stereotypical representations. A significant gender disparity emerges in the drawings, reinforcing the traditional association of science with male figures. This trend appears even more pronounced when compared to our previous study conducted with primary school pupils (published in 2023), where 70% of young primary school girls depicted female scientists, compared to only 52% of prospective female teachers involved in this study. Beyond the gender issue, this paper also proposes other interesting analyses and highlights the presence of typical elements that characterise the figure of scientists, typically wearing lab coats and working indoor, usually in a laboratory where there are test tubes. By contrast, most of prospective primary teachers depicted scientists as young (37%) or middle-aged (34%) persons, while only 16% drew elderly figures, differing from the classic "old scientist" stereotype. Finally, absence in the drawings of digital tools, such as computers, smartphones, or tablets, despite their widespread use in modern scientific research, suggests a disconnection between the reality of contemporary science and the perception of prospective teachers, highlighting the need for greater integration of digital literacy in teacher training programs.

1. – Introduction

In today's technological era, where scientific progress shapes our daily lives, scientific literacy (SL) plays a crucial role in preparing society to face global challenges [1-3] and represents a cornerstone of lifelong learning [4]. Scientific Literacy enables individuals to evaluate the implications of scientific progress for daily life, society, and the environment, fostering informed and sustainability-oriented citizenship. SL is not limited to understanding scientific concepts; it also requires the ability to critically evaluate information, make informed decisions, and actively participate in public discussions [5-8]. From this perspective, it is more appropriate to introduce the concept of Civic Scientific Literacy (CSL) [7], which represents "a cornerstone of informed public policy" [9].

Promoting SL among prospective primary school teachers is therefore crucial: they will help future generations to become familiar with scientific principles and also to contribute meaningfully to a science-driven society. SL in teacher education goes beyond the acquisition of theoretical knowledge [10]; it encourages exploration, critical thinking, and the use of interactive teaching methodologies, with a particular emphasis on actively engaging students in constructing scientific knowledge [11, 12].

However, the perception of science and scientists among prospective primary school teachers may influence how they will foster pupils' scientific understanding. A positive view of science, seen as an accessible, dynamic, and stimulating discipline, can foster a proactive attitude toward teaching STEM (Science, Technology, Engineering, Mathematics) subjects. Conversely, negative perceptions or stereotypes can hinder SL in primary education. For example, negative stereotypes associated to gender in science may support a perception of scientific and technological subjects (STEM) as a male domain [13-15] thus discouraging girls in studying STEM and implicitly guiding them towards courses and careers with higher female participation [16].

Therefore, investigating the perception of science and scientists among students enrolled in the Primary Education Sciences program is of strategic importance to understand how they will teach science and what strategies they may adopt to foster a positive attitude toward STEM in their future pupils.

2. – The use of "Draw a Scientist Test" (DAST) in the Italian context

Understanding the perception among science of primary school children is crucial, because, at this stage, fostering an inclusive and accurate representation of science is essential for building a scientifically literate and civically engaged society. Early exposure to non-stereotypical images of scientists can help break down biases, encourage curiosity, and inspire all students to see themselves as active participants in the scientific community, regardless of gender or background. Research on this topic dates back to the 1950s, Mead Métraux [17] first documented high school students' stereotypical image of scientists, typically portrayed as elderly men in lab coats, wearing eyeglasses, and engaged in sometime dangerous experiments. To systematically investigate these perceptions, Chambers [18] developed the *Draw A Scientist Test* (DAST), a widely used tool for assessing the preconceptions and stereotypes that children associate with scientists. Many studies conducted after the DAST test revealed a common view of scientists as a white male, wearing a lab coat while performing experiments [19-22]. Comparable results emerged in our previous study with Italian children presented at national conference CooFIS23 (*i.e.*, the national conference of the "Italian Coordination Committee for Physics Education and History of Physics") in Naples. In this study we slightly revised

the DAST from Chambers' original formulation to adapt it to the Italian context and we used it to assess children's drawing. Further details on the theoretical background and methodology are available in ref. [23].

