The Art of Science Learning

WP4 Assessment Analysis of Goal 4
Barcelona Case Study

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BARCELONA CASE STUDY
GOAL 4: RRI VALUES

General Framework of Analysis

As a way to explore how the workshops approached Goal 4 (i.e., including RR values in the participatory learning process and boosting motivations towards science), we focus on three different aspects of **RRI values: i) inclusiveness, ii) engagement,** and **iii) ethics integration.** We also analyze **students' general perceptions and attitudes towards science before and after the workshops** in order to contextualize our analysis and identify potential changes resulting from students participation in the project. **Gender** is included as a variable of analysis along all these aspects.

We conceptualise **inclusiveness** here as the capacity of the learning process to reach diverse students' profiles and learning styles. This has been approached through three criteria: i) balanced participation, as the inclusiveness and involvement of all students, making sure that each one has the opportunity to contribute to the process in an active way; ii) fostering dialogue, as the capacity of the process to build learning upon students' mutual exchange of ideas and opinions so as to integrate different perspectives and work together; and iii) students' acceptance of process/ outcomes, as the degree to which participants accept and feel ownership of the different learning outcomes and processes involved in the activity. Furthermore, although a gender perspective has been transversally addressed in all the evaluated aspects, we have also included in this section some specific items related to: i) gender balance in participation, that is, participation differences according to gender and ii) gender differences in students' engagement, reactions to the methods and topics proposed and interactions among them.

We understand **engagement** as the capacity of the process to foster students' active involvement in science and scientific research. We have approached this both as i) e*motional engagement,* that is, students' *a*ctive involvement in the activity or project, related to intrinsic motivation, affective reasons and/or interest; and ii) c*ognitive engagement,* as students' *s*ustained, engaged attention during a task or process requiring mental effort. We also refer here to RRI values, such as, critical thinking, as students' ability to actively conceptualise, analyse, apply and evaluate information and knowledge.

We consider as **ethics integration** the capacity of the learning process to address ethical aspects of science and research and foster reflection with students. Specifically these include: i) *understanding of the nature of science* (NOS) as sharing with students key principles and ideas, which provide a description of science as a way of knowing, and the characteristics of scientific knowledge; ii) the *social relevance of the topics addressed*, that is, the degree to which the scientific issues approached are connected to relevant broader social contexts and challenges; and iii) *connecting scientific topics with values*, that is, the identification and exploration of the diverse values and normative aspects behind scientific practice and knowledge.

Finally, our analysis is oriented towards exploring to which extent PERFORM workshops facilitated learning spaces integrating process requirements and fostering learning outcomes

related to these three dimensions of RRI, and what aspects of the design and implementation facilitated or hindered such integration.

Methodological Approach

Following the same approach as in Goal 3, these motivations and RRI values **are explored through** students' inputs provided in the surveys (as a first quantitative approach) and researchers' observations of the workshops complemented by students', teachers' and ECRs' inputs (as a qualitative in-depth approach).

Quantitative approach

We first collected quantitative data through **a questionnaire implemented twice**: 1) **before the realization of the workshops** (Pre-PERSEIA survey) and 2) **after the workshops** (Post-PERSEIA survey). In order to evaluate whether students' answers were specific to the PERFORM group, we also conducted these questionnaires (pre- and post-PERSEIA) among a group of students who did not attend to the workshops: the control group. In total, the **PERFORM group was composed by 54 students** (**33 students in Terrassa and in 21 students in Castellbisbal**) and the control group by 34 students (16 students in Terrassa and in 18 students in Castellbisbal).

We first analyzed students' answers for both questionnaires (Pre- and Post-PERSEIA) separately by looking at **the percentage of answers reported by students**. In this case, since we were not comparing pre- and post-survey answers, we included the whole PERFORM group (n=**63 students**, 41 from Terrassa and 22 from Castellbisbal). We then compared answers from PERFORM group with answers from the control group by running Wilcoxon Ranking Tests. For PERFORM students, we used the same test to analyze whether there were differences between boys and girls, and between groups of students (as students were divided into two groups in each school). In order to see **whether students' answers changed between the pre and the post surveys, we calculated the variation for every individual answer for each question**. As most of the questions were answered with a scale of agreement (from 1: totally disagree with the statement to 7: totally agree with it, and 4: neutral or indifferent), variation was calculated as follows: "Post Survey Answer – Pre Survey Answer". In that sense, a negative individual variation indicated that students' degree of agreement was lower after the performance of the workshops. Similarly, a positive variation indicated that students agreed more with the statement after the development of the workshops. Finally, we used ordinal logistic regressions to analyse whether such variations were associated to gender and groups, when controlling by the control group. For the sake of clarity, **only statistically significant differences have been reported in this document**[1]. Likewise, specific highlights are present only when the variation of PERFORM students' answers did not follow the same pattern as the control groups. Furthermore, results from statistical analysis showing significant associations should be taken with caution due to the limited sample of the case study.

[1]This means that if no specific interpretation related to group or to sex of the students is included in the text, the trends described were not different according either to the group or the sex of the students.

Qualitative approach

Students' answers have been further explored through learning charts they filled in after each workshop (n=45) and a focus group conducted with a reduced but representative group of students who participated in the workshops (n=10, 6 girls and 4 boys). Finally, in order to explore how the pedagogical context and related factors of the workshops could have integrated RRI process requirements and fostered learning outcomes, we analyse the transcription of our observations during the whole process. To complete such analysis we explore both involved teachers' (n=10) and the ECRs' (n=7) perceptions of the educational process implemented.

For the analysis of inclusiveness, our observations mostly focused on the implementation of the designed activities and their facilitation (to identify process requirements) and on students' performance and participation throughout the workshops. Most specifically, in terms of process requirements we focused on: i) the number of students by sex in the activity; ii) the provision of specific support to students with special needs, if any; iii) the use of students' previous experiences and knowledge in the activity to include them; iv) students' possibility to make choices during the workshops, v) the relationship that the facilitators established with the students; vi) the type of dialogue between students and science communicators, ECRs and teachers and vii) the use of arts-related and ICT methods in the activity to foster dialogue. In terms of students performance we focused on: i) the number of students by sex in the activity; ii) the type of dialectic interactions among students (only in relation to inclusiveness); iii) students' sharing of tasks and roles during the activity (only in terms of inclusiveness and gender); iv) the type of tasks and roles assumed by gender during the activity; and v) students' affective responses by gender during the workshops. We further explored with students in the focus group their perceptions of the process in terms of their capacity to participate and feel included in the group, and the extent to which they could make decisions. The teachers' interview included a question about students' involvement and participation in the process and the attention to students with special needs when making the groups. We also looked for emerging contents related to inclusiveness in students' learning charts and and ECR's interviews.

We analysed students' cognitive engagement in the workshops mainly through observations focused on the capacity of the learning process to foster: i) questioning and reframing, or the promotion of understanding through questions that allowed students complex thinking and the possibility to see the issues approached in new or different ways; ii) systems thinking, or the holistic approach to analysis that considers the interactions between the constituents of a system; iii) connecting topics with experience, or the contextualisation of the issues approached within their broader societal context and connection with participants' experience; and iv) seeking other points of view, or the consideration of different perspectives and points of view in students' discourse. We also collected data on **emotional aspects**, such as i) students' predisposition or tendency to respond positively or negatively towards the methods and topics proposed; ii) students' enjoyment or the feelings of pleasure caused by doing or experiencing the workshops; iii) students' emotional awareness and reflexivity, or student's capacity to identify or express emotions associated with the topics addressed and to reflect upon and through their emotional responses; iv) body and spatial awareness, or students' body

movement and expressiveness, sensual awareness, and relation with the physical space, and v) students' sense of ability to do things and feeling of acceptance as part or member within a group or learning environment. Teachers were also asked about students' engagement in the process and they were asked to evaluate the different activities conducted through the workshops. We also looked for emerging contents related to engagement in students' learning charts, the open questions of the survey (i.e. what they enjoyed the most and the least; what they learnt) and in ECR's interviews.

Finally, **we analysed ethics integration** through the observation of different process requirements during the implementation and facilitation of the workshops that might facilitate the sharing of the human dimension of science (science as a process). Most specifically, we focused on: i) the contextualisation of STEM topics within societal challenges and/or daily life; ii) the inclusion of ECR's personal stories during the activity; iii) the sharing of contrasting perspectives about science; and iv) the encouragement of students' reflection about ethical behaviours in research practice. We also looked at students' interventions related to their understanding of the nature of science (verbalised perceptions) during the workshops and in the focus group. Emerging contents related to ethics integration in students' learning charts and in ECR's interviews were also included.

OVERALL HIGHLIGHTS

Students' perceptions and attitudes towards science

- Overall, **PERFORM students reported contrasting perceptions about their enjoyment of STEM related subjects at school as enjoyable ways to acquire new knowledge, finding significant differences between boys and girls.**

- **Students in Castellbisbal reported feeling more at ease while doing science-related activities**, **whereas students in Terrassa reported contrasting feelings** ranging from "desperate" to "motivated", **without showing a clear pattern**.

- **Workshops did not produce any significant changes on students' perceptions related to the role of science in society**, which they generally perceived as positive, being in Castellbisbal more in agreement.

- **Students responses generally showed a lack of gender-bias in their perception of science** as most of them disagreed that men are better scientists than women and **that scientific careers are mostly for boys,** both before and after the workshops.

- **Students showed contrasting feelings towards the idea of studying a scientific career, some of them felt motivated while others did not agree with the idea.** However, answers suggest that the workshops have, at least in Terrassa, **put on the table the idea of studying a scientific career among boys and girls.**

- **S**tudents in Castellbisbal tended to agree more than in Terrassa with the idea of seeing **themselves doing science in the future** before and after the workshops.

Inclusiveness and gender

- **Overall, students felt positive about their active participation in the project and felt included in the group**: they felt their work was recognised and dialogue had been fostered. Indeed, i**n both schools, facilitators created a relaxed and comfortable atmosphere, which facilitated inclusiveness.** Students and facilitators related in a conversation-like manner, in which students could participate spontaneously and both facilitators were very constructive in their comments and feedback to students.

- **Students were provided with the possibility to make choices through the creation of their monologue** and they generally perceived **they could participate "as they wanted to".**

- **Facilitators commonly built-up on students' previous experiences about the topics -** rather than on their previous knowledge, which was scarce- to enhance inclusiveness, while the **presence of ICT tools to support students' dialogue during the workshops was low or absent.**

- **Some aspects to improve inclusiveness were also identified**. In Castellbisbal students reported they would have liked to have a better sense of the overall organisation from the onset (representations, groups) and their participation in the final performance. In Terrassa, were participation was high, the higher number of students hindered balanced

participation during plenary discussions, as **generally only half of the students participated actively**. A teacher also suggested that **more attention could be paid to include students with learning difficulties and other special needs.**

- **In terms of gender and participation, different dynamics were observed in Castellbisbal and Terrassa.** While in Castellbisbal groups were balanced according to sex and the distribution of tasks did not follow a gendered-pattern, in Terrassa girls were commonly assuming the leadership, concentrating the tasks and performing the main roles in the monologues.

- **Students in Castellbisbal generally showed a less stereotyped approach towards gender in their interventions than students in Terrassa. However, some students in Terrassa reported** broadening their view of science in relation to women discrimination and the role of women, thanks to the project. **They also expressed** the **difficulty to connect gender reflections with the monologues** created (although one of the groups did include it in their PERSEIA). One ECR suggested devoting more time to critically reflect about relevant issues emerging from students' monologues in order to foster such a connection.

Engagement

- **We observed a difference in students' general involvement in both schools.** While in Terrassa it was very high in both groups, showing a constant willingness to participate throughout the sessions, in Castellbisbal one of the groups was generally involved and the other was more reluctant to participate. Teachers in both schools also appreciated the capacity of the project to engage some **students who usually do not participate in academic tasks.**

- **Students generally showed excitement towards the methods proposed.** Such excitement seemed to be **more towards the approach of the project and the fact of doing something different than towards learning science per se,** especially in Terrassa. **In both schools, most of the students reported finding interesting the reflection activities and their participation in the creation of the PERSEIAS**.

- **Regarding the performance of the monologues, students showed a different degree of interest and motivation in performing. In Terrassa, students generally showed more willingness and motivation to perform, as supported as well by their feedback in the surveys. In Castellbisbal more students expressed their concern to perform, specially at the end of the process.**

- **In terms of cognitive engagement,** the workshops **did not seem to reach an optimal cognitive engagement of students.** Students' lack of previous knowledge about some of the scientific topics approached (especially in Terrassa), together with the general lack of time and tools for an in-depth approach of scientific topics or in-depth discussions might have hindered such capacity of the process. The weight of the PERSEIA development allocated to homework did not help either, as students were generally disengaged with it. However, a **progression in students' engagement with work was observed in Terrassa throughout the sessions.**

- Similarly, **the activities on critical thinking and gender** done during the participatory workshops **tended to stay in the workshops without permeating into students PERSEIAs.**

The nature of science: ethics integration

- When asked in the written surveys, **an important number of students showed an awareness of science risks and uncertainties**, despite **contrasting perceptions about science as a process**. In this regard, although the workshops did not seem to have a significant impact, they seemed to reinforce positive trends regarding students' perceptions of the unexpected impacts of research in society, the possibility of failure within science, and the nature of scientific knowledge. Such reinforcement could have a special added value in Terrassa, where **students' interventions' during the sessions suggested little *rapport* with science as a process.**

- **Regarding the integration of social and ethical aspects of research in the activities,** during the workshops **an effort was done in the contextualisation of science and its social relevance, through the contextualisation of STEM topics within societal challenges.**

- **However, the sharing of science as a process remained an aspect to better explore with students** (e.g. showing contrasting perspectives about science, integration of ECR's personal stories in the workshops, fostering reflections about ethical behaviour in science). **The lack of depth in the approach to scientific topics and of specific moments for sharing ECRs experiences** have been identified as aspects hindering such sharing. In this regard, the teachers in Castellbisbal **felt the overall scientific content of the PERFORM was not developed enough and it felt quite superficial at some points.**

IES Santa Eulàlia, Terrassa

STUDENTS' PERCEPTIONS AND ATTITUDES TOWARDS SCIENCE

Main highlights

- Overall, **PERFORM students reported contrasting perceptions about their enjoyment of STEM related subjects at school as enjoyable ways to acquire new knowledge. Informatics seems to be the subject most enjoyed by students, while the other subjects (**Biology and geology, Physics and chemistry, Technology and Maths**) are equally liked and disliked.** However, **those reporting lack of engagement were positioned in the highest degree of disagreement**, **suggesting an important disenchantment of a group of students with these subjects**. Significant differences were also found between boys (enjoying more Technology and Informatics) and girls (enjoying more Biology and geology and Physics and Chemistry).

- **Similarly, students reported contrasting feelings while doing science-related activities**, ranging from "desperate" to "motivated", **without showing a clear pattern**. The workshops did not provoke significant changes in students' answers.

- **Workshops also did not produce any significant changes on students' perceptions related to the role of science in society**, which around half of them perceived as positive.

- **Students responses generally showed a lack of gender-bias in their perception of science** as most of them disagreed that men are better scientists than women and **that scientific careers are mostly for boys,** both before and after the workshops. However, significant differences were found between boys and girls' answers, being boys the only ones who agreed with the statement. In the case of "men being better scientists than women", these differences according to sex remained after the workshops.

- **In general there is not a clear pattern in students motivations for learning science and studying scientific careers and their changes after the workshops, although answers suggest that the workshops have, at least, put on the table the idea of studying a scientific career among boys and girls.**

- Almost half of the students (20 out of 46) reported not thinking about the idea of studying a scientific career, number that **was reduced almost to half** after the workshops (13 students). Still, **students' willingness to study a scientific career was highly polarised before the workshops and the project did not change this pattern, although more students provided neutral answers after the workshops.**

- **Students identification with scientific professions was also low both before and after the workshops**, as suggested by their answers to the statement *"I can see myself doing science in the future".* Despite this, a relevant group of **students do value learning science as relevant for their future success, especially after the workshops.**

Results description

We first present the results of **students' feelings on science learning at school** gathered through the pre-PERSEIA survey as an introduction to the results related to students' potential changes in perceptions and attitudes towards science and scientific careers and jobs as a result of their participation in the workshops.

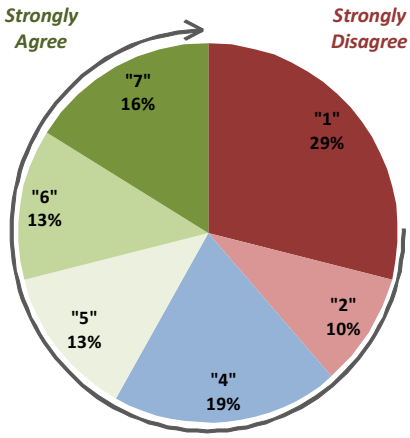
Overall, **PERFORM students reported contrasting perceptions about their enjoyment of STEM related subjects at school as enjoyable ways to acquire new knowledge. Informatics seems to be the subject most enjoyed by students**: 24 reported enjoying the subject (among which 12 strongly enjoyed it) while only 8 students reported not enjoying it. With this exception, around half of the **students answered they enjoyed STEM related subjects and the other half responded they did not enjoy them** (i.e., 13 students reported enjoyment for Biology and geology while 12 reported not enjoying this subject, 14 enjoyed Physics and chemistry vs. 15 not enjoying, 17 enjoyed Technology vs. 14; and 14 vs. 12 for Maths). Interestingly, in all these cases, **those reporting lack of engagement were positioned in the highest degree of disagreement**, which **suggests an important disenchantment of a group of students for STEM subjects**. For instance, 9 students out of the 12 who reported not enjoying Biology and geology were mostly concentrated in the position of stronger disagreement while those who reported enjoyment, were distributed among the three degrees of agreement (see distribution of students answers in the following figures).

We found statistically **significant gender-related differences since girls enjoyed more than boys Biology and geology** ($z = 2.455$; $Prob > |z| = 0.0141$) **and Physics and chemistry** ($z = 1.788$; $Prob > |z| = 0.0739$)**, while boys enjoyed more than girls Technology** ($z = -3.275$; $Prob > |z| = 0.0011$) **and Informatics** ($z = -2.118$; $Prob > |z| = 0.0342$).

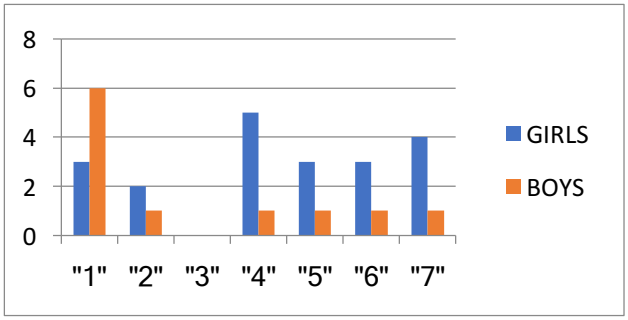
Furthermore, significant differences were also found for Biology and geology between PERFORM and control group (the PERFORM group reported less enjoyment; $z = -2.854$, $Prob > |z| = 0.0043$). Students' answers related to Physics and chemistry also showed significant differences between the PERFORM and control groups (the control group showed more neutral positions, $z = -1.691$; $Prob > |z| = 0.0909$).

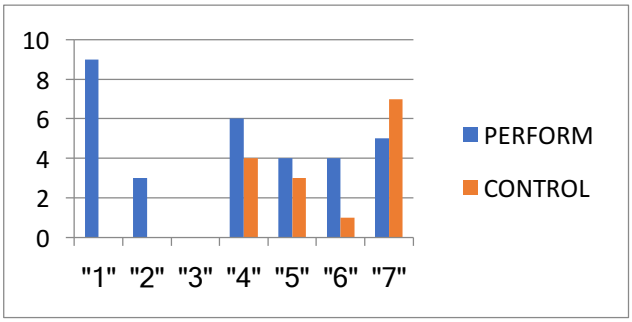
"I enjoy acquiring new knowledge in…"

Biology and Geology

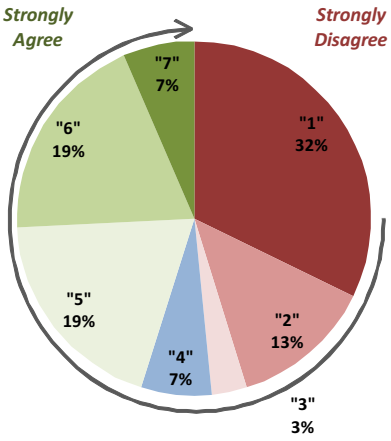


Before the workshops

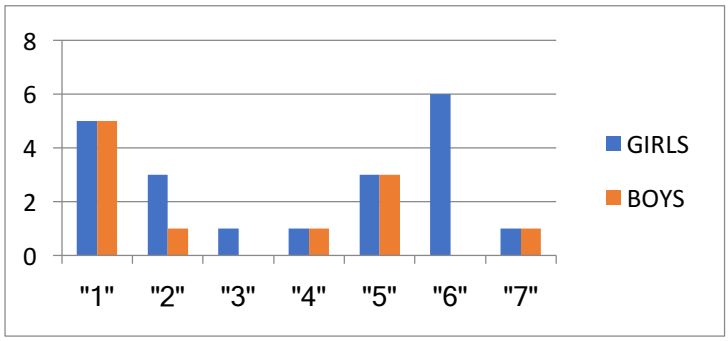


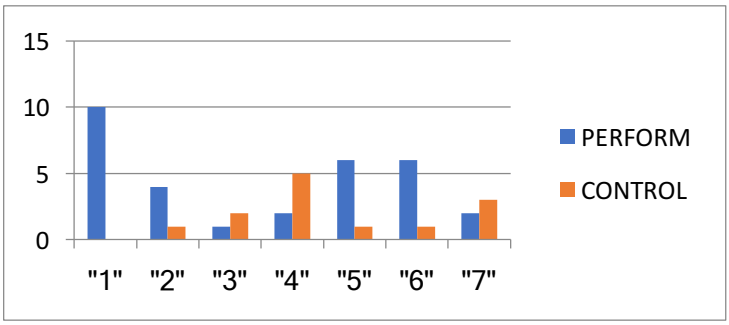


Physics and Chemistry

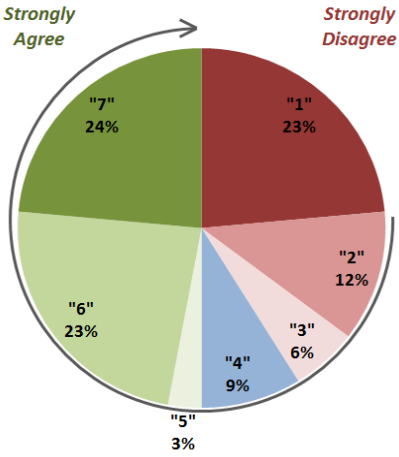


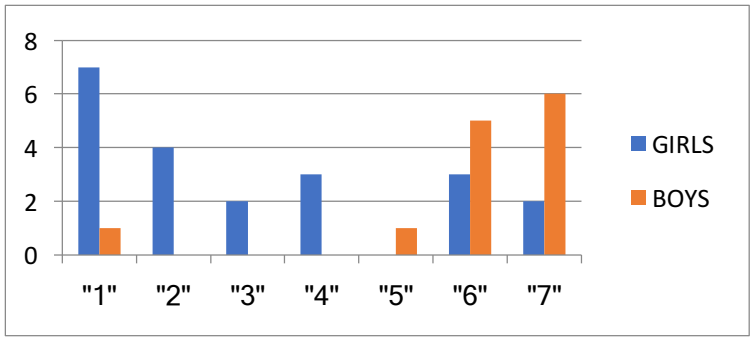
Before the workshops



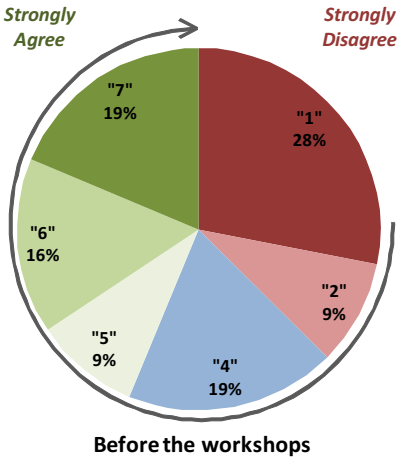


Technology



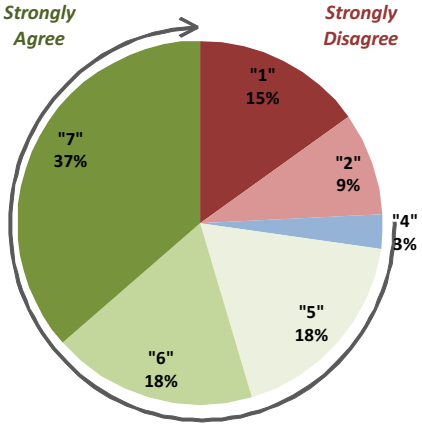


Maths



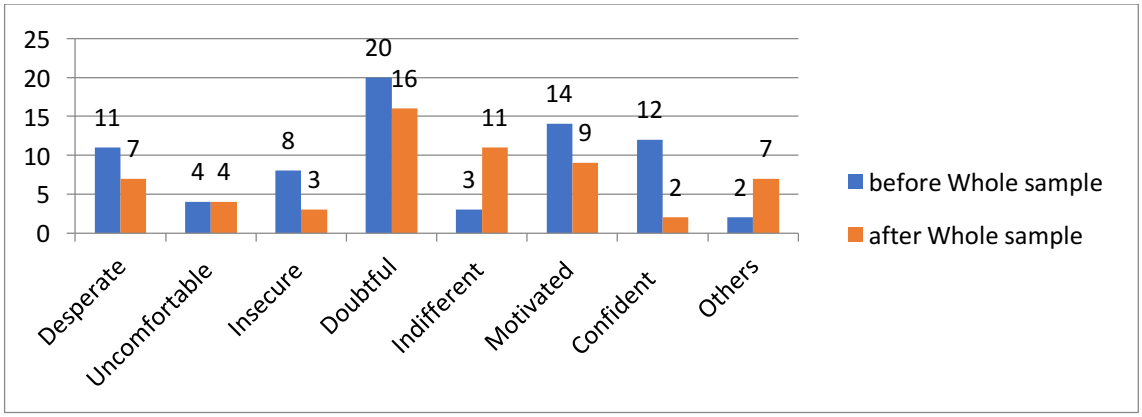
Before the workshops

Informatics



Before the workshops

Students also reported contrasting feelings when asked how they felt in a science class or while doing science-related activities. In the pre-survey, most students answered they felt "doubtful" (20 out of 33 students), "motivated" (14 students), "confident" (12) and "desperate" (11). After the workshops, they still felt "doubtful" but to a lesser extent (16 students), and the number of students reporting feeling "desperate" or "insecure" also decreased (to 7 and 3 students, respectively). However, students also reported feeling much more "indifferent" than before (11), less "motivated" (from 14 students to 9) and much less "confident" (from 12 students to 2). These answers do not provide a clear idea on the potential effect that workshops could have had on their feelings while doing science activities. It is also possible that students had difficulties (or boredom) to answer these questions about emotions, as some of them mentioned in the focus group, which is a methodological limitation of the survey.



"In a science class or while doing science-related activities, I usually feel..."

Interestingly, when asked in the focus group about these changes, students did not consider that PERFORM had a bad impact in their relation to science or undermined their confidence while doing science-related activities. They explained that the reason behind the overall decrease in confidence[2] could be that they now doubt more on the scientific information available at internet:

> *KARLA: …Why these results?*
>
> *BOY SP1109: Because they explained us that webpages are not...*
>
> *BOY SP1113: Not truthful.*
>
> *BOY SP1109: Then, sure, we thought we had to make more research and...*
>
> *BOY SP1113: You get more obsessed with it.*
>
> *GIRL SP1108: True.*

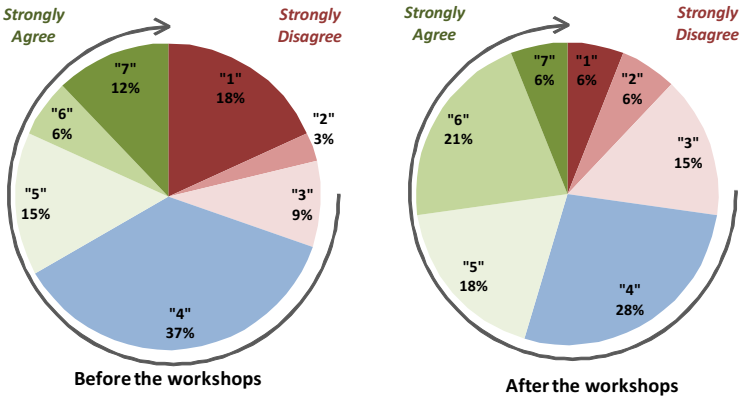
In this regard and as mentioned below, students' interventions in the focus group suggested that **the discussion generated during the critical thinking session might have also fostered students' questioning of available information. We don't know, however, to which extent such questioning –which was mostly framed as being suspicious of information and webpages, could have also generated some mistrust towards science**. Furthermore, students

[2] Note that in Catalan the word "confiat" (just as in Spanish) is applied for "confident" and "trustful".

acknowledged that the project did not increased general interest in science of those who were not previously interested in the subject.

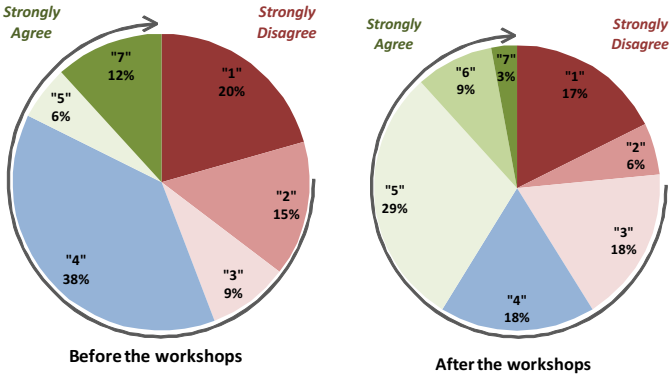
In line with this diversity of feelings reported, **students did not follow a clear pattern when explicitly asked if they feel comfortable when doing science-related activities**: before the workshops answers were quite balanced between feeling comfortable (11 students), uncomfortable (10 students, 6 of them in the most extreme position) and feeling in-between (neutral answers, 12 students). Although no statistically significant differences were found, students' answers after the workshops were more positive and the number of students feeling comfortable increased to 15, while those reporting negative or neutral answers decreased.

"I feel comfortable while doing activities or tasks related to science"



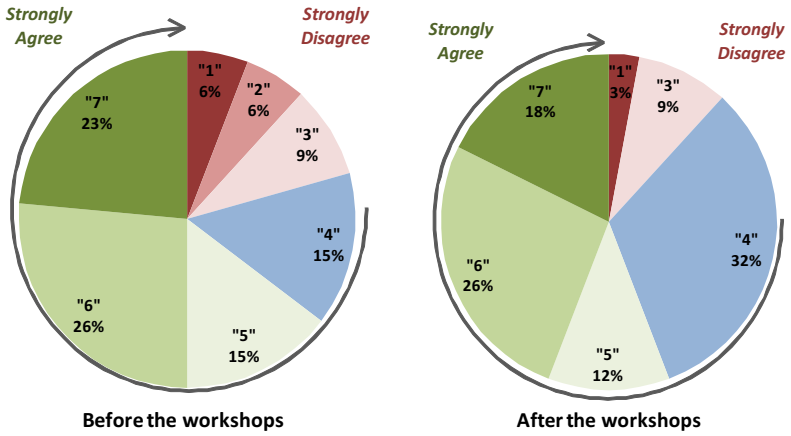
Students were also asked in the survey for their perceptions about the **role of science in and for society**. In general, **there was a big group of students (around half of them) with a positive perception about science's role in society while** a smaller group of students showed indifferent positions or negative ones. Workshops did not produce any significant changes since students' perceptions related to these items remained quite similar afterwards.

Around half of the students considered science related to real-life problems and this number remained stable before and after the workshops (15 and 14 out of 34), without any significant changes. Despite the lack of statistical significance, students' answers did shift from a big group of students with a neutral or in-between position (13 students in the pre-PERSEIA survey) to an increase of students agreeing with the lack of connection of science with real-life problems after the workshops (from 6 students to 14, although 10 of them in mild agreement).

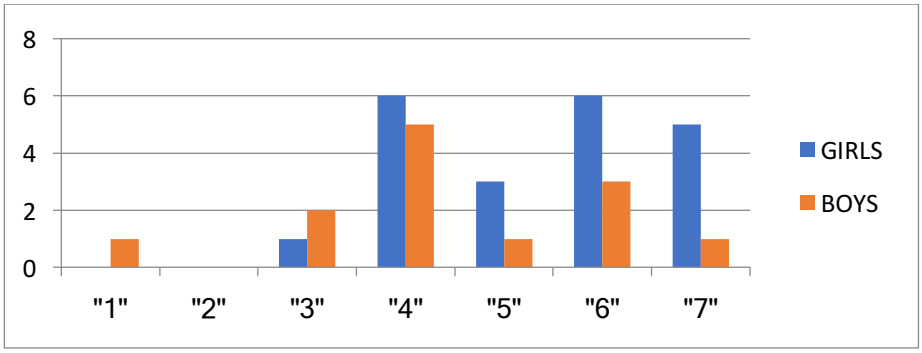


"Science has nothing to do with real-life problems"

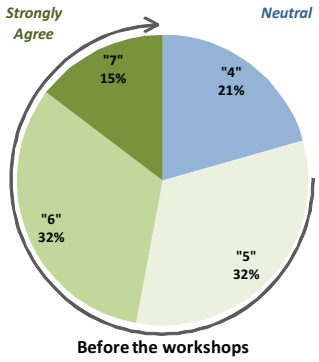
Similarly, more than half of the students considered that science will help them understand more about world-wide problems and this number has remained stable after the workshops without significant changes. A big group of students (22 out 32, 64%) agreed with the statement before the workshops, while 7 students did not agree and 5 were neutral. After the workshops the number of students agreeing with the statement slightly decreased to 19 students, but those in disagreement also decreased to 4 students (and 3 of them close to the neutral position). Thus, the workshops did not seem to provoke significant changes in students' perceptions, but **significant differences were found in the post-PERSEIA survey between boys and girls, being girls more positive about the statement** ($z = 1.809$; Prob > $|z|$ = 0.0705).



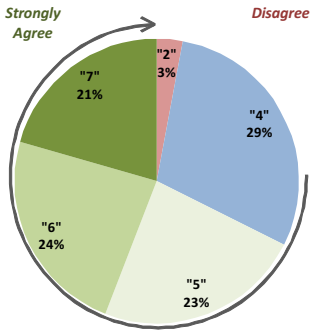
"Science will help me understand more about worldwide problems"



Also, related to the students' perceptions of the role of science in and for society, **overall most students perceived that scientific jobs are important for having a better society, both before and after the workshops** (27 and 23 students, 79% and 68% of the group). Unlike the other items, in the pre-PERSEIA survey there were not students reporting disagreement, suggesting students' perceived importance of scientific jobs. Although after the workshops some positive answers shifted towards the neutral position and 1 student showed disagreement, there were not significant differences in students' responses in the pre- and post-surveys.



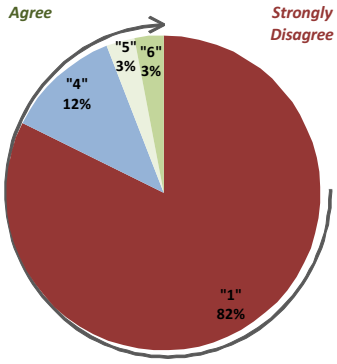
Before the workshops



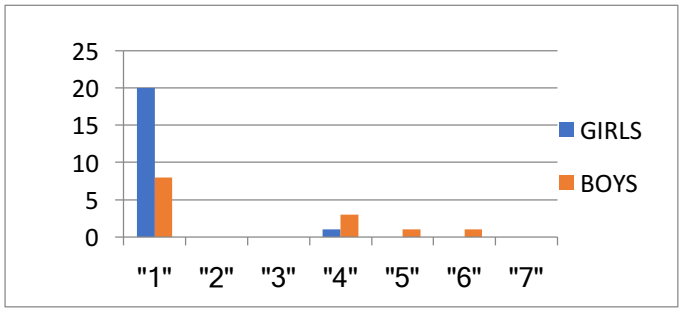
After the workshops

"Scientific jobs are important for a better society"

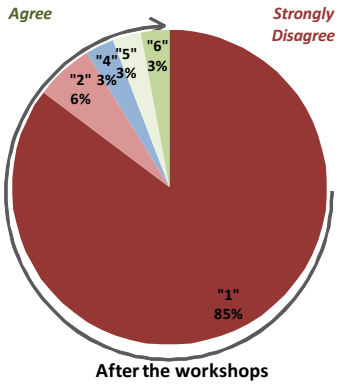
Students also answered questions about their **perceptions of gender-related roles in science**. **Overall, students disagreed that men were better scientists than women both before and after the workshops** (28 and 31 students respectively, among which 81% and 85% reported strong disagreement). Only two students agreed with the statement (none of them in the position of total agreement) and the workshops did not produce significant changes in students' answers. **However, significant differences were found between boys and girls' answers both in the pre- and post-PERSEIA surveys** ($z = -2.510$, $Prob > |z| = 0.0121$; and $z = -3.020$, $Prob > |z| = 0.0025$, respectively), **being boys the only ones who agreed with the statement.** These gendered differences were slightly higher after the workshops as no girls reported neutral answers.



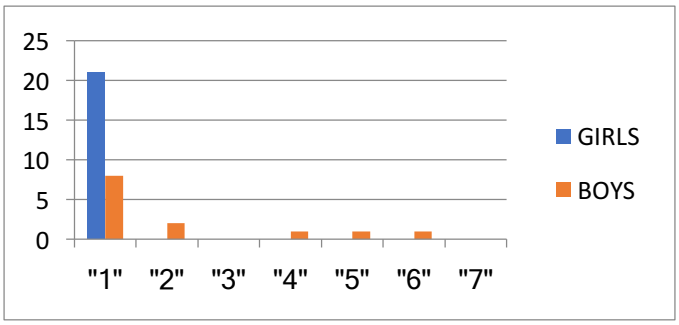
Before the workshops



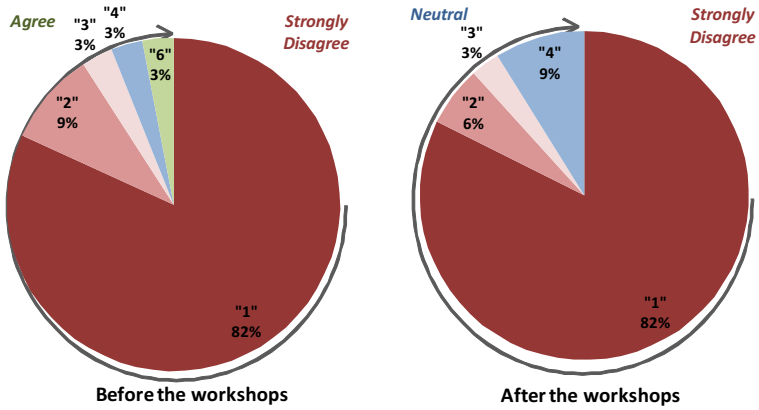
"Men are better scientists than women"



After the workshops



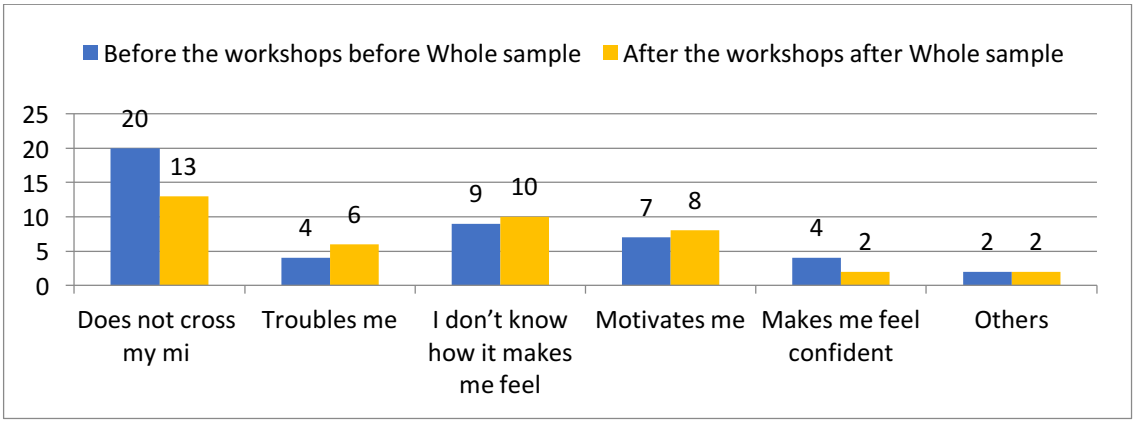
Similarly, most students disagreed that scientific careers are mostly for boys: 31 students before and after the workshops (93% and 91% of the group respectively), most of them in the position of total disagreement (see Figure below). Again, only one boy agreed with the statement and he changed his answer after the workshops, with no students reporting agreement. Although changes were not significant, **significant differences were found between boys and girls before the workshops** (due to the one boy in disagreement), **which were not present afterwards**.



"Scientific careers are mostly for boys"

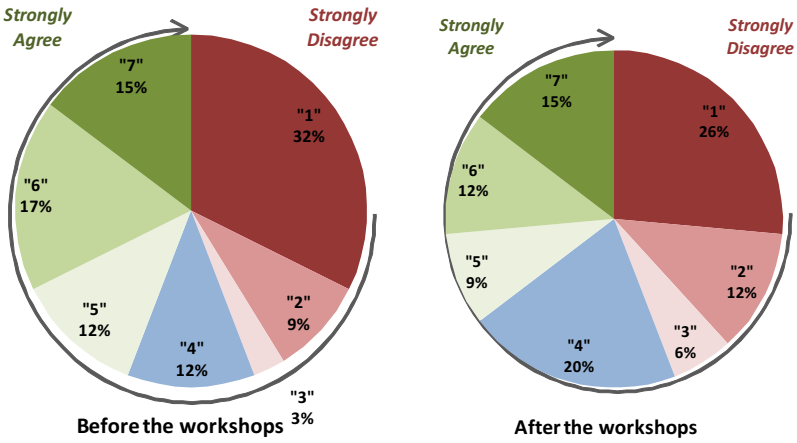
Finally, **students' were asked for their motivations for learning science and studying scientific careers. In general there is not a clear pattern observed in students answers before and after the workshops, although these answers suggest that the workshops have, at least, put on the table the idea of studying a scientific career among boys and girls.**

Before the workshops almost half of the students (20 out of 46) reported not thinking about the idea of studying a scientific career, number that was reduced almost to half after the workshops (13 students). A smaller group of students reported either "not knowing how that makes them feel" or being motivated by the idea. In both cases, the number of students remained stable after the workshops (from 9 to 10 students and from 7 to 8 students, respectively). To a lesser extent, students reported "feeling confident" and "being troubled" (4 each). Little changes were also observed when students reported feeling confident (from 4 to 2 students) and feeling troubled (from 4 to 6). Again, reflecting about emotions in a written survey might have constrained students' answers.

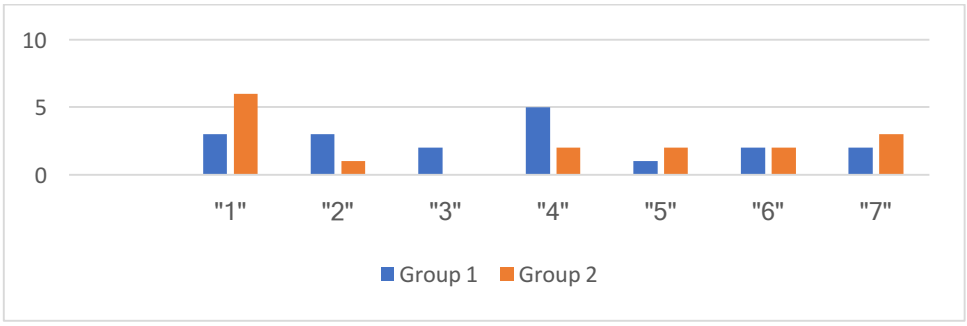


"The idea of studying a scientific career…"

Coherently with other results, students' willingness to study a scientific career was highly polarised before the workshops and the project did not change this pattern, although few students changed from positive answers to neutral answers after the workshops. Before the workshops around half of the students (15 out of 34) reported agreement with the item *"I would like to study a career involving science (…), technology, engineering or mathematics*", while the same amount of students did not agree and 4 were neutral. After the workshops, 15 students were still in disagreement while the amount of students agreeing slightly decreased to 12 and neutral answers increased to 7. However, these changes were not significant. Significant differences were only found between Group 1 and Group 2 after the workshops: Group 1 provided more neutral answers and less "strong disagreement" than Group 2 ($z = -2.249$; Prob > |z| = 0.0245).

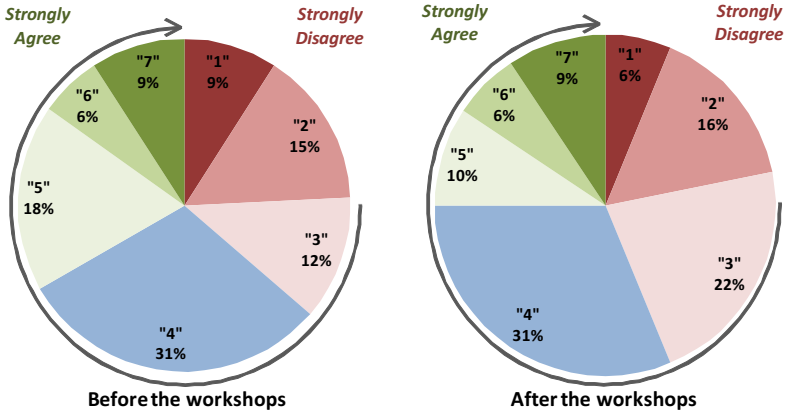


"I would like to study a career involving science (like biology, geology, physics, medicine or chemistry), technology, engineering or mathematics"



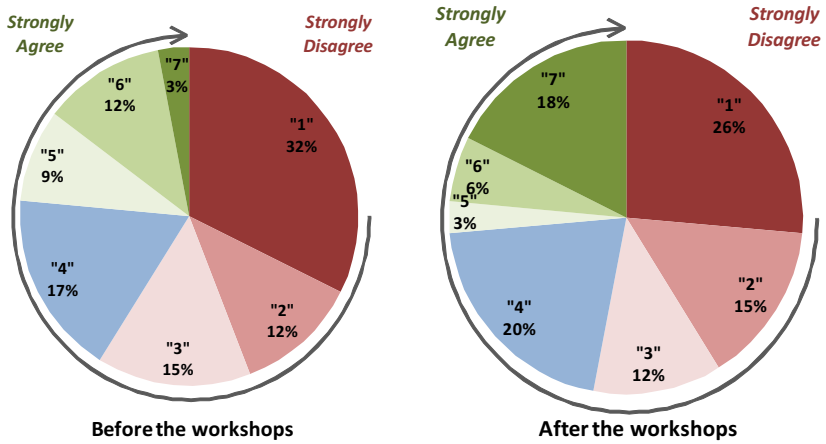
Despite these results, as mentioned in Goal 3 a relevant group of **students did value learning science as relevant for their future success, especially after the workshops (47%)**, while there was also 1/3 of the group providing neutral answers, suggesting indifference. **Similarly, survey results showed a diversity in students' perceptions of learning science as helpful to get a job in the future, which did not change much after the workshops**. Before the workshops, when asked whether "*What [they] learn in science class will help [them] to get a job*", answers were quite shared between not considering it helpful (36%, 12 out of the 33 students that answered), providing a neutral answer (31%, 10 students) and considering it helpful (33%, 11 students). After the workshops, students' answers remained very similar, but their agreement to the statement decreased to 25% (8 students), while neutral answers remained the same and negative answers increased (32% and 44%, respectively). However, no significant differences

were found between the pre- and post-PERSEIA surveys and the variation between answers was almost null.