Several studies consistently highlighted a persistent gender bias in children's perceptions, representing science predominantly associated with male figures [24-26]. Starting from such studies, in our previous work, we addressed this issue by developing a revised version of the DAST within the AgoràLAB project at the University of Calabria, in collaboration with the GEO inter-university research centre. The traditional instruction "Draw a Scientist" was reworded to avoid gendered connotations, given that the standard Italian translation of the word "Scientist" ("Scienziato") is often interpreted as male. To foster a more inclusive and unbiased gender representation of scientists among primary school children, we changed the instruction to "Draw a Person Doing Science", that in Italian is translated with "Disegna una Persona che Fa Scienza" (the Italian instruction explains the acronym DPFS). In 2023 we presented the analysis of almost 1200 drawings performed by primary school pupils of different Italian cities (from north to south), who were asked to depict a person doing science at work, incorporating a caption where the scientist describes their activity.

Additionally, pupils were asked to provide explicit information about their drawings, including the scientist's perceived gender, workplace, and tasks, while anonymous data on their parents' education and employment were collected to assess potential socio-cultural influences.

The analysis, fully reported in [23], confirmed the persistence of well-documented stereotypes about scientists. The majority of the enrolled Italian primary school pupils depicted scientists as male figures working indoors in a laboratory, aligning with the classical representations identified by Mead *et al.* and Chambers [17,18]. However, unlike the traditional stereotype of an elderly, balding scientist, many children portrayed middle-aged individuals with neat hairstyles, such as a chignon. These findings highlight both the persistence and the evolving nature of scientific stereotypes among young students.

3. – DPFS and primary teacher education

As summarized in the previous sections, international literature has highlighted and stressed that understanding children's perceptions of science is crucial for shaping early attitudes toward STEM disciplines. The DPFS relies on the intuitive assumption that such a stereotypical image of scientists may discourage students from pursuing a career in science [21, 24, 27-29]. In this study we started from a different perspective, focusing on teachers because they play a pivotal role in shaping students' conceptual understanding and attitudes toward science from an early age. Their implicit biases, personal perceptions, and engagement with scientific subjects can significantly influence how they present science in the classroom and, consequently, how their pupils perceive and interact with scientific concepts.

There are few studies investigating teachers' view about scientists using DPFS. Recently, the DPFS task was proposed to a sample of 625 undergraduate students from six different programmes for prospective teachers [30]. The analysis of the drawings showed that the participants focused more on the scientist's appearance and work than on the workplace [30]. However, the lack of studies applying DPFS to future primary teachers in other national contexts, teaching areas, and school levels calls for further research. To our knowledge, no such study has been carried out in Italy. For this reason, we extended DPFS to prospective primary teachers enrolled in the Primary Education Sciences (PES)

programs at the Universities of Calabria and Palermo. These students, as future educators, will be responsible for introducing scientific concepts to young learners, and their perceptions of science can either facilitate or hinder the development of scientific literacy in their classrooms. A positive and inclusive view of science, perceived as accessible, dynamic, and engaging discipline, can foster a proactive approach to teaching STEM subjects. On the other hand, if prospective teachers hold stereotypical or negative view of science, perceived as distant, difficult, or influenced by gender biases, such perceptions may unconsciously be transmitted to their pupils, reinforcing existing stereotypes and reducing children's interest and involvement in scientific subjects.

Investigating the perception of science among future teachers is therefore a strategic step in understanding how they will approach science education and what strategies they may adopt to foster a positive and unbiased view of STEM disciplines in their future classrooms. By analysing the drawings produced by students of the PES program using the DPFS framework, it is possible to explore whether they exhibit persistent stereotypes about scientists like their young pupils, or whether their advanced education and pedagogical training influence their conceptualization of science and scientific roles.