"What I learn in science class will help me to get a job"

Students identification with scientific professions was also low both before and after the workshops, as suggested by their answers to the statement *"I can see myself doing science in the future".* Whereas before the workshops 20 students (59% of the group) did not agree with the statement (most of them placed in the extreme disagreement) and only 8 agreed, after the workshops the number of students disagreeing slightly decreased and those in agreement slightly increased (see figures below). Although no statistical differences were found, interestingly, students' agreement moved towards total agreement (from 1 student in the pre-survey to 6 out of 9 in the post-survey). The number of students providing neutral answers remained stable (6 and 7 respectively).



"I can see myself doing science in the future"

INCLUSIVENESS AND GENDER

Main highlights

- **Students generally considered that they had actively participated in the** workshops, although girls significantly agreed more and **only boys** reported **not actively participating.** We also observed such active participation but **it was not always balanced**: there were clearly some students that interacted more than others, and **generally half of the students participated actively in the plenary discussions**.

- **The high number of students (around 20) might have influenced such unbalanced participation since the facilitators created a relaxed and comfortable atmosphere in their relation with the students, which facilitated inclusiveness.** In this regard, students and facilitators related in a **conversation-like manner**, in which students could participate spontaneously and both facilitators were very constructive in their comments and feedback to students. Students in both groups seemed to feel integrated in the group, as well as recognised and supported by the facilitators, as suggested by observations and students' answers to the surveys.

- **Students were provided with the possibility to make choices through the creation of their monologue and they generally perceived they could participate "as they wanted to"** and that, in this regard, the process was very open. Furthermore, this was also expressed in terms of **feeling listened,** as they could always express their opinions and they were taken into account.

- **Facilitators commonly built-up on students' previous experiences about the topics - rather than on their previous knowledge**, which was scarce- to enhance inclusiveness, while the **presence ICT tools to support students' dialogue during workshops was generally low.**

- **We did not observe any specific support to students with special needs** (although students were supportive with each other) and a teacher suggested that **more attention could be paid to include students with learning difficulties.**

- **In terms of gender and participation,** girls outnumbered boys in both groups and **tasks were generally not shared among students in subgroups: girls were commonly assuming the leadership**, concentrating the tasks and performing the main roles in the monologues (especially in Group 1). I**n the final performance** of the monologues, except for a couple of groups, **girls' interventions were generally longer and had more content than the boys'.**

- **In terms of gender as a topic, students expressed** the **difficulty to connect gender with the monologues and only one group integrated gender issues in their PERSEIA.** One ECR suggested devoting more time to critically reflect about relevant issues emerging from students' monologues in order to foster such a connection.

- However, when asked about changes in their perception of science, some students mentioned gender issues, suggesting the **contribution of the workshops to refine some students' perception related to women discrimination in science.**

Both groups were composed by 24 students each, although due to students' absenteeism, the sessions counted with 15 to 22 students. Girls outnumbered boys in both groups, representing ½ to 2/3 of the group depending on the session.

Balanced participation and dialogue

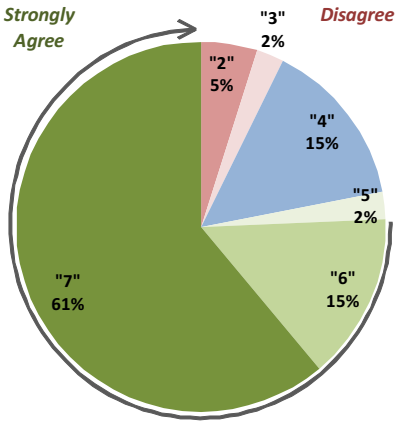
As reported in GOAL 3, **71% of the students** (29 out of 41) **considered that they had actively participated in the** workshops and **statistically significant differences were found between girls and boys**, as **only boys** (4 out of 14) **reported not actively participating in the workshops**, while all girls provided positive or neutral answers. We also observed differences in balanced participation as **there were clearly some students that interacted more than others**. For instance, in Group 1, generally half of the students participated actively in the discussion. Among these, there were some girls that were recurrently active in the discussions, while some students did not engage much in the discussion but interacted by laughing and making comments related to other things. A smaller group of students (around 3-4) paid attention but did not intervene (e.g. shier students) while some other students (3-4) used to disconnect. A similar dynamic was seen in Group 2. The high number of students (around 20 in each session) could have influenced such dynamic, as the learning environment generated by the facilitators was globally inclusive.

Indeed, since the beginning of the workshops, **facilitators created a relaxed and comfortable atmosphere in their relation with the students, which facilitated inclusiveness**. They maintained a **horizontal relationship** with them, even if clearly guiding the group: students and facilitators related in a **conversation-like manner**, and students could participate spontaneously, intervening when they wanted to share something and listening to the facilitators when they talked. The facilitator in Group 1 often repeated students' comments as they talked, reinforcing their interventions and showing that she was listening to them. She was very attentive to any reaction in the group and showed herself opened to repeat the contents and solve any doubts. Both facilitators were very constructive in their comments and feedback to students. When students showed uneasiness (for instance provoked by acting), they responded in a reassuring way: providing them encouraging inputs and transmitting confidence (for instance, mentioning that rehearsing is a strategy for feeling more confident afterwards in scene). The recurrent use of humour also captured students' attention and allowed to release any punctual tension within the group. Students in both groups seemed to feel comfortable with the facilitators and perceived their availability during small group work as we observed them approaching directly the facilitators when they had doubts and also sometimes calling their attention to share ideas about the monologue.

Such feeling was also reported in the written surveys. For instance, when asked about what they liked most. See for instance the following quote:

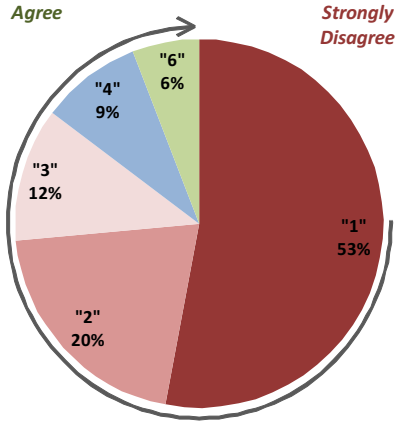
"What I liked the most has been the enjoyment and the laughs we all shared in the workshops, and the enthusiasm of the facilitator towards us. I really liked his presence during the workshops"
Girl SP1108, Group 2

Furthermore, students reported they felt they could ask the facilitators whatever they wanted to, as 32 students (78% of the group) supported this statement, while only 3 students (5%) disagreed and 6 remained neutral:



"During the workshops I asked the facilitators whatever I wanted to"

Other answers to the survey also support these responses and observations, **as the majority of the students felt included in the group, as well as recognised and supported by the facilitators and ECRs**. Overall, **students' felt part of the group** during the workshops (29 out of 34, 85% of the group). Only 2 boys from Group 2 reported not feeling part of the group and 3 students provided neutral answers. Significant differences were found between Group 1 and Group 2, as the latter group provided more negative and neutral answers.

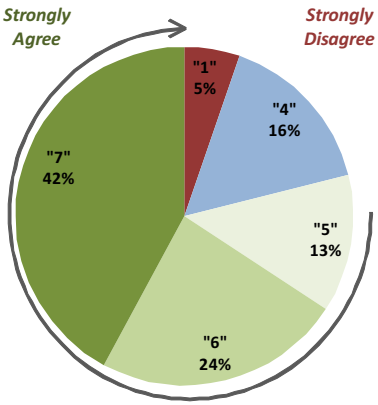


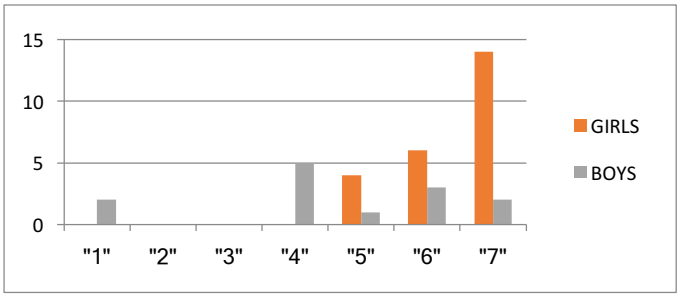
"I did not feel part of the group during the workshops"

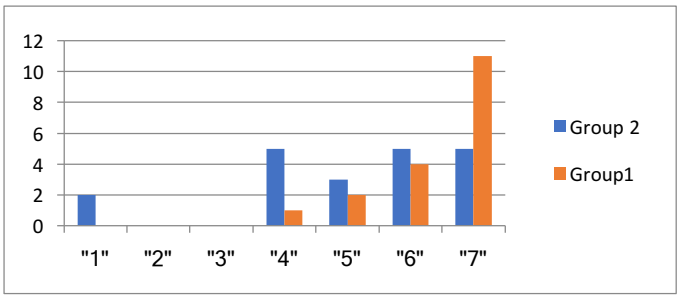
When asked whether they felt their work was recognised by the adults in the project, **students generally perceived their work had been recognised by the facilitators, ECR and teachers**. **Such perception was stronger in Group 1** (z = -2.580; Prob >|z|= 0.0099) **and among girls** (z= 3,135; Prob>|z|= 0,0017). Whereas 79% of the students **(30 out of 38) reported their work was recognized by the facilitators or science communicators** (most of them in position of total agreement), only 2 students reported not feeling recognised and 6 provided neutral answers. Similarly, 74% of the students reported their work was recognised by the ECR, while only two boys did not agree. **Coherently with observations on teachers engagement reported in GOAL 1, students perceived less support from their teachers** as the percentage of students reporting feeling recognised dropped down to 44% and 25% disagreed with the statement. For both science communicators and teachers, significant differences were found between boys and girls (z = 2,84; Prob >|z|= 0,0045; and z = 2,014; Prob >|z|= 0,044, respectively) , while for ECRs there were also differences between Group 1 and Group 2 (z = -3.438; Prob >|z|= 0.0006) (girls and Group 1 feeling more recognised than boys).

"I felt my work was recognized by…"

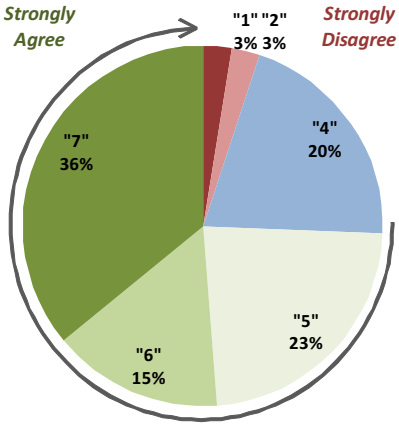
The facilitators

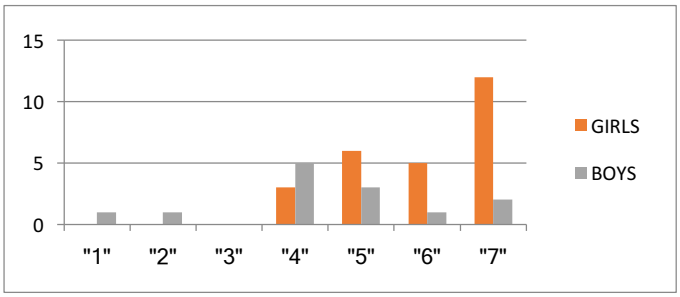


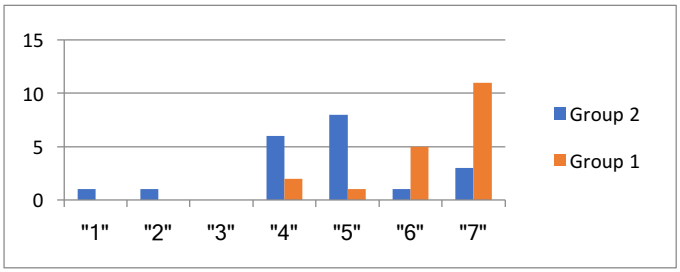




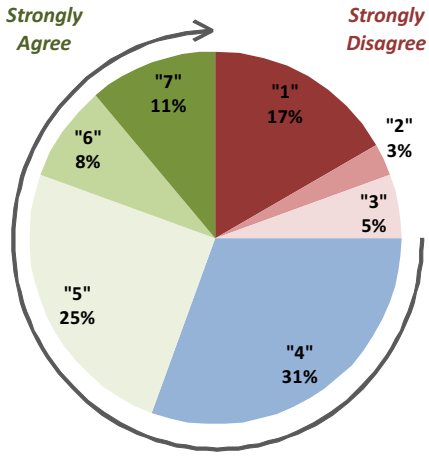
The ECRs

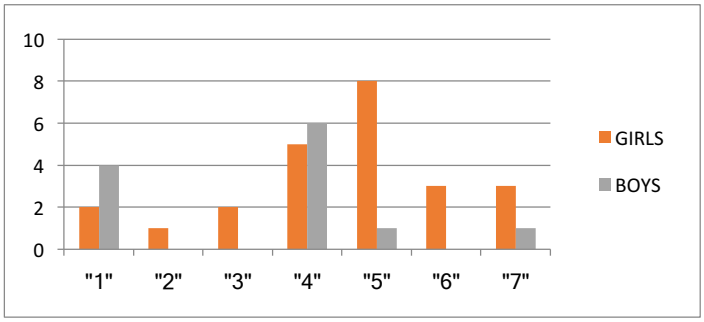






The teachers

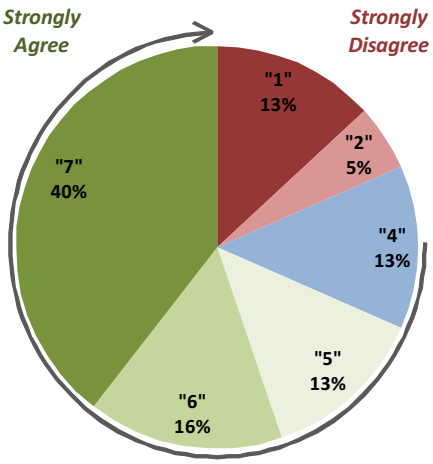




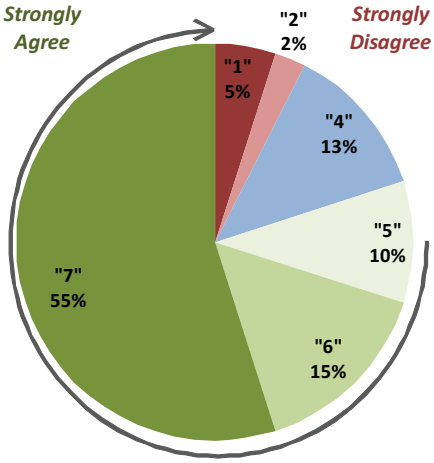
During the focus group, students expanded on this issue and mentioned that they felt the facilitators listened to them and they could all participate the way they wanted to. Indeed, beyond students' interaction with the facilitators, we observed students' capacity to make choices during the process. **Students were provided with the possibility to make choices through the creation of their monologue**: they chose the topic for their PERSEIA and what questions they wanted to explore through their monologue, and developed their own script. When writing the script, the students discussed and decided the content and jokes to be included. Groups of students were previously made by the teachers, but some punctual changes were allowed, when requested by students.

More specifically, **students generally reported high levels of agreement with their capacity to make decisions about different aspects of the monologue.** As the following figures show, 68% of the students considered they could make decisions about the topic of the monologue, 71% about the research questions, and 73% about the content of the monologue. Interestingly, the aspect gathering more agreement was students' performance in the monologue (80%), which suggests that both groups felt freedom in this regard. Differences between boys and girls and groups were found for the capacity to make decisions about the **questions of research** ($z = 2.385$; Prob > |z| = 0.0171) **and the content of the monologues** ($z = 2.691$; Prob > |z| = 0.0071)**, in which girls agreed more than boys, suggesting they perceived they could make more decisions.** Also for research questions, students in Group 2 agreed more than students in Group 1 with significant differences ($z = -2.040$; Prob > |z| = 0.0414).

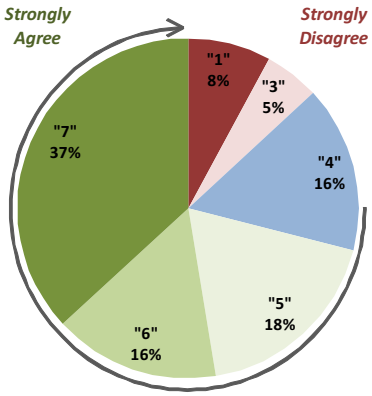
"During the creation of the PERSEIA, I could make choices on …"



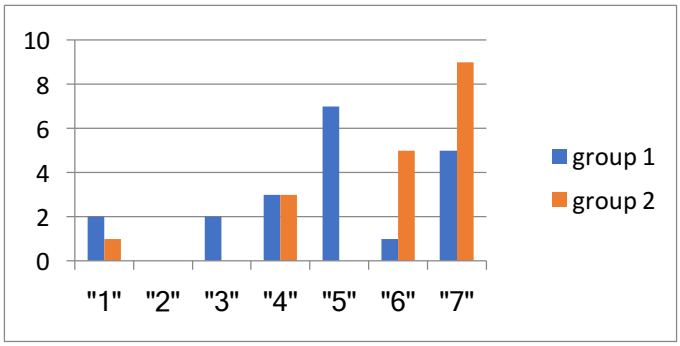
The topic of the monologue

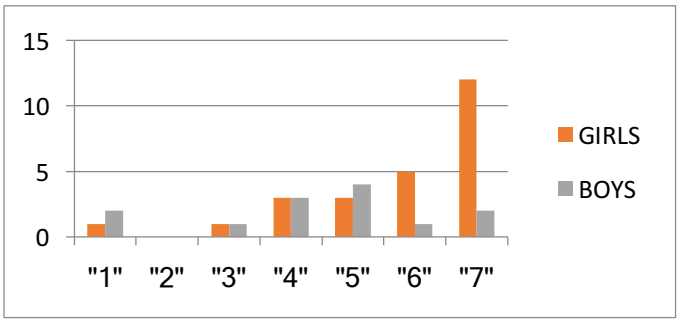


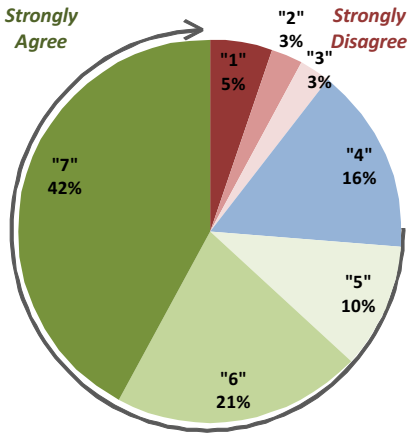
The acting in the PERSEIA



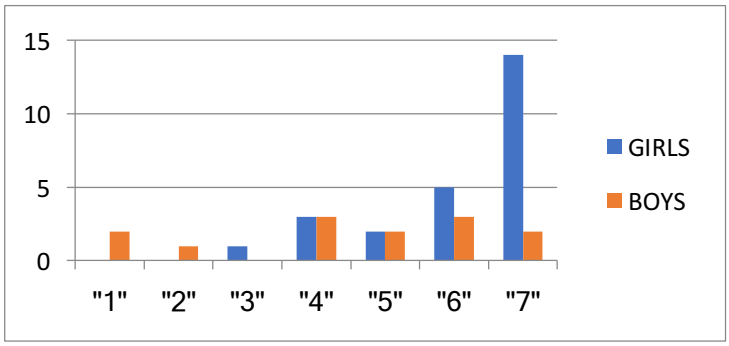
The research question







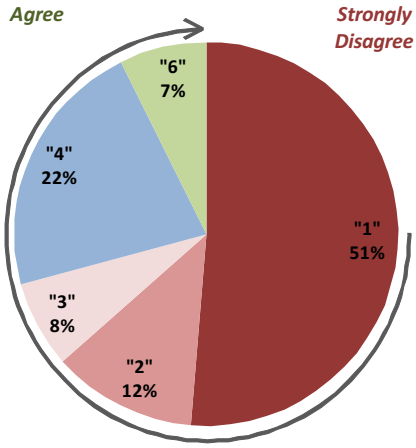
The content of the PERSEIA



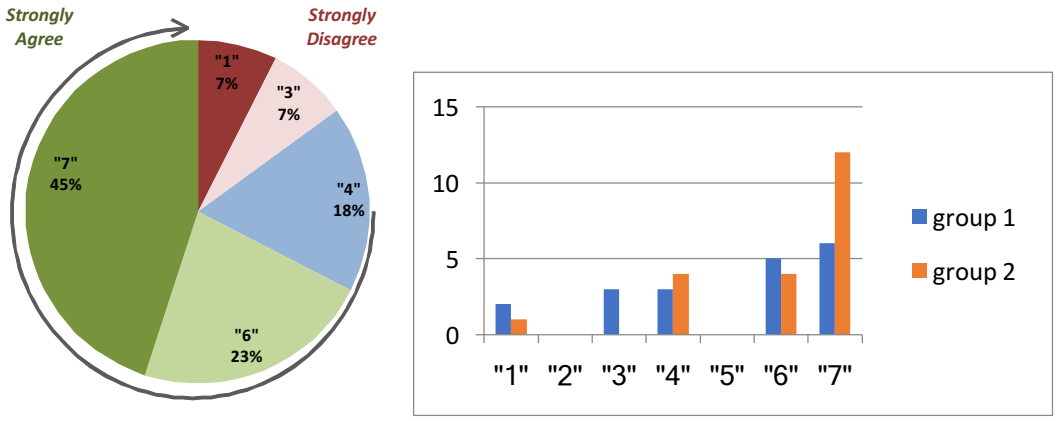
"During the creation of the PERSEIA, I could make choices on …"

Consequently, **students reported in the survey that the final monologue included their ideas** (71% of support to this statement, while only 3 students did not support it). Similarly, significant differences were found between boys and girls () being girls in positions of stronger agreement than boys, while boys responses were more distributed and a third of them were neutral (z = -1.905; Prob > |z| = 0.0568).

"Our [PERSEIA] did not include my ideas"



On the other hand, in the reflection activities students participated within the guidelines provided, but without much margin to make decisions (for instance, in the role-play game, roles were already assigned among students by facilitators. This fact punctually annoyed some students who wanted to participate in a different role (like girls who wanted to be the interviewers), but generally did not seem to bother them as suggested by **students strong agreement with the item "*I could choose how I wanted to participate in the PERSEIA*" (Figure below).** While 27 students (68% of the group) considered they could decide how to participate in the monologue (in positions of very strong agreement and strong agreement), only 6 students did not agree (3 boys and 3 girls). Also, 7 students (18% of the group) provided neutral answers. Significant changes were found between both groups (z = -1.764; Prob > |z| = 0.0778) and students in Group 2 agreed more with the statement that students in Group 1 (note that 5 of the 6 students in disagreement belonged to Group 1). This is coherent with the different guidelines provided by each facilitator in each group, as in Group 1 all students were required to perform in the rehearsals and most of them did it in the final PERSEIA (see below in Engagement).



"I could choose how I wanted to participate in the PERSEIA"

This possibility of choice was further echoed by the students in the focus group, somehow perceived as the "freedom" to decide their level of involvement. Students agreed that **they could participate "as they wanted to"** and that, in this regard, **the process was very open**. Furthermore, this was also expressed in terms of **feeling listened, as they could always express their opinions and they were taken into account**:

MARÍA: Why do you say that you could participate the way you wanted to?

BOY SP1113: Because your opinion mattered.

GIRL SP1206: Because we have all shared our opinion... and it counted what we all said.

GIRL SP1218: And you could add and take out whatever you wanted to, that is, you could do as you wished... I mean, being respectful and so on, but you could. (...) For instance, if you were a group and you didn't want do to anything, well, you didn't.

BOY SP1113: Obviously, cause no one is going to force me, if I don't want to do anything, they are not going to force me to.

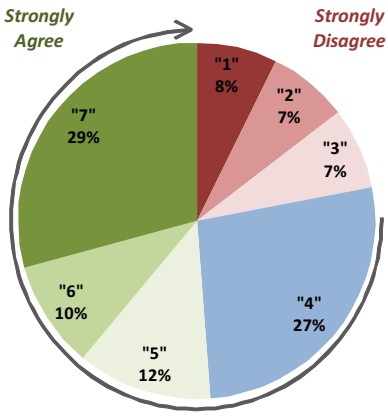
MARÍA: So you mean you felt the freedom to go as far as you wanted to...

BOY SP1113: And besides, when you gave your opinions, they were listening to you.

GIRL SP1210: That's right.

Nonetheless, a couple of students also mentioned that despite having freedom to choose their PERSEIA topic, the choice had been imposed by one member of the group, rather than being a group decision (see GOAL 3, on Social and Civic Competences).

The presence of arts-based or ICT tools to support students' dialogue during workshops (an indicator proposed by students in Spain and France) was generally low. Beyond the creation of the monologue (which is in itself a performance-based methodology), facilitators included two activities based on drama to prompt students dialogue: a role-play game in PW3 and an image-theatre exercise in PW4. While the role-play game stimulated students' discussion, the image theatre exercise observed in Group 1 did not achieve to generate a dialogue (working groups were big –around 10 students each, only a few students worked in the activity, and there was not dialogue afterwards). ICT (e.g. videos, music, internet) were not applied by the facilitators during the workshop activities, but an internet-based platform was applied to upload homework and a WhatsApp group was created to interact with facilitators and ECR in between sessions. However, according to inputs from students in the focus group, ECRs and teachers, none of them seemed to engage students in dialogue related to the learning process (see below in Cognitive Engagement and GOAL 1). When students were asked in the survey whether "the use of online platforms helped [them] participate more in the project" they were more positive (half of the group agreed), although ¼ of the group disagreed and another ¼ reported neutral answers:



"The use of online platforms helped me participate more in the project"

Finally, it is worthy to note that facilitators commonly built-up on students' previous experiences about the topics - rather than on their previous knowledge, which was scarce- to enhance inclusiveness. For instance, in PW2 on critical thinking, the facilitator used as starting point for the reflection, students' own experience when looking for information (*where do you search for information?)* and trusting such information (*how do you decide whether to trust it? how would you verify the info?*). Students' experiences were brought up recurrently in the discussion and sometimes challenged by the facilitator. Also, in both groups the discussion in PW3 (Gender) was highly mediated by students family experiences related to gender (e.g. division of work at home, caring tasks) grounding the discussions to contexts relevant for the students. This was the case for the first 4 sessions in which some topics were approached, with

the **exception of PW1** which seemed difficult to relate either with students' previous knowledge or with experiences on the topic (science and societal challenges).
This said, **we did not observe any specific support to students with special needs** (i.e. there were several students with learning difficulties in both groups and one student with autistic traits in G2) during the sessions. We did observe students helping their peers to overcome specific difficulties (mostly related to language, e.g. reading to a peer that has reading difficulties, writing the monologue in Catalan language for one peer). Nonetheless, the facilitators mostly spoke in Spanish, which made it easier for some students to understand the language, as mentioned by the teacher in charge of the *Aula d'acollida* (a specific program to integrate immigrant students recently arrived)[3]. This teacher also mentioned in the interview that **more attention could be paid to include students with learning difficulties**, as she saw some of "her" students lost during the process. Indeed, teachers did not mention the integration of students with special needs as a criterion for making the groups (rather the emphasis was on ensuring one student that worked well, see GOAL 3). The teacher in charge of the *Aula* suggested, thus, that **collaboration with the school orientation departments when preparing and implementing the project** could help identify students with special needs and ensure an individual follow-up. Similarly, one ECR also suggested during the interview that **knowing the student profiles in advance** could help them interact with them through the sessions in a more adapted way.

Gender

In terms of gender and participation, as mentioned above, girls, commonly doubled boys in the sessions (except in PW1 in which there were 10 girls and 7 boys and, in PW3 on gender with 11 girls and 4 boys).

As already reported in GOAL 3, **tasks were generally not shared among students in subgroups and girls were commonly assuming the leadership**, concentrating the tasks and performing the main roles in the monologues (especially in Group 1). **Differences between girls and boys were also observed in the type of tasks and roles assumed in Group 1** (such differences were not observed in Group 2). For instance, while **girls tended to be among the most participative students in the discussions and concentrated the working tasks** (including homework), **those in the group adopting a more passive or disengaged role were frequently boys**. Such unequal sharing of tasks seemed to upset some girls, who expressed in the focus group that they had to assume other peers' work (see GOAL 3, Social and Civic Competences), although they did not make any connection to gender.

Also, in Group 1, **girls seemed to have more interest in performing well than boys** during the monologue rehearsals: they seemed more aware of what they said, cared about how they said it and also about the reactions of other students. In this regard, interestingly, when providing feedback to each other's performance in the rehearsal of the monologues, **girls received more critical comments than boys**, who received feedback in a less serious mood (e.g. jokes).

Furthermore, **in the final performance** of the monologues, except for a couple of groups (1 group from Group 2 was composed only by boys), **girls' interventions were generally longer and had more content than the boys'**.

[3] In contrast, this same fact also generated friction with the Catalan teacher, since the workshops were delivered during his lessons and he was supposed to mark the students.

In terms of gender as a topic in the workshops, students were explicitly asked about gender in the question on critical thinking. Their first reaction was to relate gender to the interview role-play (which they all remembered well) and the question about having kids, without further reflections. Nonetheless, when further asked if they had integrated any of the issues or reflections raised that day, **only one girl responded positively** while some students mentioned the **difficulty to connect gender with the monologues**:

> *"MARÍA: And from that interview (role-play) and the discussions you had, have you afterwards worked on anything related through your monologue or not? I mean, have you connected it?*
>
> *BOY SP1113: Directly in the monologue no, because my monologue did not talk about anything related with gender, you know? It was about (mobile phone) waves.*
>
> *GIRL SP1210: In your monologue [talking to GIRL SP1206]*
>
> *GIRL SP1206: Let's see, I did it yes, about girls in science. And we talked about Marie Curie, which is one of these girls.*
>
> *GIRL SP1122: That's true.*
>
> *BOY SP1201: But when you mentioned it in the monologue, it was like… what does it have to do with that?*
>
> *GIRL SP1210: It has a lot to do with that because it's like now there are scientists…*
>
> *BOY SP1201: Yes, but what's the connection…?*
>
> *GIRL SP1210: Listen to me.*
>
> *GIRL SP1206: Because we are supposed to be talking about science, like lab-on-a-chip. And then we were saying that before women could not do research and so on, but in this project there are girls. Before they didn't allow woman study and now they can and that's why we have told it.*
>
> *GIRL SP1108: Because we are girls.*
>
> *BOY SP1201: No, it's more the way they introduced it, I couldn't understand…*
>
> *GIRL SP1218: Me neither, they didn't explain it well*
>
> *GIRL SP1210: i did understand it, because now there are male and female scientists but still they only name the male ones…*
>
> *GIRL SP1206: Or for instance, they put the man first, because they think he is more important*
>
> *GIRL SP1210: Yeah, or they say the last name of the man but the girl… they call her María. You know what I mean?"*

The lack of perceived connection between gender and the scientific topics approached in the monologues, was also brought up in ECR's reflection during the interview. One ECR suggested devoting more time to critically reflect about relevant issues emerging from students' monologues in order to foster such a connection:

"I think it could be interesting maybe to reflect in the social issues of the monologues, with time, and maybe not before the monologue, maybe after doing the monologue. Just to talk about these things, sexism, gender... I don't know, many things. (….). Because it's true that we were talking about gender and we didn't have more time to talk about other social issues or even gender, when they were developing the monologues".

Female ECR, Terrassa

However, later on the interview, when asked about changes in their perception of science, one boy raised the gender issue and some students supported it with a few ideas, suggesting the **contribution of the workshops to refine students' perception related to women discrimination in science**:

"BOY SP1211: I mean, not changing my idea (about science), but (now) knowing that women before could not do that, study to be scientists. O sea no cambiar de idea, sino de saber que antes las mujeres no hacían eso, de estudiar para poder ser científicas.

BOY SP1109: Like understand

GIRL 1122: They wanted to do it, but society didn't…

BOY SP1113: But what has changed? That before they looked weird to Marie Curie because she was a woman and a scientist at that time

GIRL SP1206: Yeah and also to Lise Meitner

BOY SP1113: ... but now there are actually more women scientists than men.

GIRL SP1206: … and Vivian Hek

GIRL SP1102: But (women) well-known not that much, not directly"

Finally, the teacher attending in the workshops briefly suggested that the gender workshop could benefit from a stronger and clearer discourse against gendered violence, in front of some students' interventions showing stereotypes.

ENGAGEMENT AND CRITICAL THINKING

Main highlights

- **Students' general involvement observed in both groups was very high, showing a constant willingness to participate throughout the sessions**. Teachers also observed such involvement and further appreciated the capacity of the project to engage some **students who usually do not participate in academic tasks.**

- **Indeed, most of the students reported finding interesting the reflection activities** (26 students, 66% of the group), **and their participation in the creation in the PERSEIAS** (29, 72% of the group).

- **The reflection activities proposed were received with excitement from the students**. Such excitement seemed to be **more towards the approach of the project and the fact of doing something different than towards learning science per se,** as suggested by observations and students' learning charts.

- **While students' interest and excitement towards the activities was quite stable, students' interest towards the topics approached changed depending on the workshops**, being the topics approached in PW3 and PW4 (**gender and the scientific method**) those that seemed to generate more interest. **The sharing of ECRs research** in PW1 also captured students interest.

- **Affective responses in relation to the reflection activities** were mostly observed in **the debate on gender**, which **generated heated discussions in both groups**, and especially in Group 2. We also observed some **moments of students' disclosure** during the forum after the interview role-play in Group 1.

- **Regarding the performance of the monologues, students showed a different degree of interest and motivation in performing. While some students manifested concern** as a reaction to performing in front of others, **an important part of the group also considered performing the monologues and acting as the best part** of the project.

- **In terms of cognitive engagement, a progression was observed in students throughout the sessions, both in terms of involvement in doing the tasks and in processes related to higher-order thinking such as reasoning and arguing, reframing concepts or making critical questions.**

- **Similarly, students' critical thinking in relation to science seemed to be low. Students questions to the facilitator and ECR were commonly clarification questions, related to doubts about the activities, the topics and the monologues, and critical questions digging deeper on the contents or the discussion were less often observed**.

- **When asked whether they had incorporated critical thinking in any way in their monologue, several students mentioned that they did it while looking for information in the internet.**

- **Students' lack of previous knowledge about some of the scientific topics approached, together with the general lack of time and tools for an in-depth approach of scientific topics or in-depth discussions might have hindered** the capacity of the process to foster students' **critical thinking. The teacher attending the workshops suggested some aspects of the design** that could be improved to adapt the materials to students' cognitive and school skills, mostly the **adaptation of technical vocabulary, the connection of contents to the curricula and the provision of clearer guidelines**.

- **Cognitive engagement might also have been hindered by the fact that much workload was placed outside the workshops, in the form of homework**. However, both teachers and students reported **students' general difficulty to deal and engage with homework outside school time.**

- However, and very importantly, our observations suggest that **although cognitive engagement was generally low, the project did manage to progressively motivate students to work during the sessions.** In this regard, **while students initially showed difficulties to keep focused on small group work, they progressively increased their concentration on the tasks.**

Students' involvement

Students' general involvement in both groups was very high, showing a constant willingness to participate throughout the sessions. In the big group, the discussion and activities generally flew without problem. **Students showed attention and interest most of the time and reacted actively to the facilitator questions**. Actually, many of them seemed **eager to express themselves and be heard** and also to discuss with other peers (even if they did not elaborate much their ideas). For instance, sometimes students would participate spontaneously, even if a question was made to another student. In this regard, **both groups were very active and no difficulties were observed in the group's general involvement**.

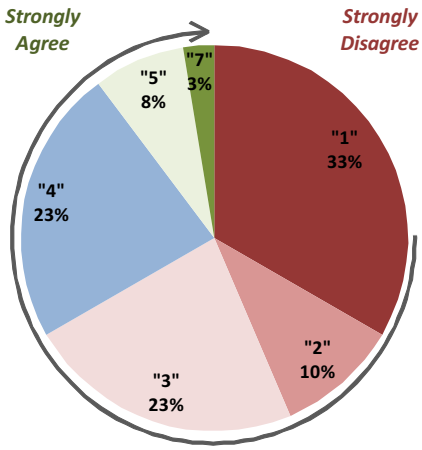
All teachers agreed that students were motivated to engage in the workshops and their involvement was high. Some of them were also surprised by the **involvement showed by some students who usually do not participate**:

> *"There were some positive changes since some students that commonly have quite poor academic results have made an important job if we compare it with their trajectory and results during the school-year"*
>
> *Male teacher, Catalan teacher, Terrassa*

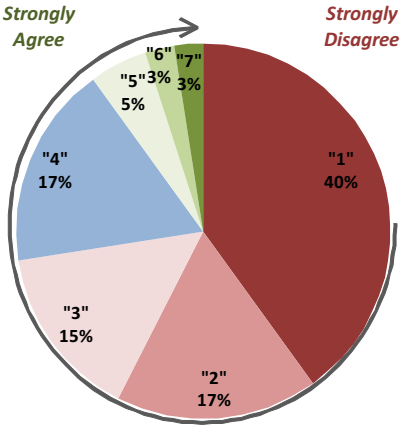
Emotional engagement

Such involvement was also observed through a general **motivated attitude towards the methods proposed and the participatory approach of the activities. Overall students engaged both in the activities fostering reflection and the development and performance of the monologues**.

Students answers to the post-PERSEIA survey also support these observations. As the following figures show, **most of the students reported finding interesting the reflection activities** (26 students, 66%), **and their participation in the creation in the PERSEIAS** (29, 72%), in contrast with 4 students that did not find the activities interesting (for both kinds of activities). However, also a group of between 7 and 9 students provided neutral answers, suggesting also an intermediate position.



"I found it of little interest to get involved in the reflection activities and group discussions (cards activity, articles activity, interview role play and art and science activity."



"I found it of little interest to get involved in the creation of our PERSEIA"

Indeed, as observed throughout the workshops, **the reflection activities were received with excitement from the students**. For instance, in Group 1, and as mentioned above, there was a constant group of about 10 students that generally showed interest and were motivated to work on the tasks. As mentioned in GOAL 1, this interest was especially observed when the two ECR presented their research during PW1 (we could even observe a change in students' body position that suggested interest). In this regard, in both groups **we observed more excitement towards the approach of the project and the fact of doing something different than towards learning science per se**. **Students' answers in the learning chart also echoed such enjoyment of the methodological approach**. As mentioned in GOAL 3 (Learning to Learn Skills), a big group of answers referred to a different way of learning through enjoyment and fun, which in turn, fostered their motivation to engage in learning. One boy explicit alluded to the arts and expressed it in the following terms:

"(I've learnt) that Arts are useful to interpret actions and raise awareness in people"
Boy SP 1109, Group 2

While students' interest and excitement towards the activities was quite stable, students' interest towards the topics approached changed depending on the workshops. While in PW1 students seemed less motivated about the topic (e.g. they did not ask questions to know more, no elaboration of ideas), students showed special interest towards gender in PW3 (gender) and towards the scientific method in PW4 (observed in Group 1). For instance, the gender activity generated by far the liveliest reactions and discussions and the debate clearly attired students' attention as we only observed 3 students with a distant or disconnected attitude (e.g. hardly participating, looking at their handy, bored expression). Similarly, in PW4 students in Group 1 showed special interest towards the explanation about the scientific method and one student even took notes, which had not been observed previously. Also, in the learning charts, a few students reported learning about the scientific method.

Affective responses in relation to the reflection activities were mostly observed in **the debate on gender**, which **generated heated discussions in both groups**, but especially in Group 2. Furthermore, in Group 1, we observed some **moments of students' disclosure** during the forum after the interview role-play. For instance, one boy shared his experience of privileged gender treatment at home (compared with his sisters) and the contradictions this generates on him. Also, when the woman ECR shared an experience of discrimination by gender in her PhD, a couple of girls reacted angry (e.g. "I would have bit him", "he does not have the right to decide

that"). Interestingly, in both groups, students showed surprise and curiosity when they were told the statistics of females in leading roles in academic or STEM institutions.

Regarding the performance of the monologues, students showed a different degree of interest and motivation in performing. For instance, in Group 1, with the exception of G4 (in which no student seemed to be highly motivated), there were motivated students in all the groups. While some students expressed their shyness and some concerns about performing, most of them engaged in the final performance showing a willingness to participate.

Differences were also observed between the two groups, probably due to the different guidelines provided by the facilitators. While in Group 2 participation in the final monologues was always framed as voluntary, in Group 1 students were told that they would all perform and only in the last session the possibility not to perform was opened. This allowed students in Group 1 to have a first direct experience of performing the monologue before taking the decision and seemed to foster a sense of responsibility towards the group that motivated shyer students to participate, as suggested in the focus group (see GOAL 3, Sense of Initiative). This way, while in Group 1, all students performed at least in the rehearsals and 16 students performed in the final monologues, in Group 2, only 8 students performed both in the rehearsal and final performance. This also affected students' attitudes towards working on the monologues at the end of the process and in PW6 in Group 2 while we observed two especially motivated groups that worked without the presence of adults, the other 3 groups showed low motivation.

Furthermore, **regarding students' affective responses, some students in both groups expressed at different moments their concern about performing in front of students of a different grade. At these moments, both facilitators responded in a very reassuring way**, framing their reactions as part of the process and encouraging students to rehearse to feel sure. In Group 1 in which all students performed in the rehearsals, **around half of the group seemed confident with performing, while 4 seemed a bit more shy and the rest seemed just a bit disconnected** sometimes or not that much interested. In this PW students could rehearse twice, which seemed to enhance their confidence. **Also, as mentioned above in Inclusiveness, differences in affective responses were observed between boys and girls in Group 1. When rehearsing in the last two workshops, generally the students that showed any concern about being ready to perform or made questions and comments about the performance (e.g. when, who, how) were girls**. For instance, in PW4, during small group work in G2, two girls seemed a bit frightened by the fact that they only had 2 more workshops before the performance. In G1, one girl (the same that talks about her shyness in the FG) shared her thoughts about feeling embarrassed in the final performance, while one of her peers showed confidence in herself. While showing more concern about the result of their performance, during the two rehearsals **girls also seemed more confident and sure about what they were saying than boys** (who with a couple of exceptions need to read their text).

Students in the focus group also expressed contrasting opinions about performing in front of a public of other students. The issue was brought up by one girl that shared that she did not like the fact of performing in front of students from a different grade (3º ESO, one year younger), which initiated a discussion. Some students expressed that it was not a problem from them, while some mentioned that despite not liking it, they understood the sense of performing for a different audience (e.g. showing the monologues to younger students that might engage in the project afterwards, overcoming their shyness). **They all agreed however, that they had enjoyed performing with the other group**, so they could get to know the work done in the other class.

Similarly, when asked in the survey *what they liked the most of the process*, many students alluded to the performance of the monologues. See for instance the following answers:

"The day of the final performance"
Girl SP1104, Group 2

"Representing my monologue in front of everyone and feel confident in the scenario because I had never performed anything in front of so many people"
Girl SP12 18, Group 1

"The acting, we felt stressed and then everything ended and we felt like relaxed"
Boy SP1119, Group 2

Also, one teacher shared a comment from a student that illustrates the potential effect that the process might have had in the engagement and motivation of some students' who commonly do not engage much in academic tasks:

> *"This was so exciting for me… I saw the students performing and the day after I had class with them and Girl SP1222, entered the music room and plenty of euphoria she told me: "Teacher, did you like my monologue? The one about music and the brain" and I said "yes, of course!". And I was pleased to see her so moved by an academic task… it really surprised me"*
>
> *Female teacher, Music teacher, Terrassa*

Furthermore, **the performance of the monologues also seemed to engage some students that commonly do not show engagement in the classroom and even some that were not much motivated through the previous workshops, as suggested by the observations and teachers interventions during the interview**. For instance, in Group 1, G4 was one of the subgroups which seemed less interested in the monologues and worked less. However, during the rehearsal in PW5, 2 of the students (both born abroad and Spanish speakers) made the effort of presenting in Catalan and one of the boys improvised his presentation without reading, which suggested interest about and knowledge of the topic presented. During the same session, in G1, one girl that had missed several workshops and was outside most of the session (she was feeling sick), performed the monologue with her group, quite engaged with the activity. This girl ended up presenting the monologues with another girl during the final performance.

Cognitive engagement and critical thinking

A progression was observed in students' cognitive engagement throughout the sessions, both in terms of involvement in doing the tasks and in processes related to higher-order thinking such as reasoning and arguing, reframing concepts or making critical questions[4].

[4] See GOAL 3 –Learning to learn skills for a detailed description of these items (students' involvement in reasoning and argumentation during the activity, students' ability to ask questions, discuss, make conclusions during the activity, students ability to reframe related scientific concepts and develop their ideas). Here we just emphasise the main ideas related to these items, to avoid redundancy.

In terms of engagement with high-order thinking, according to the design of the process, PW1, PW2 and PW3 were the workshops providing more space for discussion, reasoning and argumentation as they all included a group activity and a guided debriefing afterwards (PW4 also included an activity about the scientific method but there was no group sharing afterwards).

Along these workshops, **students observed involvement in reasoning and discussion significantly increased, from being low at the beginning** (e.g. students mostly shared their first thoughts and did not provide arguments) **to engage students in some arguing and reframing during the gender workshop**. As mentioned in GOAL 3, **this was the workshop generating more discussion in both groups.** During group discussion, several students engaged in argumentation and reasoning when answering and discussing about gender, and some elaborated conclusions with the support of the facilitator and ECR whose questions helped them go further. In Group 1, students' reasoning was more oriented towards reinforcing other peer's comments, like a brainstorming of complementary arguments (for instance, the three interventions on the impact of societal pressures on women). In the case of G2, **during the discussion about gender** there was a group of about 10 **students that articulated their answers and were quite incisive in their reasoning and arguing**. This core group was very engaged and even if sometimes the discussion got quite intense, the argument grew richer during the workshop.

Similarly, students' critical thinking in relation to science seemed to be low. Students questions to the facilitator and ECR were commonly clarification questions, related to doubts about the activities, the topics and the monologues, and critical questions digging deeper on the contents or the discussion were less often observed.

Also, **students frequently needed the guiding of the facilitator or the ECR to engage in reasoning and in the elaboration of ideas**, which made plenary discussions flow more easily than those held in small groups. **Students' lack of previous knowledge about some of the scientific topics approached within the workshops, might have influenced this**, as suggested for instance by students' different involvement in reasoning and questioning in PW1 focused on EU societal challenges and in PW3 focused on gender through examples close to their daily lives (see section below on Ethics Integration). In this regard, **students' reasoning was mostly based on their daily experiences (rather than on specific knowledge about the issue, for instance knowledge from the school curricula) and as common to their age, they lacked a rapport with science and scientific practice**.