In particular in this study, we focused on the following Research Questions:

RQ1) Which kind of stereotyped views about scientists emerge from prospective primary teachers?

RQ2) Is it possible to explore whether prospective primary teachers exhibit stereotypes about scientists like their young pupils?

Our research is still ongoing, and a significant number of additional drawings are expected to be collected during the second semester of the 2024/25 academic year (the expectation is to reach and possibly exceed approximately 1000 drawings).

In this paper, we present a preliminary analysis based on data collected and analysed during 2023/2024 (290 drawings) at the University of Calabria as part of a master's degree thesis in PES([1]). This preliminary analysis was necessary to validate the protocol of analysis (described in our previous paper, *i.e.*, [23]) in the case of PES students. This protocol will be the base to develop future studies on DPFS involving a larger sample.

Furthermore, this preliminary study will provide an insightful first look into how prospective primary school teachers perceive scientists. Understanding these perceptions can promote specifically designed actions aimed to increase prospective educators' awareness of the effect of stereotypes associated to scientists and, also, to support future teachers in developing educational activities specifically designed to fight this kind of stereotypes in their students'.

4. – Context and methodology of the study

Sample. – This study has been conducted by three research group in physics education from the Universities of Calabria, Naples, and Palermo, collecting data over the last three academic years (from 2022/23 to present). Participants were third-year students in PES([2]) at the University of Calabria and Palermo.

PES degree courses are structured in five year, during which students attend courses from psychological, pedagogical, humanistic and scientific areas. In particular, students

([1]) This research project, completed within the framework of a graduation thesis, was defended in December 2024.

([2]) This kind of degree is necessary, in Italy, to teach in primary schools.

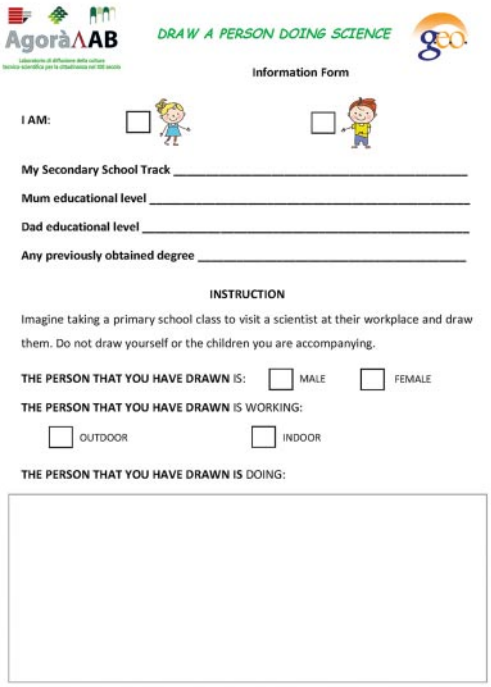

Fig. 1. – The figure shows the "Information Form" used with prospective primary school teachers enrolled in the PES program: the first part of the form offers the opportunity to fill in some anonymous information about students and their parents (the education levels and the employments); the second part permits to collect additional information about the drawn person (the gender, the workplace, the activities that the scientist is doing).

have to attend at least one course in Physics Education. According to national data [31] about 94% of student attending PES are female students, this percentage is consistent with the gender composition of the PES sample analysed in this paper. Furthermore, this gender composition of our sample is coherent with in-service gender composition as reported by data from Italian Ministry for Education.

The socio-economic background of PES students was also similar across the two universities.

Instruments and methods. – Before starting this study, approval was obtained from the University of Calabria's Ethics Committee.

We collected data submitting to PES students a paper-based task (fig. 1), similar to the one introduced in our previous study [23]. Students were asked to draw a person working in STEM areas and to answer, anonymously, to some questions about their background and the drawing they made.

Data were collected during Physics Education lessons by researchers who were not the course instructors. Students were informed about the aims of the study, assured that participation was voluntary, and told it had no impact on their exams.