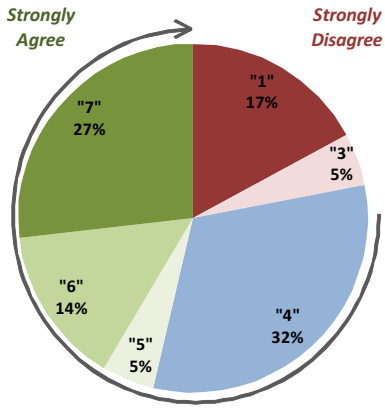
Also, the general lack of time and tools for an in-depth approach of scientific topics or in-depth discussions might have hindered the capacity of the process to provide students with a systemic approach to the topics addressed. Again, the workshop on gender, with its limitations, was an exception to this. Although the approach to gender was focused on symptoms of gender discrimination, there was more time devoted to discussion and it brought up reflections connected to work, home and school contexts. Also at the end of the discussion in Group 2, the facilitator briefly connected the issues raised with the creation of the monologues and being sensitive to gender-related messages.

In this line, **the teacher attending the workshops identified some aspects of the design** that could be improved for the next implementation to adapt the materials to students' cognitive and school skills: i) technical vocabulary more adapted to students (identified in PW1 and PW2), ii) the connection of the contents to the school curricula to foster synergies, and iii) if the stations exercise in PW2 is to be repeated, the provision of clearer articles and a more comprehensive explanation of the activity proposed and questions to discuss. **These aspects might have**

hindered some students' cognitive engagement in the activities proposed and could be tackled for the next implementation.

Cognitive engagement might also have been hindered by the fact that much workload was placed outside the workshops, in the form of homework. This contrasts with students' general **negative attitude towards doing homework** for the project, as expressed both in the surveys and in the focus groups.

In the survey, **students did not seem to value the contribution of homework to their PERSEIA learning and creation process**, as almost half of them (17 out of 40) considered that the monologues could have been done without homework and 32% provided intermediate answers.



"The [PERSEIA] could have been done without homework"

Teachers also referred to **students' general difficulty to deal and engage with homework outside school time**:

> "*There were some groups that were working well, like those from Girl SP1206 and Girl SP1204… But then we had other groups that were less balanced at a working level and we had to struggle with them all the time, insist them, because otherwise they would do absolutely nothing".*
>
> *Female teacher, tutor Group 1, Terrassa*

This was referred both in terms of: i) doing the assignments in-between sessions, and ii) using the Moodle platform to share their assignments. In both cases, the two tutors provided support to the students, either dedicating time from their lessons (also for the rehearsal of the final performance, see GOAL 1) or reminding them about the tasks.

One teacher also mentioned that, despite not engaging much with homework, he could observe an increasing cognitive involvement with the project along the workshops:

> *"(Involvement) Went in crescendo, as the date was getting closer… Honestly, there was a dynamic that was a bit scary at one point because they were not uploading anything in Moodle and then we told the students and the next day they had uploaded it, right? And I think they were quite involved, very involved, actually. They even argued when choosing the topics… you know what I mean?"*
>
> *Male teacher, tutor Group 2, Terrassa*

Similarly, although students acknowledged that it did not represent a lot of work, they reported in the focus group already having a lot of homework from other subjects, which made it difficult for them to engage with it. Only one girl openly expressed that finding time was "a matter of motivation" and homework could have been done. Furthermore, they mentioned **doing homework during the time provided by their tutors** (in lessons or supervision sessions), especially students from G1 which mentioned the 2 hours their tutor let them for recording the video and uploading it. Some students also mentioned the lack of engagement with homework of some of their peers, which forced them to assume all the work in-between sessions (see GOAL 3, Social and Civic Competences) or prevented them from uploading the homework in the Moodle platform. They also related this with the **frequency with which some students are temporarily expelled from school**, as a factor negatively affecting their involvement in the project and consequently, the dynamics of the group.

Furthermore, some students associated **the time span in-between sessions as a factor hindering their cognitive involvement,** as they sometimes forgot the work done in previous sessions. In this sense, a couple of students suggested reducing the time in-between sessions, for instance**,** splitting the 2-hour session into two sessions of 1 hour and having workshops twice a week, or having longer sessions.

In this regard, in terms of students' involvement in cognitive tasks, while students initially **showed difficulties to keep focused on small group work, they progressively increased their concentration on the tasks.** Very importantly, our observations suggest that **although cognitive engagement was generally low, the project did manage to progressively motivate students to work during the sessions.** For instance, in Group 1, three out of the five groups seemed motivated by the monologues and engaged easily in group work for the PERSEIAs. For instance, in PW3, girls in G5 (music and the brain) showed themselves very motivated towards both the topic and the monologue and engaged in a creative sharing of ideas and an enthusiastic brainstorming (they actually got so many ideas that they wondered how to proceed). They also expressed their motivation to do the homework and wrote a text to upload in the Moodle platform. Similarly, in PW4, students in G2 seemed very motivated during small group work, quickly answering to the facilitator questions and expressing their interest on the topic while explaining it to other peers (one girl even explained to another peer how they were organising themselves with the homework to make it "team work"); and students in G1 did an extensive brainstorming of sentences for their monologue. Again, and similarly to other aspects observed, this was more frequently observed in those students leading the group, while some students connected and disconnected throughout the workshops.

Finally, **when asked about "critical thinking" students associated the term with criticising and with providing constructive feedback to their peers** (e.g. "expressing the bad things you see", "when you criticise someone but to improve", "something bad that helps you learn"). In this sense they seemed mostly to recall the facilitators guidelines provided during the rehearsal of the PERSEIAS. Then, when we provided a general definition and suggested that there was a workshop about critical thinking, students quickly mentioned the stations activity. **When asked whether they had incorporated critical thinking in any way in their monologue, several students mentioned that they did it while looking for information in the internet** (e.g. looking at different sources and not believing whatever they read). No mentions to the way they approached the topic were made until we explicitly asked about gender (see section above).

Similarly, some students' answers' in the learning charts, reported learning related to critical thinking, and most specifically related to trusting information, which suggests a certain influence of the workshops:

"I've learnt to better look for information, comparing it from different places"
Girl 1106, Group 2

"I've learnt not to trust whatever from the Internet if it is not proved by several people"
Girl 1116, Group 2

One ECR also reflected about the potential value of the workshops in fostering critical thinking, even if it was not seen at the moment:

> *"I thought it was a very nice project for some things, for example to create these spaces for critical thinking, to discuss about gender... Maybe they are not applying this thinking or these processes in the moment of the monologues or maybe this year, but maybe in 5 years they have this "ok, yes... I did that and I can apply that" or something that is there in their brain. And I think that is positive"*
>
> *Female ECR, Group 2, Terrassa*

THE NATURE OF SCIENCE: ETHICS INTEGRATION

Main highlights

- In general and as mentioned above, **students interventions during the workshops suggested little *rapport* with science as a process and a general lack of understanding of the nature of science.** However, when asked in the written surveys, **an important number of students showed an awareness of science risks and uncertainties**, despite **contrasting perceptions about science as a process**.

- In this regard, although the workshops did not seem to have a significant impact, they seemed to reinforce positive trends regarding students' perceptions of the unexpected impacts of research in society, the possibility of failure within science, and the nature of scientific knowledge.

- **Regarding the integration of social and ethical aspects of research in the activities,** during the workshops **an effort was done in the contextualisation of science and its social relevance, through the contextualisation of STEM topics within societal challenges.**

- **The sharing of science as a process remained, however, an aspect to better explore with students** (e.g. showing contrasting perspectives about science, integration of ECR's personal stories in the workshops, fostering reflections about ethical behaviour in science). **The lack of depth in the approach to scientific topics and more spaces for sharing ECRs experiences** have been identified as aspects hindering such sharing.

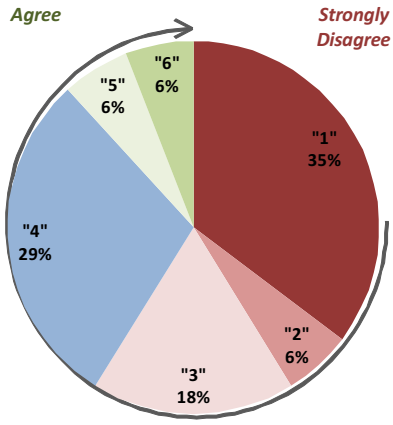
- **Despite these key aspects to improve,** students reported in the focus group a **broadening in their views about science,** which is **related with some ethical and social aspects of research**, as the **incorporation of ideas about women discrimination and the value of women to science**.

Finally, we approached the understanding of the nature of science, both through the perceptions of students, and through the capacity of the project and the activities designed, to include ethical aspects of research and share science also as a process.

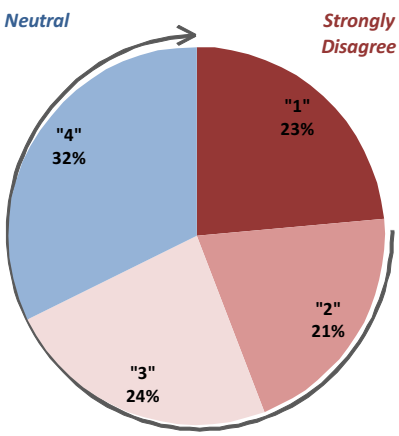
In general and as mentioned above, **students interventions during the workshops suggested little *rapport* with science as a process and a general lack of understanding of the nature of science.** For instance, in PW2 on critical thinking while discussing the criteria for assessing information in Group 1, students sometimes compared science communication with advertisement (which is how they connected the discussion to their personal experience) and one girl mentioned that people in universities are not trained enough to carry out research. They showed, thus, a flawed perception of science and some extended mistrust or scepticism (which, in turn, might have been emphasised through the critical thinking session).

However, when asked in the written surveys, **students reported contrasting perceptions about the nature of science and scientific knowledge** depending on the item, **although an important number of students showed an awareness of science risks and uncertainties**.

Specifically regarding the impact of science in society, before the workshops, more than half of the students (20 out of 34) seemed to be aware of the potential risks or unexpected impacts of science as they disagreed with the item "*Science only has good impacts on people*", while only 5 students reported mild agreement (close to the neutral positions). However, a number of students (10) provided neutral answers, suggesting no clear positioning in this regard. The workshops reinforced such trend without relevant changes as the number of students disagreeing increased to 23 in the post-survey, no single student agreed with the statement and neutral answers remained stable (11). Significant differences were found only between boys and girls, as girls' agreement was milder than boys' (z = 1.927; Prob > |z| = 0.0540).

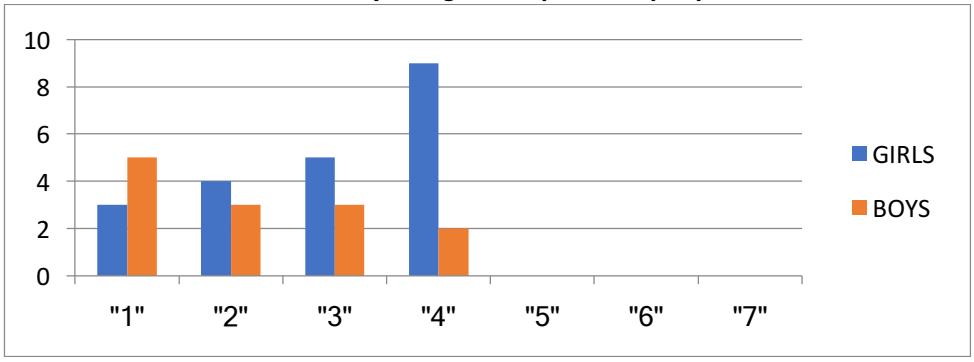


Before the workshops

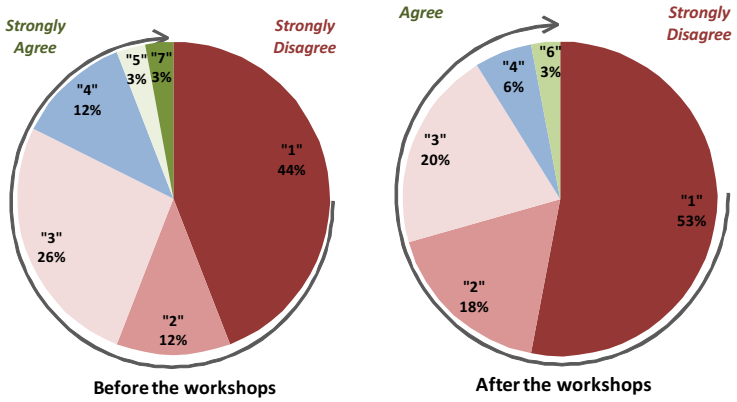


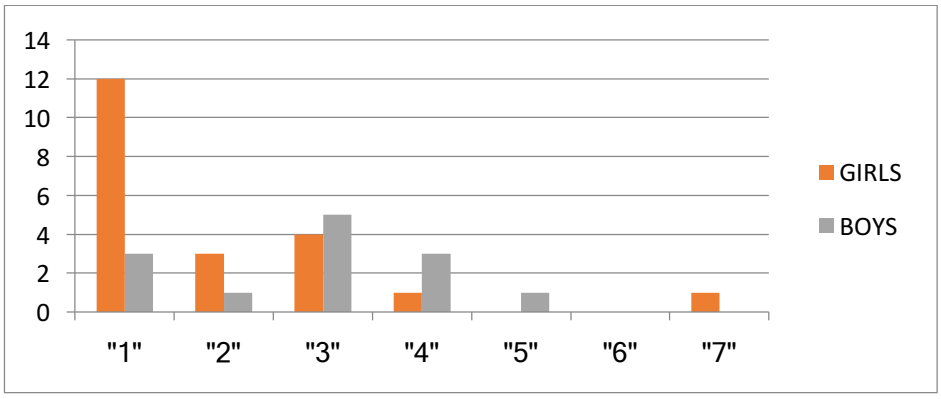
After the workshops

"Science only has good impacts on people"



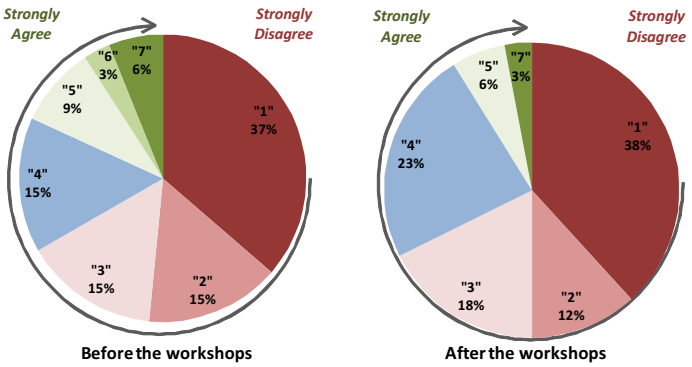
When approaching notions of failure and good science, the majority of students disagreed with the item “good scientists do not fail while doing science” both before and after the workshops, although the number of students increased from 82% to 91% and only 1 student agreed with the statement. Differences before and after the workshops were not significant but they were for boys and girls before the workshops, since boys were positioned more towards the neutral position (z = -2.19; Prob > |z| = 0.028). After the workshops, such difference was not found and both boys and girl were positioned towards the pole of agreement.





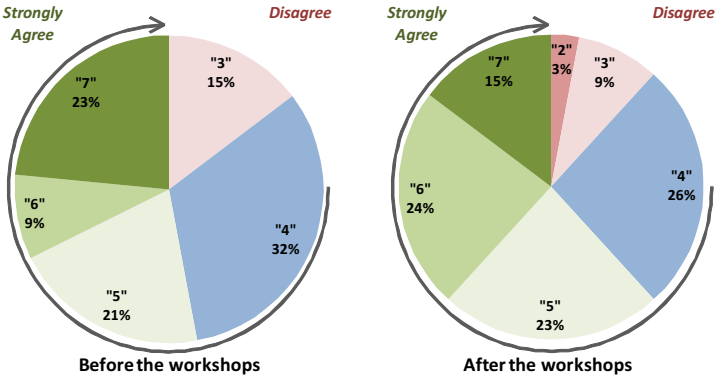
"Good scientists do not fail while doing science"

When asked about the nature of scientific knowledge, students generally disagreed that it “is always certain and therefore never changes over time" both before and after the workshops (67% and 68% respectively). Although changes were not significant, after the workshops, neutral answers increased from 5 to 8 students, while only 3 students agreed with the statement and they were placed close to the neutral position (see Figure below).

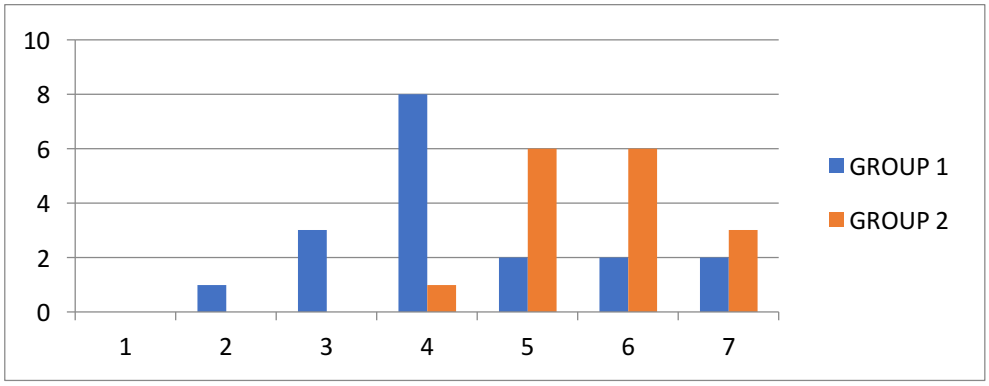


"Scientific knowledge is always certain and therefore never changes over time"

Students perception of the production of scientific knowledge as involving human imagination and creativity received less support with 54% (18 students) that agreed to the statement and 32% (11 students) providing neutral answers. Although differences were not significant, this support increased to 63% (21 students) after the workshops, while neutral answers slightly decreased to 26%. However, we found significant differences between groups after the workshops (as Group 2 provided more neutral answers than Group 1; z = -2.9; Prob >|z|= 0.003).



"The production of scientific knowledge involves human imagination and creativity"



Regarding the integration of social and ethical aspects of research in the activities, during the workshops, **an effort was done in the contextualisation of science and its social relevance.**

Overall, **when the facilitators approached STEM topics in the reflection activities, they frequently contextualised them within societal challenges.** The most evident case was PW1 in which through the examples of the cards game, students could approach some societal challenges and their connection to STEM topics/careers (although there was no deepening on the topics and no further contextualisation in students' daily life). Also, in PW2 in Group 1, the facilitator shared criteria for searching information which were contextualised through the news exercise and connected to students' daily experiences in the discussion afterwards (e.g. applied products they consume and the research-appearance of their publicity). Furthermore, the scientific monologue was in itself a contextualisation of a STEM topic, although many of the final monologues elaborated lacked scientific content or a development of it (see GOAL 2).

However, **the sharing of science as a process remained an aspect to better explore with students** (e.g. showing contrasting perspectives about science, integration of ECR's personal stories, reflections about ethical behaviour in science).

In this regard, **we did not observe a global approach from the facilitators to embed contrasting perspectives when approaching science or a given scientific issue, probably due to the lack of depth in the approach to scientific topics**. For instance, although the cards game in PW1 provided indeed a diversity of scientific profiles, the topics/challenges presented were not approached in-depth and therefore there was no chance to show contrasting perspectives about them.

Similarly, and probably due to the same reason, **reflections about ethical behaviour in science were not frequent.** We observed, however, two specific moments in which they were introduced. First, in the critical thinking session in Group 1, in which ethical guidelines in research to guaranty some ethical values and human rights were brought up in the discussion (e.g. discussion about cloning, although students did not elaborate a reflection about it, the idea was clearly communicated). Second, in the gender discussion in both groups, in which students were encouraged to reflect about gender through the role-play of the interview. Also, the female ECRs in both groups shared their personal experiences in the PhD related to the topic (one of gender discrimination and the other about subtle gendered-pressures), inviting the students to reflect about them. This was a **nice example of including ECR's personal experiences to foster students' reflection and awareness of science as a process**. In this regard, the two ECR in Group 1 seemed to have more space to share their stories than in Group 2 and besides briefly presenting their research on the first day (the second day for the ECR in Group 2), they also shared their research questions and how they got to them as an inspiration for the students in PW2. As suggested in GOAL 1, **the project would benefit from more opportunities for including ECR personal experiences in the sessions and in the sharing with students**.

Despite these key aspects to improve, when asked about changes in their perception of or their relation to science **as a consequence of the project**, several students commented that although **their global perception of science (in terms of interest and motivation) had not changed, the project had indeed broaden their view**. Such "broadening" seems to be related with some ethical and social aspects of science, as they mentioned, for instance, the **incorporation of ideas about women discrimination and the value of women to science**.

Interestingly, in terms of approaching science as a process, **students still considered science as "hard"** and in this sense, students differentiated between what was done at PERFORM –sharing

a funny methodology of science communication that fosters science learning, with doing actual science –which can be rather stressing**:**

MARÍA: What is your view about science right now?

GIRL SP1102: None

GIRL SP1108: That it's hard, but well...

BOY SP1113: Why?

GIRL SP1108: Well, it's not going to be easy, right?

BOY SP1113: But there are two kinds of science, right? There is the one we were taught here... But then, maybe when you go into a lab you dont' practice it as we did, I mean, like a fun thing and so on. When you go into a lab... I think it is more of stressing yourself.

GIRL SP1122: That's obvious, they are not going to be laughing around, you know? ...

MARÍA: What about here?

GIRL SP1206: Well, (I think) everyone can get to learn it, but with effort.

Also, as reported in GOAL 1 students' comments suggested that **the project has helped them overcome some general stereotypes about scientists**, i.e. from a mad man who never gets out of his lab where he conducts big explosions to seeing them as normal people.

GOAL 4: RRI VALUES

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1) STUDENTS' PERCEPTIONS AND ATTITUDES TOWARDS SCIENCE

Main highlights

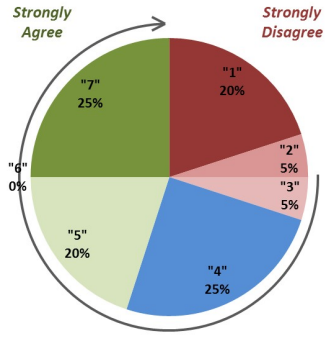
- Around half of the students perceived learning STEM as enjoyable, being **Biology the most enjoyable subject,** and having a **sharp difference in answers between boys and girls regarding Maths** (girls enjoyed it more than boys) and **ICT/Computing and Chemistry and Physics** (boys enjoyed them more than girls).
- **Students seemed to feel very at easy with doing activities related to science,** but workshops appear to have widened **a little students' emotional scope towards science**, having **"motivated" as the main emotion** but developing a slight tendency towards **negative emotions such as "uncomfortable"** after participating in the workshops.
- Students **were aware of the importance of science and scientific jobs for society**, which rather changed after the workshops, suggesting a **low impact of the workshops** in this regard.
- Students were also perceptive of potential **gender inequalities in science** and were in disagreement with them, both before and after the workshops.
- Students showed **contrasting feelings** towards the idea of studying a scientific career, some of them felt motivated while others did not agree with the idea. **Despite not significant**, the percentage of students motivated towards the idea of study a career involving STEM **decreased** after the workshops.
- **Similarly,**60% and 30% of students agreed and disagreed with the idea of seeing **themselves doing science in the future** before and after the workshops. These results suggest that **workshops did not have a clera effect on students' perceptions and motivations towards science**.

Description of main results

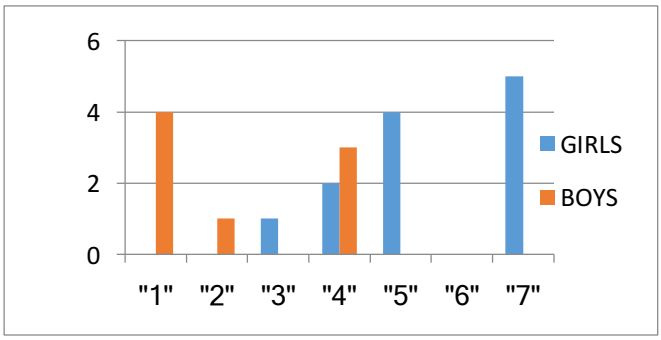
We first present some data on **students' feelings on science learning at school** gathered through the pre-survey as an introduction to the results related to students' potential changes in perceptions and attitudes towards science and scientific careers and jobs as a result of their participation in the workshops.