The analysis of drawings has been based on the protocol of analysis described in detail in our previous work [23], developed starting from the original rubric introduced by Chambers [18], later refined by Finson, Beaver, and Cramond [32], as well as by Ferguson and Lezotte [24]. Additionally, we have incorporated in the rubric the classification of scientists' job.

The analysis was conducted by recording the characteristics of each drawing into an Excel-based rubric, described in details in our previous work [23], where a) each row represents a PES student and b) each column corresponds to a specific binary feature.

The protocol used for analysing the drawings performed by PES students is the same that we used to analyse the representation proposed by primary school pupils. As described in detail in our previous paper, the analysis was conducted using a series of indicators, including graphic characteristics, author and family attributes, work environment features, and inferred personality traits. To facilitate subsequent analysis using Machine Learning techniques, all indicators were binarized also in this analysis, transforming them into a larger set of binary features. Readers interested in a more comprehensive description of the methodology are referred to our previous work [23].

Two of the authors independently analysed the drawings using the rubrics proposed by Sapia *et al.* [23]. To answer to our RQ1 and RQ2 we adopted descriptive statistics and qualitative analysis to understand the main characteristics of the depicted scientists and their relation to the gender of the authors.

5. – Results and discussion

A first interesting outcome emerges by fig. 2, showing the correlation between the gender of PES students (Male or Female Author of the drawing, respectively indicated with MA and FA) and the gender of the Scientists (Male or Female Scientist, respectively indicated with MS and FS). Figure 2 highlights a notable asymmetry in gender representation. Although the small number of male participants does not offer the opportunity to make inferences, a significant finding is that 48.4% of female PES students depicted male scientists. This confirms the persistence of gender stereotypes among female prospective teachers, consistent with previous literature, and it is particularly significant in the Italian context because the gender composition of our sample is representative of the Italian gender distribution of in-service primary teaches.

This disparity in gender representation observed in the drawings of prospective primary school teachers becomes even more significant when compared to the findings of our previous study [23] regarding primary school pupils (fig. 3). Children tended to depict scientists of their own gender. However, a key difference emerged between male and female pupils: 94% of primary school boys drew male scientists, while only 6% represented female scientists. In contrast, 70% of primary school girls depicted female scientists, while 30% chose to illustrate male scientists. These findings already highlighted a gender-related issue, aligning with previous researches [24], which have shown that while male students strongly associate science with their own gender, a significant proportion of female students do not make the same association with scientists of their own gender. Instead, many female pupils still depict scientists as male figures, reflecting broader influences that associate STEM fields with men. The data collected from students enrolled in the PES program (in the 2022/23 and 2023/24 academic years) show that this trend becomes even more pronounced (fig. 3 summarizes the differences among the two enrolled samples). The small male sample (6%) limits comparisons, though 88% drew male scientists, consistent with primary school pupils, as the majority PES male

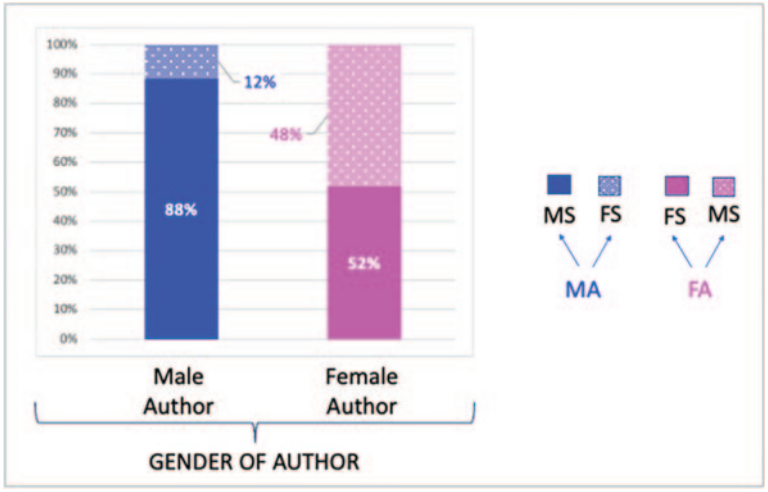

Fig. 2. – The figure illustrates the relationship between the gender of the author of the drawing (*i.e.*, Male or Female Author, respectively indicated with MA and FA) and the gender of the drawn Scientist (*i.e.*, Male or Female Scientist, respectively indicated with MS and FS).

participants (88%) depicted male scientists (88% of them). The number of drawings produced by PES female students puts in evidence an important shift: while 70% of primary female pupils drew female scientists, only 52% of PES female students drew scientists of their own gender. In other words, while primary school girls already showed a tendency to perceive science as a male-dominated field (since 30% of them still drew male scientists despite being female themselves), this perception becomes even more pronounced among female prospective teachers, where nearly half of them depicted male scientists.

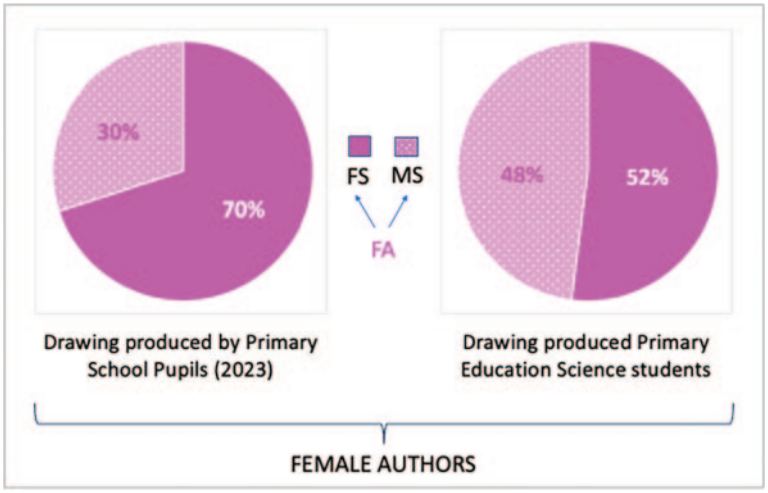

Fig. 3. – The figure illustrates the relationship between the gender of the female author of the drawing (indicated with FA) and the gender of the Scientist (*i.e.*, Male or Female Scientist, respectively indicated with MS and FS).

This trend is particularly concerning because it suggests that, rather than decreasing over time, the association of science with male figures remains strong even among those who are training to become teachers. The shift from 70% to 52% in self-representation among female participants seems to highlight how, as students advance in their educational journey, the internalization of gendered perceptions of science seems to grow rather than decrease. This issue is critical, as primary school teachers play a fundamental role in shaping children's early perceptions of science. If they do not see female scientists as a natural and frequent representation in their own drawings, they may unknowingly reinforce this stereotype in the way they present scientific subjects in the classroom. Their implicit biases may influence their teaching style, the examples they use, and the role models they highlight, ultimately affecting the aspirations and self-perception of their students.

A second key aspect of our analysis concerns the perception of the scientist's workplace, specifically whether people doing science are depicted as working indoors or outdoors. Figure 4 presents the distribution of workplace representations found in the drawings of PES students. The results indicate that 83% of the scientists drawn by prospective primary school teachers are shown working in an indoor environment, typically a laboratory. In contrast, only 6% of the drawings represent scientists working outdoors, while 11% of the participants did not explicitly classify the workplace of their depicted scientist.