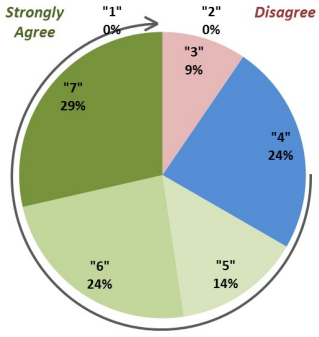
Before the workshops we asked students if they **enjoyed acquiring new knowledge in STEM.** Overall around half of the students were appreciative of learning STEM-related subjects but with variations according to the discipline. **Maths was the subject less preferred** by students (45%, 9 out of 20 students who answered this question) with statistically significant differences between boys and girls, **being girls those who enjoyed the most learning on Maths** and boys those who enjoyed less doing it ($z=3.32$; $p<0.01$). In turn, **Biology was the most enjoyable subject according to the students** (67%), having a statistically significant difference between the **PERFORM and control groups since the students participating in the project agreed more on enjoying learning on Biology** than their peers in the control group ($z=2.42$; $p<0.02$). The other STEM-related subjects were enjoyable for a similar percentage of students: Design and Technology (57%), ICT/Computing (53%) and Chemistry and Physics (52%). We found significant differences between girls and boys in two of these subjects. **Boys agreed more than girls when asked about enjoying learning about ICT/Computing** ($z=-2.15$, $p<0.03$) **and Chemistry and Physics** ($z=-2.24$, $p<0.02$). Last but not least, it is worth noting that the disagreement was almost null in the case of Biology (2 students, 9%) whereas higher in the other subjects: Maths (30%), Chemistry and Physics (33%), ICT/Computing (33%) and, Design and Technology (38%).

"I enjoyed acquiring new knowledge in…"

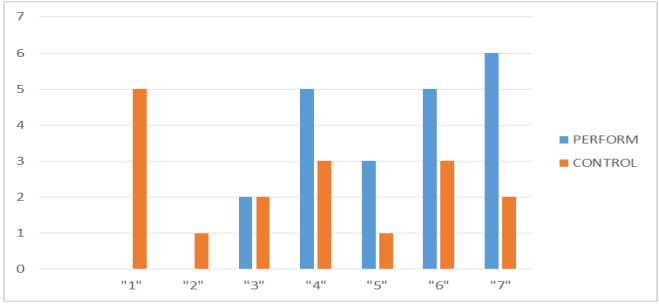


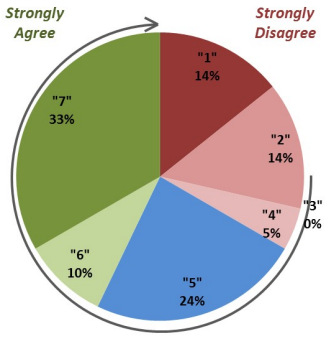
Maths



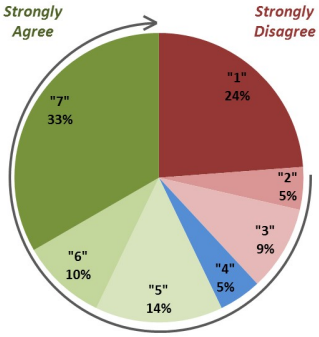


Biology

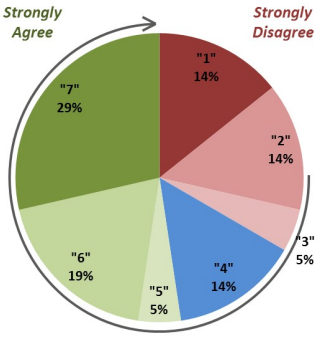




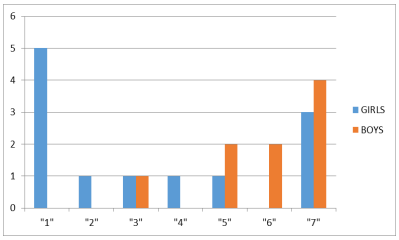
Design and Technology

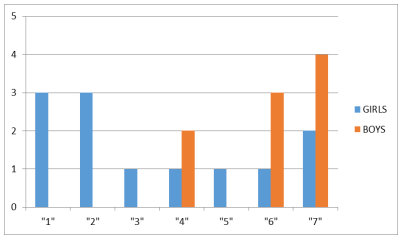


ICT/ Computing



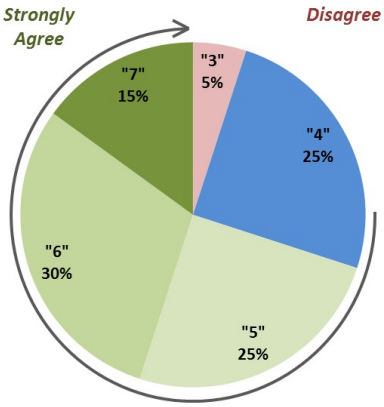
Chemistry and Physics



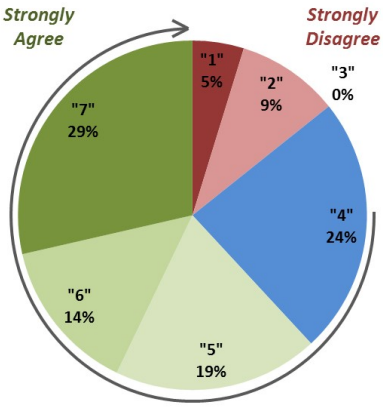


"I enjoy acquiring new knowledge in…"

In this regard, when students were asked in the focus group if they felt at ease after taking part in PERFORM, students said that generally they do, although one (Boy SP2107) stated that he was already feeling comfortable when doing this type of activities related to science. Indeed, **their answers in the pre-test showed that students were already feeling very at easy with doing activities related to science** (70% agreement, 14 out of 20 students), with only 1 students disagreeing (5%) and 5 providing neutral answers (25%). **After the workshops the number of students strongly agreeing with the statement increased** (from 3 to 6) **but also those who disagreed** (from 1 to 3 students). These differences were not significant. On the focus group no student reported a negative impact of the project in this regard.



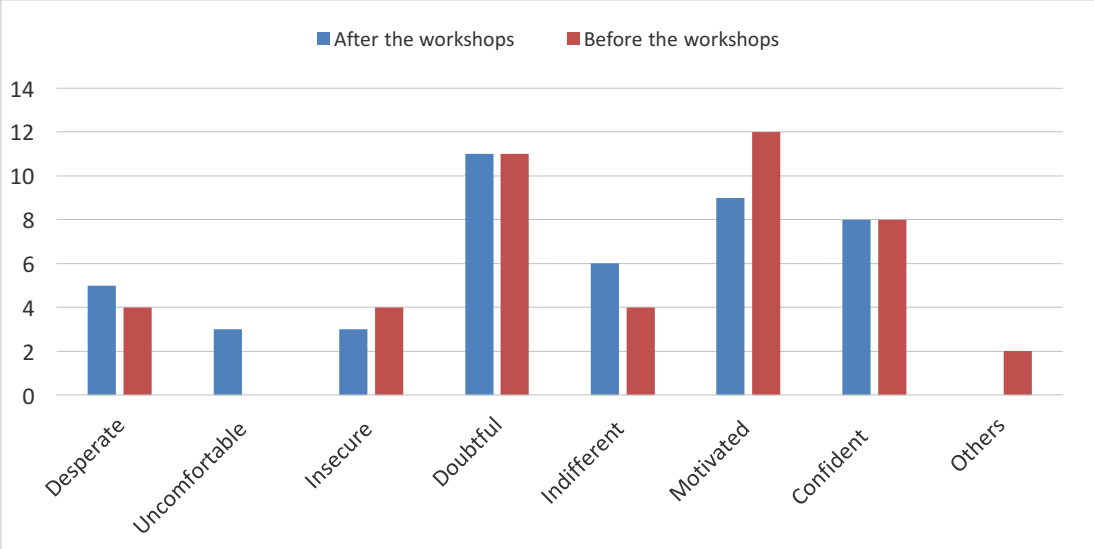
Before the workshops



After the workshops

"I feel comfortable while doing activities related to science"

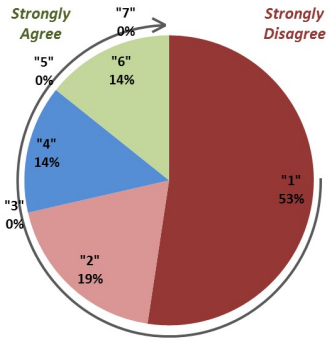
In this regard, the workshops appear to have widened a little the emotional scope towards science class or related activities, **with a slight and not significant tendency towards less positive emotions afterwards**. Before the workshops, when asked **" At science class or while doing science related activities, I usually feel..."** the main emotion reported was “motivated” (27%) that decreased to 20% after the workshops. The other main emotions were “doubtful” (20%) and “confident” (18%) and both remained constant afterwards. None student felt "uncomfortable" when doing science-related activities before the workshops, but after 3 of them reported to have this feeling. Moreover, one student changed to feeling "desperate" after the workshops, raising the percentage from 9% to 11%. By contrast, 9% answered "insecure" at the pre-test, a percentage that was reduced to a 7% at the post-test.



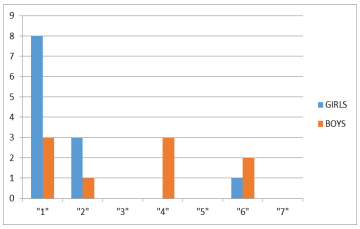
“In a science class or while doing science-related activities, I usually feel...”

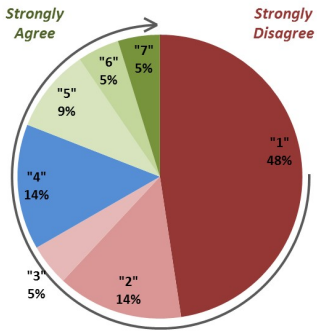
Students were also asked about **their perceptions of the role of science in and for society**. Overall, participating students showed **positive perceptions towards the importance of science and scientific jobs** for society. This pattern rather changed after the workshops, suggesting a low impact of the workshops in this regard.

Before the workshop, when students were asked whether they agreed or not with the statement "***science has nothing to do with real-life problems***", 72% of them was in disagreement and 14% of them agreed. After the workshops, 1 student changed opinion so disagreement was shared by 67% of the students and 19% agreed. Consequently, significant changes were not found between students’ responses before and after the workshops. We only found statistically **significant differences between girls and boys before the workshops**, being girls more in disagreement than boys, which was not found after the workshops.



Before the workshops

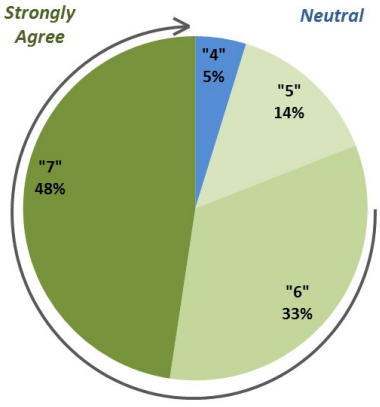




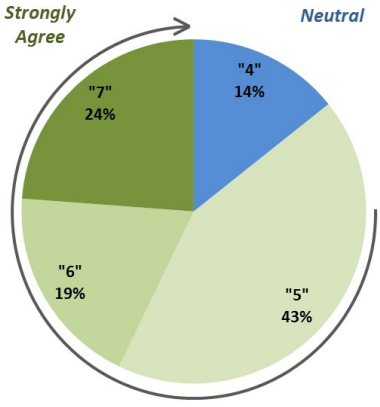
After the workshops

"Science has nothing to do with real-life problems"

Such general perception about the connection of science with societal challenges was also supported by students' responses to the statement ***"science will help me understand more about worldwide problems"*.** There was no disagreement, but before the workshops 48% of students strongly agreed and 14% slightly agreed whereas after the workshops these percentages changed to 24% and 43% of strongly and slightly agreement respectively. Such **difference between students' answers before and after the workshops was statistically significant** (z=-2.27, p<0.02), suggesting that **workshops might have slightly biased students' positive perception of the role of science in and for society.**



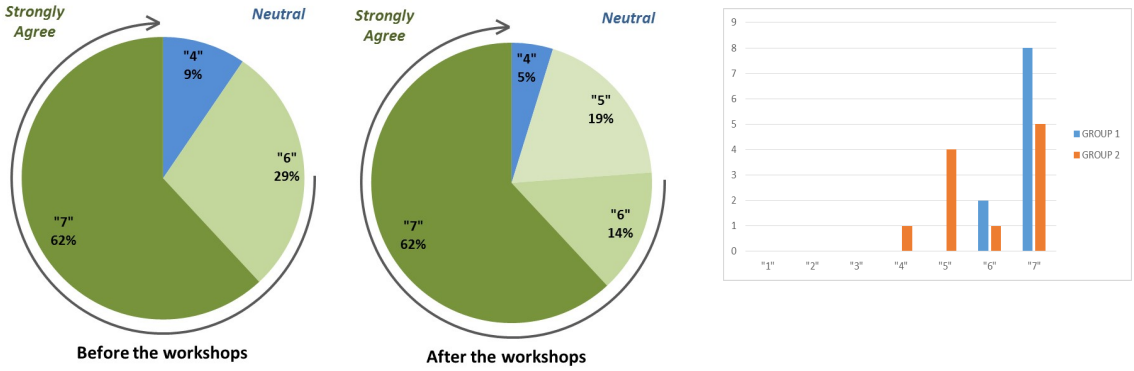
Before the workshops



After the workshops

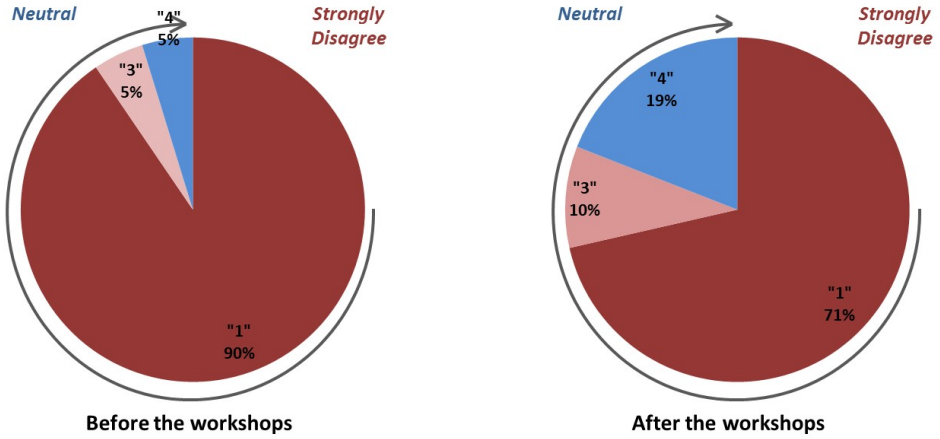
"Science will help me understand more about worldwide problems"

Also related to students' perceptions of the role of science in and for society, survey results suggest that students overall agreed about **the importance of scientific jobs for a better society, and such perception remained stable after the workshops** (93% before and 95% after). We found statistically significant differences between Group 1 and Group 2 after the workshops, because Group 1 were more in strongly agreement with the statement than Group 2.



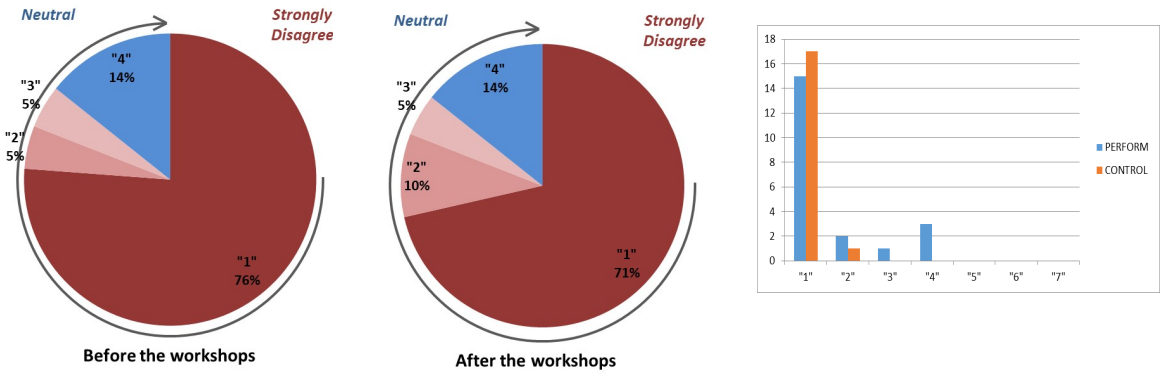
"Scientific jobs are important for a better society"

Students also answered questions on their **perceptions about gender-related roles in science.** 95% of students disagreed with the statement **"Men are better scientists than women"** before the workshops with a 5% neutrality (1 student). However, after the workshops there was a 81% of disagreement and a 19% neutrality rate (4 students), although changes were not statistically significant.



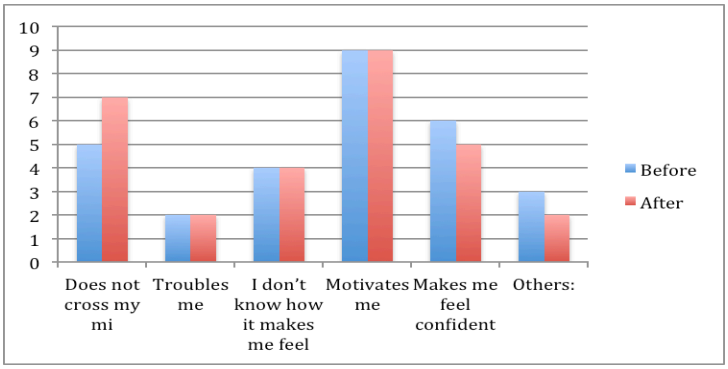
"Men are better scientists than women"

Along the line of asking about their gender related perception on science, students were asked to react to the statement **"scientific careers are mostly for boys".** Most students **disagreed with the statement both before (86%) and after the workshops (86%)**, with a 14% neutrality. Interestingly, we found significant differences in responses given by the control and PERFORM groups after the workshops: **students in the control group were more in disagreement with the statement than those in the PERFORM group** ($z=1.99$, $p<0.05$). This difference was not found before the workshops.



"Scientific careers are mostly for boys"

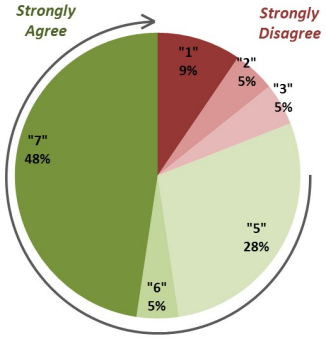
Finally, **students were asked about their motivations for learning science and studying scientific careers.** Both before and after the workshops students **showed contrasting feelings** to the statement ***"The idea of studying a scientific career makes me feel...."*. Main reactions were: "it motivates me"** (31% before and afterwards), **"Makes me feel confident"** (21% before and 17% afterwards), and **"does not cross my mind"** (17% before and 24% afterwards). 4 students responded that they did not how the idea made them feel and only 2 of them answered that the idea troubles them. No statistically significant differences were found before and after the workshops.



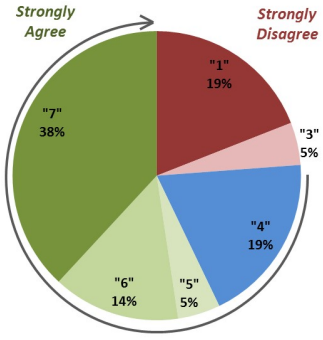
"The idea of studying a scientific career makes me feel..."

A similar percentage of students who responded that the idea of studying a science-related career did not cross their mind answered they **would not like to study a STEM career** (19% before ad 24% after the workshops). By contrast, **81% agreed they would like to study a career on STEM before the workshops**, **but afterwards this percentage was reduced to 57% of students**. **Despite not being significant**, this is quite an important reduction of students wanting to study a career involving science after the workshops (5 out of 21 students changed their mind). Among other reasons that were not sufficiently explored, such change could be related to an aspect of students realising the amount of commitment involved in studying a scientific career as a result of their involvement in the workshops and conversations with ECRs, since during the focus group a Girl SP2107 mentioned how it stricken her. In this case we did not find significant differences related to gender, as it were found when answering to **"learning science is not important for my future success"** after the workshops, being boys less in agreement than girls (see GOAL 3). We did find **significant differences between groups before the**

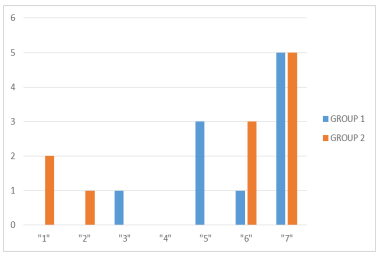
workshops: students in group 1 were more in agreement with the statement than students in group 2 ($z=1.92$; $p<0.05$). These differences were not found as significant after the workshops.



Before the workshops



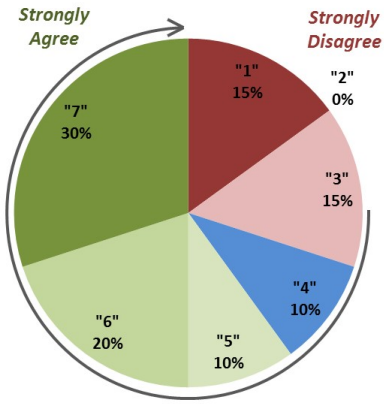
After the workshops



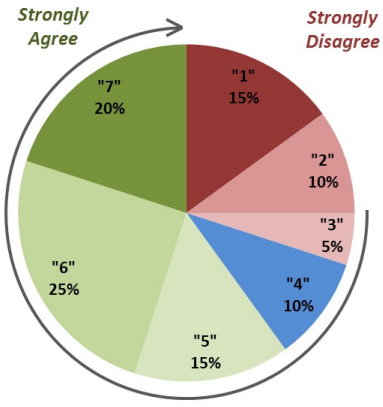
"I would like to study a career involving science (like biology, geology, physics, medicine or chemistry), technology, engineering or maths"

Such contrasting perceptions were also showed when asked if **they could see themselves doing science in the future**, since 60% and 30% of students agreed and disagreed, respectively, before and after the workshops. We found statistically significant differences between the PERFORM and control before the workshops, being those students in the control group more in disagreement with this idea than PERFORM students. Such difference was not significant after the workshops. These results suggest that **workshops did not have an effect on students' perceptions and motivations towards science**.

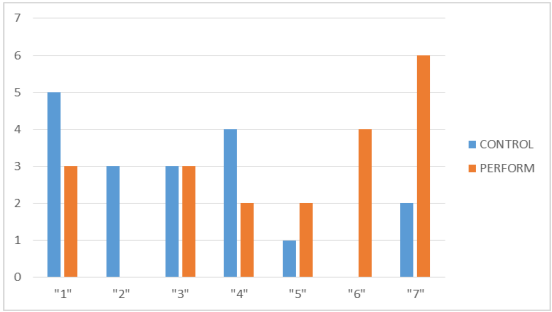
"I could see myself doing science in the future"



Before the workshops



After the workshops



2) INCLUSIVENESS

Main Highlights

- **Overall, we can argue that students generally felt positive about their role in the PERSEIA and got engaged actively in the process.** They reported their active participation in all workshop activities, having girls report feeling much more positive than boys (33% reported not actively participating).
- **Students felt included in the process:** they felt able to communicate how they wanted with the facilitators, dialogue was fostered and their ideas were included in the monologues. Nonetheless, **they would have liked to have a better sense of the overall organisation from the onset (representations, groups)**. For instance, students in group 2 complained they were **not told they would all have to act** until session 4.
- **Over two thirds of the students felt their work had been recognised by the researchers (69%) and science communicators (90%).** However, more than half of the students reported they would have liked to interact more with the ECRs during the workshops.
- **No differences in participation according to gender were observed through the process.** While approaching gender as a topic, Group 2 was able to debate about gender issues and notice them while group 1 had a hard time debating and did not seem to find there were differences between men and women

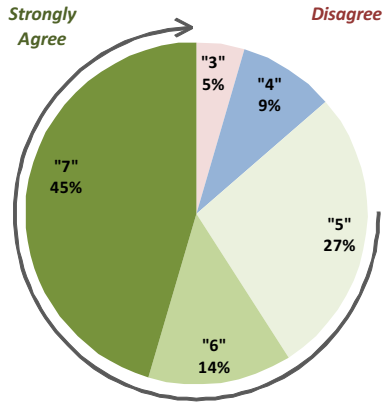
As seen in GOAL 3 (further details in Social and Civic Competences), we can say that overall students were feeling very positive about their active participation in all workshop activities, having girls (92% of them) report feeling much more positive than boys (33% reported not actively participating).