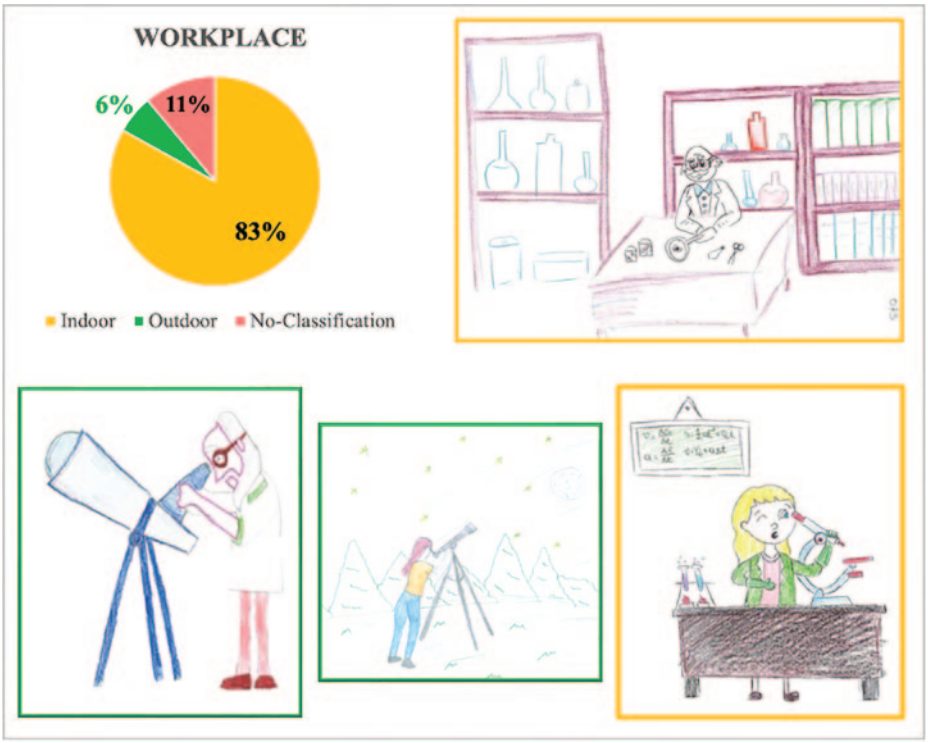

Fig. 4. – The figure illustrates the distribution of PES students' answers regarding the workplace (*i.e.*, indoor or outdoor) of represented scientists and some examples of the drawn scientists.

These findings reveal a strong tendency to associate scientific work with indoor environments, reinforcing a traditional and somewhat stereotypical image of scientists as individuals primarily engaged in laboratory research. This perception appears more considerable if compared to the findings arising from our previous study conducted with primary school pupils. In fact, our previous work showed that 77% of the children represented scientists working in indoor settings, while 18% illustrated scientists working outdoors, and 5% did not specify a workplace. This means that, although the majority of children also associated scientific work with indoor environments, the proportion of outdoor representations was noticeably higher among pupils than among PES teachers.

This stereotype, widely reported in the literature [17,18], appears even stronger among PES students than among primary pupils, suggesting that advancing through education does not broaden but narrows perceptions of scientific work that is even more confined to laboratory environments.

Another key aspect analysed in this study is the perceived age of the scientists depicted in the drawings of PES students (fig. 5). The data reveal that 37% of students represents young scientists, 34% draws middle-aged persons, and only 16% depicts elderly. Thus, the traditional "elderly scientist" stereotype [17,18] is less prominent. These results align with our previous study, where primary pupils also drew younger scientists, suggesting that contemporary influences (such as increased visibility of younger scientists in the media, education, and public debate) may be shifting perceptions of scientific careers.

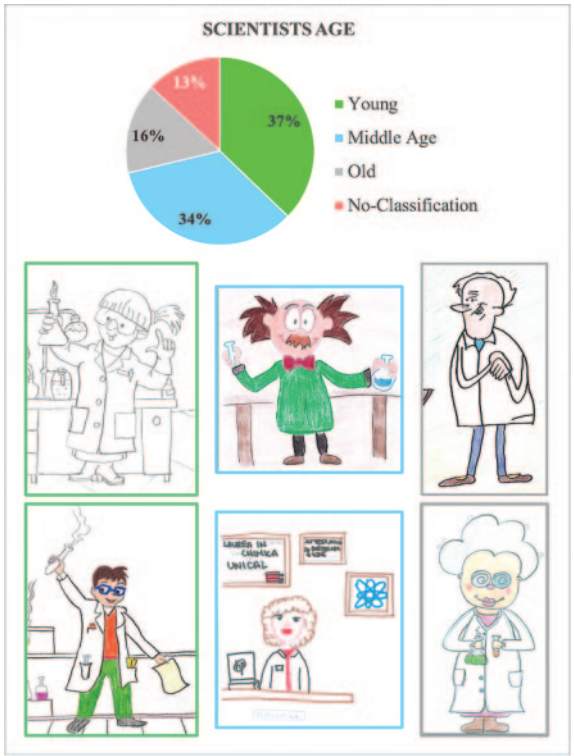

Fig. 5. – The figure illustrates the distribution of PES students' answers regarding the age of scientists and some examples of the drawn scientists.

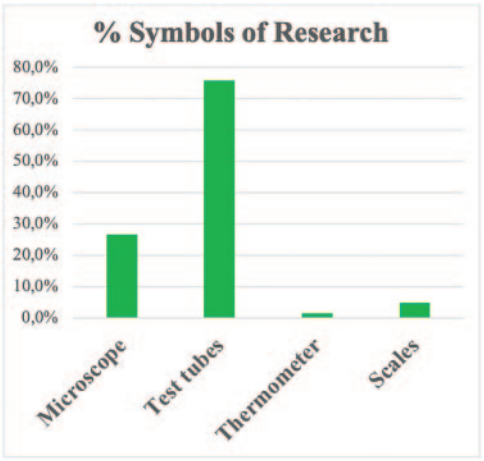

Fig. 6. – The figure illustrates symbols of research depicted by PES students. It is possible to observe mainly the presence of test tubes (76%) and microscope (27%).

Beyond gender, workplace, and age, the last crucial aspect of our analysis concerns the presence of characteristic elements in the drawings, which can further reveal how prospective teachers conceptualize the scientific careers.

One of the most prominent features is the scientist's clothes. The data show that 77% of the PES students depicted scientists wearing a lab coat, reinforcing the traditional association between scientific work and laboratory environments. Additionally, 53% of the drawings included scientists wearing eyeglasses, another stereotypical element often linked to the image of intellectuals and researchers [18, 24, 32].

An important part of the analysis regarding the characteristic elements, focuses on symbols of research and knowledge [18, 24, 32], which help us understand how scientific work is visually represented. Regarding the symbols of research (fig. 6), the presence of

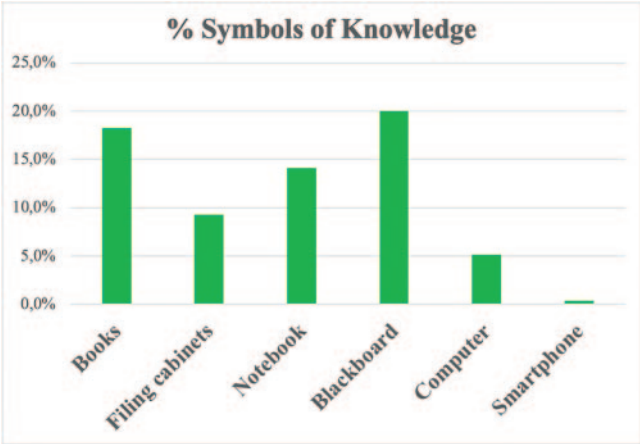

Fig. 7. – The figure illustrates symbols of knowledge depicted by PES students. It is possible to observe mainly the presence of books (18%), notebook (14%) and blackboard (20%).

test tubes is particularly striking, appearing in 76% of the drawings, while microscopes are featured in 27% of them. This strong emphasis on laboratory equipment further confirms the dominant perception of science as an experimental discipline mainly conducted indoors.