This seems coherent with researchers' observations of the process. Throughout the workshops the facilitator created a **relaxed atmosphere in both groups, based on a quite horizontal relationship**. **Students were encouraged to participate** in a conversation-manner, without the need to raise their hand (although some of them did). **Group 1 appeared to be a little less participative though, with the facilitator having to strongly encourage all participants to engage**. The facilitator in Group 2 did not need to raise his voice often, rather he kept students focused with his sense of humour and he reasoned with them when they were getting dispersed. The facilitator's and ECR's interventions were generally framed in a very positive way, encouraging students to participate and feel confident. For instance, in PW1 the facilitators reinforced students' interventions in their narratives, rather than correcting them (even if there were often inconsistencies). When in small groups, the facilitator in group 1 managed better to include all the group into the discussions, albeit in smaller groups. Session 4 had the facilitator managing to engage all students with the warming up activity, and she stated that it was about team work. **This session worked really well in terms of inclusiveness, having all students participate**. In PW6 both facilitators and ECRs provided feedback to the PERSEIAS emphasising all the positive aspects and framing their critics in a

constructive manner. In group 2, the facilitator generally encouraged all members to participate and in two out of the three plenary activities all students had to share something (i.e. all members of the group shared the narrative built during the cards game in PW1, and all of them “went up in stage” and performed during the last rehearsal, even if just a minimal role). Only during the gender activity, students who could engage in an active role during the role-play were already selected by the facilitators, which in turn provoked that one girl complaint because she wanted to be an interviewer and only boys could play that role.

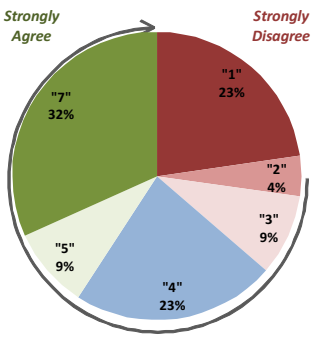
Indeed students' answers to the survey suggest that **overall, they actually felt part of the group during the sessions.** There was a 63% of the students in disagreement with the statement**" I haven't felt part of the group during the workshops**" and hence feeling part of the workshops. 29% felt neutral while only 10% were in agreement with the statement.

Students also recognised the facilitators availability as suggested by their answers to the item “During the workshops I have been able to ask the facilitators everything I wanted”. This statement had 86% of students’ agreement with, 5% mildly in disagreement with and the remaining 9% were feeling neutral about. This reinforces the observation that **students felt they had been able to communicate how they had wanted with the facilitators and felt dialogue was being fostered.**



“During the workshops I have been able to ask the facilitators everything I wanted”

When prompted about their participation in the final PERSEIA, students had quite ambivalent reactions. In the surveys, 41% showed agreement with the statement "I have been able to choose how I wanted to participate in the monologue" (of which 32% in very strong agreement), while 36% were in disagreement and 23% gave neutral answers, suggesting an in-between position. There have been no sharp differences between boys and girls or between groups.



"I have been able to choose how i wanted to participate in the monologue"

However, in the focus group, students from both groups said that **a very positive aspect of PERFORM was actually the freedom to participate in the workshops how they pleased**, that it was very dynamic and free. Furthermore, several boys remarked that one of the teachers involved was the person who actually intervened with directives:

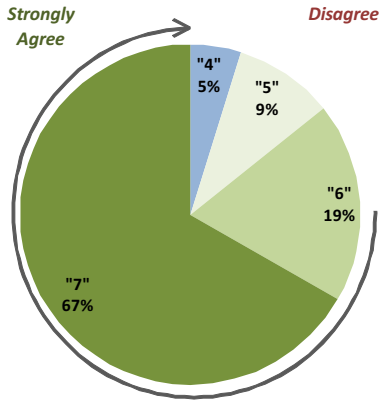
> *"María: Ok… 'I could participate the way I wanted to in the workshops'. You all marked green.*
> *Boy SP2107: A very good factor of PERFORM…. Yes, lots of freedom, there were not many…*
> *Girl SP2114: It was very dynamic.*
> *Girl SP2104: Yeah, they did not force us to do anything*
> Boy SP2109: *Well, the teacher sometimes....'Explain it in a another way, develop it differently....'"*
> *Boy SP2107: Well, but that is a teacher from the school, but the work itself (was) very free and enables us to do a lot of things".*

Similarly, **when asked about their capacity of choice of specific aspects of the monologue (topic, content, research questions) students showed much more agreement**. As shown in the following figures, a 95% of students believed they had been able to decide on the topic of the monologue, with 5% staying neutral and no student in disagreement. Similarly in the focus group, they all expressed they could choose the topic of their monologues freely, as they did in the first session. There was quite a debate around this topic as the students felt that maybe ECRs could be better suited to particular topics, but there was a reluctance to letting go of being able to choose their own topics.

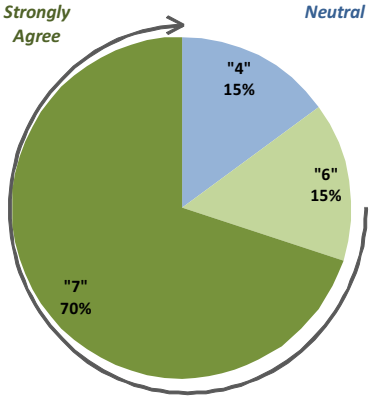
Further, 85% of students agreed that they had been able to decide on the research question the monologue aimed at solving, and 15% remained neutral. 69% of students agreed they had been able to decide on the content of the monologue, with 27% feeling neutral and 4% feeling negative about this.

Similarly, **64% of the students were in disagreement with the statement "our monologue does not include my ideas"** and hence felt their ideas had indeed been included in the monologues. 3 students (15%) did believe their ideas had not been included and a further 23% felt neutral about this statement. Significant differences were found between boys and girls for this item, girls feeling very much in disagreement while boys have been slightly more balanced in the spectre of their answers.

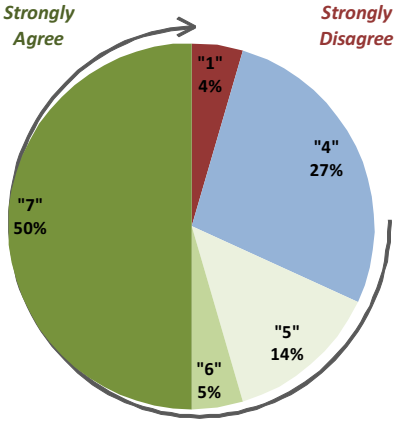
Our observations confirm and enrich these survey items on students' perceptions. In both groups students could choose the topic of their PERSEIA - being encouraged to pick up something they really liked, and took decisions about the development of their monologue (creative process). In contrast, the proposed reflection activities were more guided and structured and students followed facilitators' guidelines. Groups were already made, but the facilitator in Group 1 was flexible and accepted one change proposed by a girl.



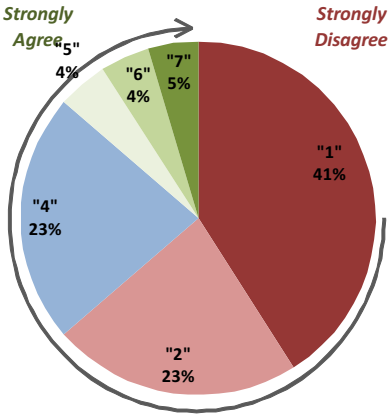
the topic



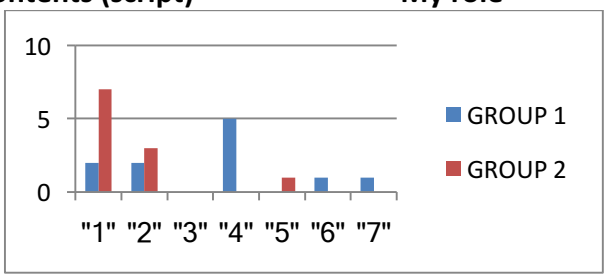
the research question



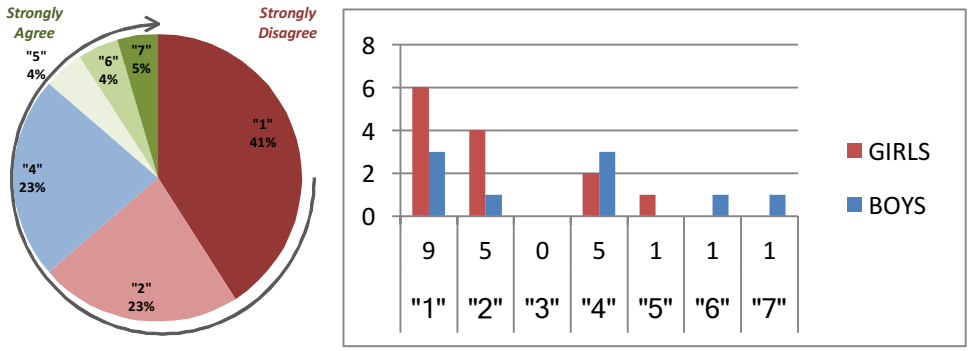
The contents (script)



My role



Difference between groups on the percpetion of their role



"Our monologue does not include my ideas"

In sharp contrast, 64% of the students felt they had not been able to decide **their role in the monologue,** while only 15% students agreed and 23% remained neutral (see Figure above). For this last sub-item there was a difference between groups, group 2 being a lot more in disagreement than group 1.

Such a difference of agreement between their general participation and specific aspects of the PERSEIA creation might be found in the fact that **students were not all given the correct information about the fact they would all have to participate in the final representation.** In this line, students in group 2 complained in the focus group that they thought it was not compulsory for all the members of the group to go on stage:

> *"Girl SP2114: The facilitator told us it was not compulsory (acting) and then he said it was, we were all a bit like...*
> *Boy SP2109: Well, he said that whomever wanted, they could... but yeah.*
> *Boy SP2107: It's true, he said so. That we had to do it but it wasn't compulsory and that as long as one of the group performed it was OK"*

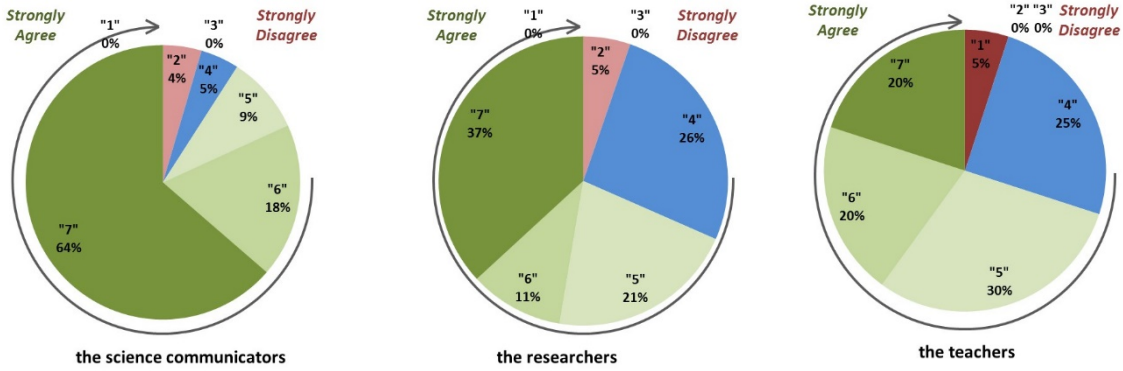
They also complained that they were told about it in session 4, and it took them out of the blue much in the same way that seeing how many people turned up to see their monologues did. Related to this, **students seemed to have a dual acceptance or refusal of the outcomes and how it came accross during the focus group**. On the one hand, there were students like (Girl SP2104; Boy SP2109; Girl SP2202; Girl SP2204; Boy SP2203) that were proud of their PERSEIAs and happy to have represented them, even though (Boy SP2109) thought that his topic was not very funny. On the other hand, there was one student (Boy SP2107) who was not feeling very happy with neither the process or outcome. As raised in GOAL 3, this was a student that took on a lot of the work, left for illness and once back saw that nobody in his group had carried on with the work.
Such a duality was also reflected in the surveys, when we asked students what they considered their role in the monologue had been as an open-ended question. 4 students said their role had been indifferent, they had either not participated, one that the ideas she had brought forward had not been accepted by the other members of the group. Four students stated that although they did not act, they had contributed to writing. Thirteen students remarked they had worked in all aspects of the creation of the

monologue and their experience had been very positive. Last but not least, there was a student that stated she had done her own monologue and also been the presenter of the overall event.

This said, we can argue that generally, students felt positive about their role in the PERSEIA and got engaged actively in the process. Overall, students felt included in the process of the workshops albeit they would have liked to have a better sense of the overall organisation from the onset (representations, groups).

When asked if they "**found their work recognised by the science communicators" a 4% of students were in disagreement, a further 5% were feeling neutral and ther remaining 91% were in agreement** with the statement of which a 64% were in extreme agreement. This item had a significant differences between groups, with group 2 clustering exclusively around positive answers while group 1 has some negative (1 student) and neutral (1 student) answers and then some positive answers too (11 students). There was also a significant difference between sexes, having boys be more ambivalent in their replies and girls to totally in agreement.

This is a very positive output by students that reflects how at ease they felt with the science communicators, as mentioned above.



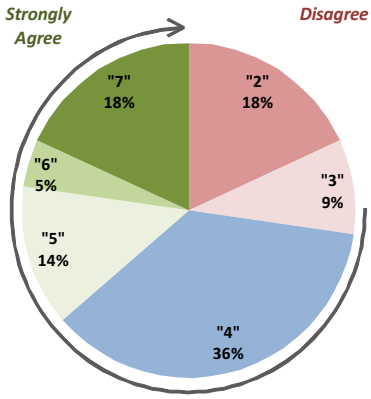
"I found my work recognised by…"

When asked if they felt their work during the workshops was recognised by the researchers, there was a 5% of the students in disagreement, a 26% neutral and a 69% of students in agreement. There was a significant difference between groups, having group 2 cluster around either neutral or positive answers, while group 1 had 4 students giving neutral answers, and the rest distributed between disagreement and all intensities of agreement.

The item also had a significant difference between boys and girls, as no girls were in disagreement with the statement.
When asked if they felt their work during the workshops was recognised by the teachers, students were less enthusiast (although still very positive) and 5% of them were in strong disagreement, 25% gave neutral answers and 70% agreed. Again this item had a significant difference between groups, having group 1 either feeling neutral or in

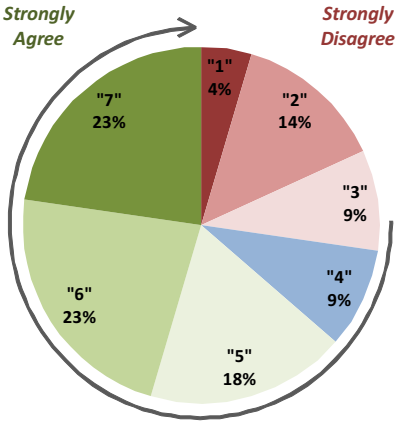
agreement, and group 1 having one student in disagreement, 1 neutral and the rest in agreement. There was also a significant difference between sexes, having boys either neutral or in agreement and girls in extreme agreement or agreement, with 2 neutral and 1 in disagreement.

Related to interaction, ICT technologies or artistic tools were generally not applied in the activities during the observed workshops to foster students' dialogue (an indicator raised by Spanish and French students). Hence, surrounding the statement "the online tools have helped me get involved in the workshops" we can see that there have been 27% of students in disagreement, 36% feeling neutral and the remaining 37% in agreement. There have been no significant differences between sexes or groups. This is a very mixed reply, indicating that the online tools did not manage to engage as many students as we would have expected.



"The online tools have helped me get involved in the workshops"

Finally, together with the feeling of recognition, we explored students' feeling of self-confidence to perform, as an aspect facilitating inclusiveness in the process. Coherently with students concerns about performing, **students reported a general lack of feeling of preparedness, there was a reluctance to act** (as mentioned earlier). 64% of the students agreed with the item "Despite all the rehearsals I did not feel prepared to represent the monologues", while 27% of students felt they were prepared to represent them and 9% felt neutral about this issue. We think there may be an influence of the discoordination of information given to students (mentioned above) in this answer.



"Despite all the rehearsals I did not feel prepared to represent the monologues"

Gender

In terms of gender and participation, no general differences between boys and girls were observed in the type of tasks and roles assumed in both groups. Only in PW3, during the role-play on gender, boys had a more active role than girls, since all the interviewers were male and most of the students in the role of observers (6 out of 7) were girls.
However in this group, girls affective responses were slightly different than boys. Particularly during warm ups, we could see how girls behaved in a more coy way than boys did, it did appear as a behaviour towards boys and not the sessions though. During the PW3 debate, boys did not participate much and needed to be asked questions by the facilitator. In PW4, in the 5 moments activity, boys tended to be the scientists while girls were the peripheral roles, either ill or peripheral people.

Finally, as mentioned in GOAL 3, we saw that during the warm up, in group 1 girls tended to adopt a rather shyer attitude than boys, however it appeared as if this coy attitude was more directed at the boys in the group than at the activities proposed.

In terms of gender as a topic in the workshops, PW3 and the discussion about gender allowed to observe some perceptions and attitudes within the groups regarding this topic. This was the only session in which there was an open discussion on gender and it worked differently for each group. In group 2, initially the conversation was dominated by 4 motivated students, but after a while almost all of them (except for 2) were participating and they paid attention until the end, suggesting their interest towards the topic. Students' general shared discourse assumed that differences in people are due to their personality and not to the sex (several students provided examples from their experience at home and at the school). Only one boy made a couple of interventions showing a more conservative or determinist perception of sex differences (e.g. women are weaker than men when they interview). When these happened, there were two boys that immediately showed their disagreement. However, after the interventions of the facilitator and the ECR they acknowledged different social pressures for women and men. Although participation in the debate (PW3) was thinly spread for group 1, when they did partake, in terms of their position, students appeared to either **not seem to**

find there were differences between men and women or to think that **women did it** (like with the sports outfits, they argued that it was 'their thing' to not want to be in loose sports oufits). Girls appeared to see there were differences but did not feel they were going to be suffering them somehow, hence there was a certain sense of detachment from the issues discussed. **They were quite surprised** for example, **when they realised that we mostly remember male scientists** instead of female when the facilitator asked if anybody remembered female scientists. During the gender activity in group 1, the facilitator had to try really hard to engage students in a debate, it was difficult because the group was extremely reluctant to talk. This session had a break in the middle, and during the break some students started commenting on the activity and upon their return, the debate lightened up a bit.

Related to the role-play, in Group 2 one of the girls being interviewed associated to sexism the fact that interviewers had made the question about kids only to her (she found she did not have the same opportunities to show off her talent as the rest) and also that the tribunal was composed only by men. At the end of the workshop, the facilitator ended up with a reflection about how gender/sex is communicated in stand-up comedy and invited the students to challenge gender stereotypes in their PERSEIA. They seemed motivated about that possibility (for instance, he says “at least not reproducing them”, and one boy insisted: “better breaking them!” and together with another girl commented on the potential of humor to break stereotypes).

3) ENGAGEMENT

Main Highlights

- **We observed a difference in students' general involvement between both groups. While Group 2 followed the facilitator quite easily through the workshops** and a group of students **participated actively, showing a willingness to get involved, Group 1 was more reluctant.**

- Students were **generally focused and concentrated during the sessions and the general discussion among students and facilitators was fluid**

- However**, a discussion requiring students' cognitive engagement** (beyond adding their part one after the other, building upon and arguing about each other's' comments) **was only clearly observed during PW4 (for Group 1) and PW3 (for Group 2). Similarly, in PW2 and PW3 some reframing resulting from reflection was observed.**
- **In this regard, there was an evolution in the level of engagement students showed in terms of a better quality of engagement towards higher thinking and reframing.**

- One commented that **she felt the students had not been able to clearly understand what had been achieved at each session**. **In this regard, teachers felt the overall scientific content of the PERFORM was not developed enough and it felt quite superficial at some points**.

- **The activities on critical thinking done during the participatory workshops had tended to stay in the workshops without permeating into their PERSEIA.**

Discussion of main results

Students' general involvement

Students' observed general involvement clearly differed between both groups of students.

Generally, **group 2 followed the facilitator quite easily through the workshops** and between half and 2/3 of the students **participated actively, showing a willingness to get involved (**e.g. conversation flew with few moments of silence, students reacted quickly to the facilitators' guidelines and questions, they paid attention). Only **4 students seemed to be more passive** (3 boys and 1 girl) and two of them were concentrated in one small group.

By contrast, group 1 tended to have 1/3 of the students quite active at the beginning and a bit over half by the end of the workshops that would participate actively without the need for the facilitator to directly ask them a question. However, in plenary group, it was extremely hard to get this group to participate spontaneously, reducing the participating number of students to slightly under 1/3.

This said, the male teacher remarked that **they had been very positively surprised with some students' engagement,** since some students that are disengaged recurrently for other topics were very involved through the project. He stressed that the dynamic in the PERFORM group has been different than in other classroom settings. He put the example of two students (Girl SP2202 and Girl SP2204) who were very engaged and participative in the sessions but in other class settings are mostly shy. One female teacher argued that there was not a lot of demand from the workshops, hence the ease in students' participation, came as it may.

Cognitive engagement and critical thinking

Students have had trouble with engaging cognitively, it has been a process that has gone from a superficial engagement, mostly on terminology to more complex term reframing over the PWs.

Group 2 was generally focused and concentrated during the sessions, there was a general level of banter for group 1 on occasion. For instance, in PW1 group2 at the beginning of the cards game, once the facilitator explained the exercise, students immediately proceeded to the tables without being dispersed. In PW3, those students (most of them girls) who were assigned the role of observers paid attention during the whole interview, without laughing at their peers, and took notes all the time. Also during the role-play, those students playing stayed within their role and improvised a coherent story, despite some of them being shy, suggesting they were engaged in the activity. Similarly, in the last session, despite manifested uneasiness of some students, still most of them performed seriously, suggesting an effort to concentrate and do the task. During role-play only one student in group 1 engaged with the character and constructed some fiction around it. In the last session it was quite challenging for the facilitator to manage to keep the banter and chatter levels controlled and, as mentioned

earlier, there was the need to raise the voice a few times. Generally speaking though the ambiance has been of respect.

In group 1, when in small groups the sharing of ideas and roles was very good. Not only did they share their ideas with a lot more fluidity than in the plenary group, but they tended to rotate in terms of the roles and ended up having a very balanced participation, their levels of engagement were a lot sharper in small groups as students were not really engaging much with each other in big group. In small group it was interesting because they helped each other and corrected each other. I observed one group for the cards activity in PW1 and they were asking each other questions and giving each other peer support and helping each other engage with the task at hand. This peer support had also been noticed in other PWs while observing other small groups. The only session observed for group 2 in which there was work in small groups was PW1. During this session, the group observed spent the 20 minutes provided for the cards activity working on it (only a few minutes of dispersion). During this time, they shared their ideas and solved doubts among them, while also approaching the facilitator and ECR if they had further doubts. However, such engagement was observed in two out of the four students, being the conversation clearly led by one of them, while two girls were connecting and disconnecting.