As regards the symbols of knowledge [18,24,32], some elements such books and blackboards are presented in significantly lower percentage of drawings (fig. 7). It seems that science is more strongly associated with experimental works rather than with theoretical studies and/or intellectual inquiry.

A particularly surprising finding is related to the almost complete absence in the drawings of widely used technological tools, such as computers, smartphones, and tablets. Considering the prevalence of these devices in everyday life and their essential role in modern scientific researches, their exclusion from the depictions of scientists suggests a disconnection between digital technologies and scientific works in the perception of PES students. This may indicate that, despite the integration of digital tools in many fields of science, they are not yet widely recognized as fundamental components of scientific activities by those who are preparing to become teachers.

6. – Conclusions

The preliminary findings presented in this study provide significant insights into how prospective primary school teachers perceive scientists, revealing the persistence of several stereotypical elements that could influence the way they later introduce science to young primary school pupils (RQ1). One of the most striking results is the gender representation observed in the drawings, considering the high percentage (48.4%) of female PES students illustrating male scientists. This highlights a deeply rooted stereotype that persists even among students belonging to the degree courses in Primary education Sciences, reinforcing the traditional association of science with male figures. This gender disparity is concerning because primary teachers play a key role in shaping children's early views of science. If their own personal representations of scientists remain predominantly associated with male people, these biases may be unconsciously transmitted to their pupils, perpetuating the idea that scientific careers are not appropriate for female students. The comparison with our previous work [23] further emphasizes this issue: while 70% of young primary school girls in that study depicted female scientists, only 52% of female PES teachers did the same (RQ2). This shift suggests that students internalize a more male-centered image of science while progressing their careers rather than moving toward a more balanced perception.

Our preliminary results seem to suggest the urgent need to address gender stereotypes within primary teachers' education programs. Encouraging PES students to reflect on their own perceptions and exposing them to different and inclusive representations of science and scientists can help address this gender bias in STEM disciplines, encouraging all students to pursue scientific careers, regardless of gender.

Beyond gender representation, our study also highlights another well-known stereotype. Most of PES students (83%) drew scientists working indoors, mainly in laboratories, while only 6% represented outdoor scientific activities. This trend is even more pronounced than in our previous study, where 77% of primary school pupils associated science with indoor environments, and 18% acknowledged outdoor scientific work. The overemphasis on laboratory-based science suggests that PES students may unconsciously reinforce the idea that science happens exclusively indoors, neglecting disciplines that involve fieldwork, environmental exploration and direct engagement with nature. It is

important to face this idea, promoting teachers' training programs that should highlight a broader range of scientific disciplines, ensuring that young pupils will be exposed in the future to a more comprehensive and realistic vision of STEM careers.

An encouraging finding arises from the analysis of the age of the drawn scientists. The enrolled prospective teachers confirm the results discussed in our previous work, proposed by primary school pupils regarding the age of the scientists. In fact, PES students largely represented scientists as young or middle-aged individuals, challenging the outdated stereotype of the elderly man doing science.

Finally, the absence of digital tools in the drawings highlights a disconnection between modern scientific works and the perception of PES students. Despite the widespread use of computers, smartphones, and tablets in contemporary society, these tools were almost entirely missing from the representations of scientists. This suggests that digital technology is not yet widely recognized as an integral part of scientific practices by those who are studying to become teachers. Addressing this disconnection through the integration of digital literacy into teachers' training programs could help bridge this gap, ensuring that young pupils will be exposed to a more accurate and modern vision of the scientific profession in their future school career.

7. – Limits of this study

The main limitation of this study lies in the engagement of a convenience sample, restricted to PES students from the universities where the authors work. This means that even if gender composition of our sample is representative of national PES students and of in-service primary school teachers, there should be differences for example in socio-economic backgrounds between PES students from different geographical zones, for example students from northern part of Italy and students in our sample that limit the generalizability of our results. For this reason, in the future we will try to involve in our study PES students from other Italian Universities.

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