There has been an evolution in the level of engagement students have showed. Not in terms of an increase of level, but yes in terms of a better quality of engagement (towards higher thinking and reframing), a more focussed engagement with a clear element of choice in it. Students in group 2 generally asked questions to the facilitators, without showing any difficulty or barrier. Most of the questions related to doubts about the activities and to a lesser extent to contents (for instance, when the ECR introduced her research, three students asked her questions). **Questions among students were less often** observed and mostly made by those students who seemed more extrovert (see GOAL 3).

In this regard, students seemed to engage more in conversation and discussion when a space facilitated by and adult was provided, like the plenaries. Around **half of the students engaged easily in conversation during the plenaries**. For instance, during PW1, despite being constrained by the lack of information and knowledge about their topic, students elaborated a small narrative and also answered the facilitator's questions beyond providing yes/no answers. Some students also spontaneously answered questions addressed to a different group, suggesting their willingness to participate. A couple of students also commented on other's peers' narrative, showing creativity in their interventions (suggesting, for instance, adding a psychologist in one of the narratives, as there were no social scientists). For students in group 1, **their first choice to ask questions was another peer**, that normally would do everything they can to help. In contrast to group 2, this group, albeit appreciated the direction of an adult to provide a space for discussion, was very at ease discussing but always within their PERSEIA groups, in plenary there was the need for the facilitator to work and engage them all together and tended to get monosyllabs and answers. In Pw1 students had trouble evolving the activity into a small narrative but the facilitator was very encouraging.

In contrast, a discussion requiring students' engagement (beyond adding their part one after the other, building upon and arguing about each other's' comments) **was only clearly observed during PW3.** For instance, during the group sharing of the cards activity in PW1 group 2, students did punctual interventions to share their narrative, but it was the facilitator and the teacher who mostly commented them and eventually made further questions. The few students that were questioned by the teacher, did not discuss with her and rather changed their framing to incorporate her comments (which were a bit harsh). **As there was no discussion there was no elaboration of conclusions**.

The activity and debate about gender managed to engage students in discussion more than in the rest of observed workshops. In contrast to the other sessions observed, many of the students provided arguments for their statements and elaborated a bit their answers as the facilitator and the ECR challenged them with their questions and comments, in order to show their position and argue it. Many students elaborated their ideas (especially in the few moments of disagreement) building up on examples from their personal experience (e.g. what they see at home, or stereotypes about women in TV, experiences of discrimination from some older friends or family members). In this regard, the activity was designed to connect with students experiences, as a starting point.

When students agreed, they also refined each other's' comments, showing an ability to elaborate on what was being said and sometimes, add complexity. Connected to this, some of them also provided arguments that recognised complexity and avoided polarities. This was the case, for instance, when girl 1 confronted the facilitator's comment about men being more competitive and women more collaborative, presenting specific contexts in which girls are more competitive than boys and further arguing that competitiveness and cooperation can also go hand by hand. Those students that participated less, made mostly short interventions.

Related to this, **the gender workshop was the only session in which some reframing resulting from reflection was observed**. During the first workshop, when sharing the narrative about the cards in plenary, some students changed their framing but this was a direct reaction to the teachers' comments, which pointed to their lack of rigour in their narrative (e.g. contradictions). In contrast, during the gender workshop, students engaged in discussion and there was an evolution of their general position (i.e. differences are mostly due to personality and character, rather than sex) to include also the acknowledgement of social pressures affecting differently men and woman. As mentioned above, the interventions from the facilitator and ECR prompted this re-framing while facilitating students reflection about some aspects they had not thought before, as according to them (e.g. commercials, glass ceiling).

Group 1 had a different experience. From all the sessions PW3, the gender one, is the session that went worse by far. The interviews did not engage the students, there was a fair amount of fooling around because the main interviewer (the male teacher) engaged students through giving the other interviewers funny names (polititians), but there wasn't much involvement in reasoning and argumentation. However, PW4 saw students **engage in reasoning about how what they do and say will it affect the final product** when they are in their perseia groups; **they were debating with each other** and

trying to agree on the ways to better present their monologues. However, they did not really seem to be listening to one another.

Some students in group 1 (Boy SP2201 for example) were able to reframe concepts and "bring them home" to examples they were comfortable relating to. Students were able to transform the information given by the facilitator and **related to the information given through giving their own examples**, like the one with the return veins in the legs when talking about mother cells that boy SP2201 put as an example, much to the surprise of the whole class. PW4 also saw students reframing after reflecting on the concepts in the activity of the 5 moments. Initially, this was a challenging activity because they didn't quite see how one related to the other (science and art methods) but **when they did, they were able to bring the concepts to their own experiences and reframe them at their will.**

Regarding the design and the opportunities to foster critical thinking and cognitive engagement we looked at the social contextualisation of STEM topics and the approach to the topics in a systemic way. In this regard, the cards' game in PW1 provided an **opportunity to contextualize STEM topics and to offer a more systemic perspective of science**, in the sense of showing the 'ecosystem' of scientific careers and jobs, connecting societal challenges with research and with different profiles of scientists. These connections were explored first in small groups (more superficially) and then in the group discussion with some reinforcement by the facilitator and the teacher. In group 1, the facilitator **contextualised STEM topics through bringing examples that were close to the students,** like the example of distrofia muscular with Petita Julia in castellbisbal**.** In PW1, she used the example of the mother cells being very illustrative with regards to societal challenges and daily life (notably when it comes to talk about it and paralysis). However, this exercise seemed also constrained by the nature of the information provided (i.e. sometimes cryptic and distant from students' experience and previous knowledge of the topics) and the lack of supporting materials to the discussion of specific contents (e.g. not all the topics were familiar to the ECR and teacher co-facilitating the session). Another opportunity for contextualizing STEM topics and providing a systemic perspective was present during the ECR presentation of her research. The ECR provided a very complete and comprehensive view of her work as a geologist, providing a tangible practical example of research and emphasising connections with other disciplines and scientists, and students seemed to understand it.
In PW3, the topic of gender was approached from different ambits (i.e. domestic, work, commercials, school) although the discourse was quite focused on women discrimination.
The monologues were also an opportunity to contextualize scientific topics in societal contexts. This was unevenly achieved though, as some pieces did not contain much scientific information (see GOAL 2).

Students in the focus group commented that the **activities on critical thinking done during the participatory workshops had tended to stay in the workshops without permeating into their PERSEIA**. In fact, during the discussion students had with the two

interviewers they systematically confused critical thinking with constructive criticism when talking about their PERSEIAs.

(talking about critical thinking) (...)"Not much"
Girl SP2114

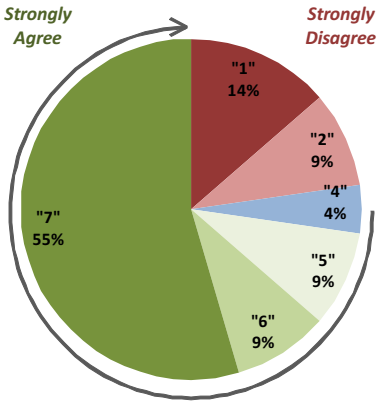
...at the end have they remained as something disconnected? (talking about the activities to enhance critical thinking)
FEMALE INTERVIEWER

"Well yes, they have taught us what is critical thinking and we have been talking about it, but we have not paid much attention, therefore, it has stayed in those two sessions and that's it"
Girl SP2104

"Ahá..."
FEMALE INTERVIERWER
"Yes, more in the workshops and not so much in the monologues, no?"
Girl SP2114

"Yes.(...)"
Girl SP2104

In Castellbisbal's focus group, homework wasn't even mentioned by students, they mentioned that the PERSEIA gave them a lot of work they had to do home, but nothing on the homework set by facilitators. A 73% of students agreed that **the monologues could have been done without homework**, with 4% of students staying neutral. However, 23% of students were in disagreement and thought monologues could not have been done without homework.



"The monologues could have been done without homework"

Students mentioned that because of their time constraints they had to do most of the PERSEIA work at home and that they would have liked to be able to get 'on-the-spot' feedback from the ECRs and facilitators if they could have researched during the sessions more intensely. Besides this, there was no mention of the moodle or any other

online tool provided for them to get more engaged online in the time span of all the sessions

Furthermore, at the teacher's interview, **one female teacher commented that she felt the students had not been able to clearly understand what has been achieved at each session**. She argued that it would be very positive to be able to recap what was achieved in the last session at the beginning of the next. This was particularly relevant in the case of PW3 where maybe not all the students gathered the importance of the weight there was on gender and how it permeates

.

The teachers further commented on this that they felt the overall scientific content of the PERFORM was not developed enough and it felt quite superficial at some points, they said there might have been an issue with the amount of time the project had. Due to this, **they could not put a finger on whether PERFORM had or had not contributed to a significant change in students' way of relating to science**, notably the female teacher that was the science teacher at the school.

Similarly, students said in the focus group that it would have been positive to have been grouped according to their interests in science (interests already known by the teachers who made the groups), as it would have helped them get deeper into the project.

Emotional engagement

Generally, students in group 2 showed an **open attitude towards the methods** proposed and the pedagogical approach, being **willing to participate most of the time and showing enjoyment**. The only session where tension was observed was PW6, in which some students felt uncomfortable about performing and the way the monologues were managed.

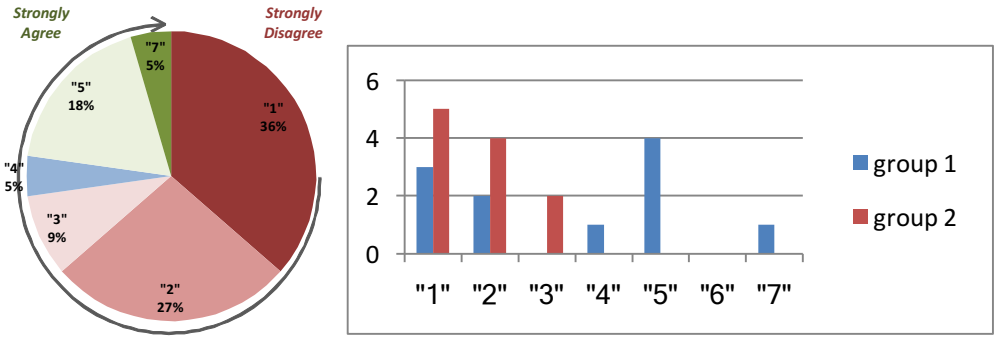
Students specially showed interest when the ECR intervened to share experiences (e.g. when she shared her research they were very attentive –including a "wow!" reaction from one boy) and three different students asked her a question) **and when the facilitator provided insights on the topics** (e.g. during group sharing and discussions, when he reinforced their comments with a research perspective).

Students in group 1 were **more reluctant to participate**, quite passive. In more than one instance, we could see students **fiddling with their hair or looking at the watches**, waiting for time to pass. Although they enjoyed listening to the ECR story, they were a bit puzzled as the latter had presented his PhD in the same format at the activity cards and it was confusing. They regained their attention when he started talking about his postgraduate research, as they could relate it to themselves (music and memory).

In the last workshop, both groups of students were gathered together and the warm-up seemed to be especially joyful for the students, who relaxed and laughed and seemed to enjoy the participation of the ECR in the games. Students started off not being super engaged, with a general flair of being rather sleepy. **The warm-up activity got them into the groove and they really liked it after a few rounds.**

When asked in the survey about the interest of the different activities proposed, students also expressed a general interest towards both the reflection activities and the PERSEIA creation, with a more positive attitude towards the reflection activities.

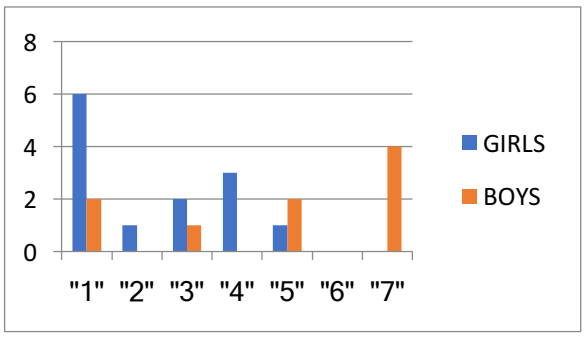
23% of students were in agreement with the statement **"I haven't found very interesting partaking in the activities to reflect and group discussions"** and therefore did not find very interesting to partake in the activities and group discussions. In contrast, a 72% were in disagreement and hence found it interesting, and a 5% were feeling neutral about it. This item has a significant difference between groups 1 and 2, where we can see that most of group 2 was in disagreement while group 1 was more evened out.
When asked about their interest in the creation of the monologue, students were a bit more moderate and those considering it interesting dropped to 54%, while 32 of the students did not consider it interesting and 14% were in-between.

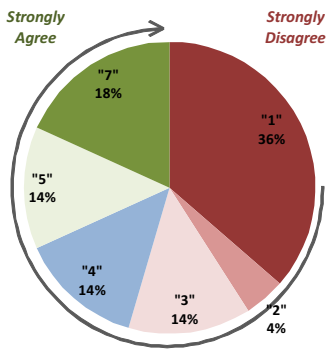


"I haven't found very interesting partaking in the activities to reflect and group discussions"

When asked what they had they enjoyed the most, 6 students said the activities had been the best part and there were two students who noted they had lots of fun in the PERSEIA. A further 4 students mentioned they had enjoyed the relationship with the scientists (this has already been noted in the section above and goal 1). Furthermore, on a general level, students had really enjoyed being able to socialise with their mates and other pupils they did not previously know and goof around a bit during the PWs.

"I found of little interest to participate in the creation of the monologue"





Regarding attitudes and affective reactions towards performing, there were some students that seemed clearly more comfortable than others. On the one hand **some students did not want to present** (the facilitators decided which group would start and they were going in the order of their small groups). On the other, **the group also showed some sense of responsibility or commitment as students made an effort to perform.** For instance, the role-play game in group 2 clearly motivated the two boy interviewers (which looked comfortable in their role and sometimes even performed) and two of the interviewees, which seemed to enjoy the creation of characters and the interview (they made up a story in detail, the girl played with the attrezzo). In contrast, the other two interviewee students (1 boy and 1 girl) were shyer and reacted a bit more skeptically to the interview. None of them wanted to be the first one performing and the girl seemed bothered because she had to act first. Still the girl seemed to try to get in the role and she elaborated her answers and invented some facts (instead of just responding yes/no).

No emotional expressions or reflections upon emotional reactions were observed beyond the affective reactions the last day of rehearsal. The last workshop **generated more affective responses from the students**. It took place during an afternoon on a day of educational strike and consequently more than half of the students from G1 were missing (both groups were gathered together). Many students showed some concerns or initial resistance to act, as mentioned above. A couple of them commented that there were not enough students to do the monologue, one girl complained because she was the only one from her group. Once they started performing, some students justified themselves or expressed concerns before going to stage (e.g. one girl mentioned that the girl with the script was missing so she could not remember the text properly, and another girl complaint because they were not allowed to read and they had not been told before). There were also some reactions of concern towards the final performance, like the boy telling his mates "*we are fucked up!*" as a reaction to another group that was performing well or some comments when they were told that they might perform in front of the high-school for Sant Jordi ("In front of who? What about if we don't have a monologue?", "You leave the bad news for the end…"). Still, students seemed to share a sense of commitment, since, as mentioned above, most of them stayed in their role seriously when performing (only 2 groups out of the 6 rehearsing were more dispersed).

Also, during the focus group, student (Girl SP2104) remarked that at the beginning of presenting the monologue, she might have felt vulnerable or criticised but then she felt confident, forgot what they were saying around and just did it. Another student (Girl SP2114) stepped in to agree that whatever people say is not relevant. Afterwards, the other students also stepped in and said that there isn't much bullying around in their classes, and that they get along quite well.

4) ETHICS INTEGRATION

Main Highlights

- **Students' answers to the surveys suggest they held an understanding of the nature of science both before and after the workshops**. **Students were already aware that scientists make mistakes (85%) before the workshops but became almost totally convinced afterwards (95%).**

- Regarding the inclusion of ethical and social aspects of research in the workshops, both facilitators **contextualised STEM topics through bringing examples that were close to the students.** The monologues were also an opportunity to contextualize scientific topics in societal contexts. This was unevenly achieved though, as some pieces did not contain much scientific information.

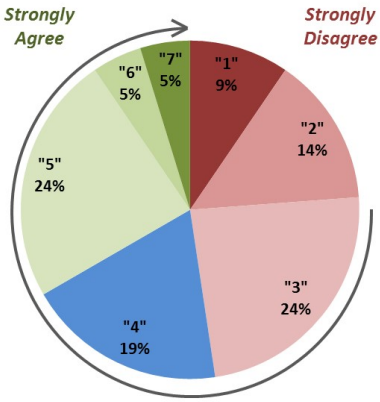
- **Reflections about ethical behaviour were also punctually included** in the workshops, during PW2. During this session, group 1 had quite an intense discussion on ethics and research

- **ECRs personal stories were more frequently included in Group 1** in which diferent ECRs introduced their experiences during diferent PWS (while in Group 2 this happenned only during the first session).

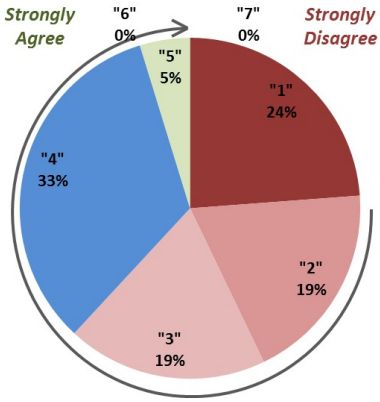
Description of main results

On a general level we can argue that **students' answers to the surveys showed they held an understanding of the nature of science both before and after the workshops**.

When asked for their perception of the impact of science in society, particularly about **whether science only has good impacts on people**, a 47% of students were in disagreement before the workshop, increasing to a 62% after the workshops. There was a 19% of neutral answer before and it increased to a 33% afterwards. Finally there was a 34% of students in agreement before decreasing to a 5% after. This item had a significative difference between group 1 and 2, having group 1 clustering around disagreement and mild agreement, while group 2 was more balanced in their answers.

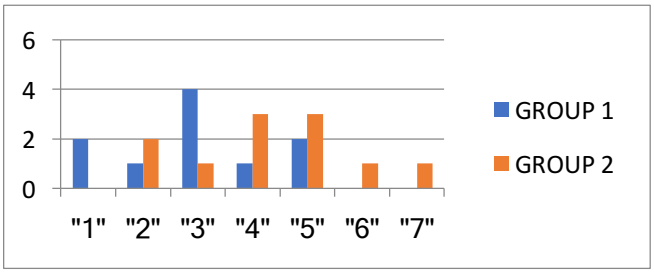


before the workshops

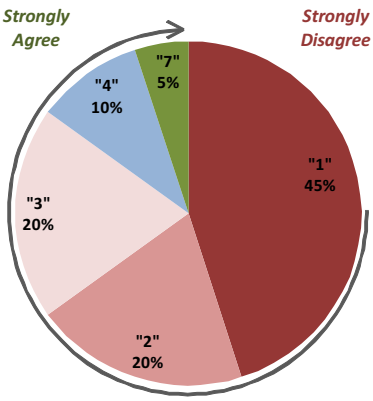


After the workshops

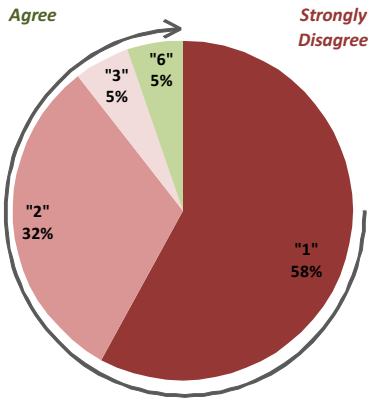
"science only has good impacts on people"



When approaching notions of failure and good science, we asked students what they thought of **"Good scientists do not make mistakes when doing science"**. B**efore the workshops an 85% of students were in disagreement and after the workshops this number rose to 95%**. Before, 10% was feeling neutral and 5% was in agreement, while after, there were no students neutral and a 5% remained feeling in agreement.

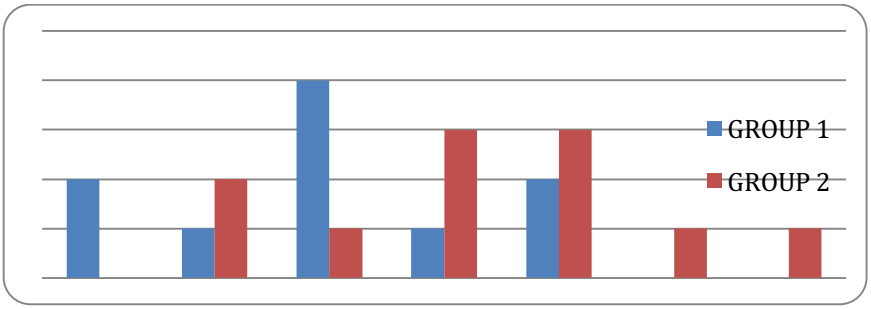


Before the workshops

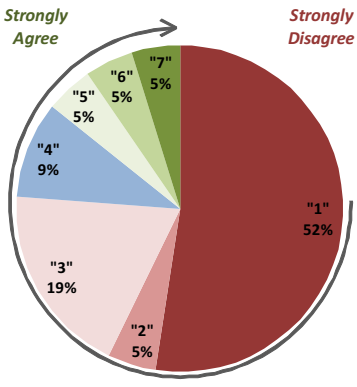


After the workshops

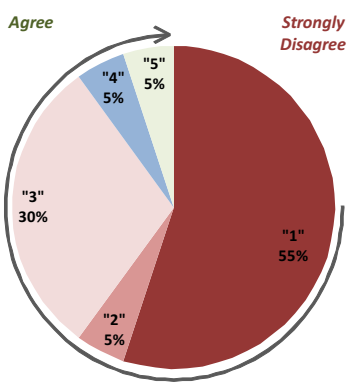
"Good scientists do not make mistakes when doing science",



When asked about the nature of scientific knowledge, before the workshops, 15% of students were in agreement with the statement "**Scientific knowledge is always correct and therefore does not change with time"**, while 10% remained neutral and the 75% left was in disagreement. After the workshops, the number of students in agreement had dropped to a 5%, with 5% neutral and the remaining 90% in disagreement with the statement. We can argue that participating in PERFORM has given students a more critical insight into ethical aspects of science.



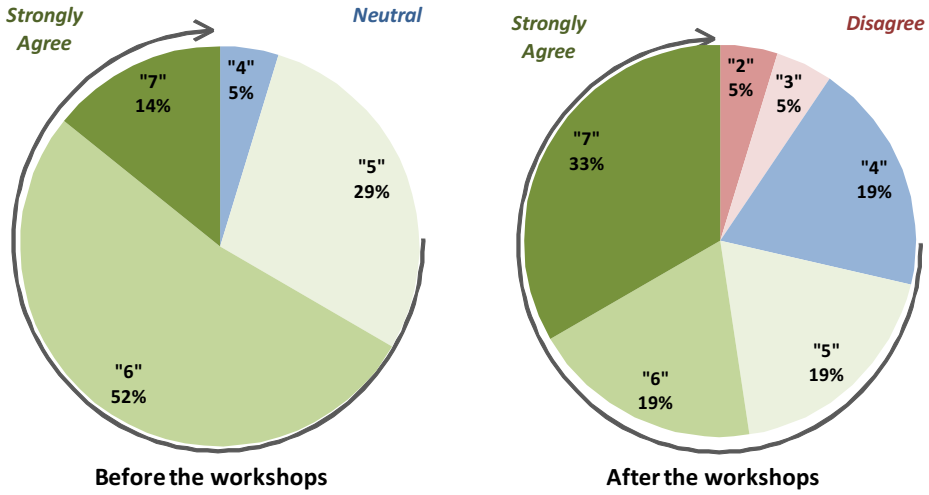
Before the workshops



After the workshops

"Scientific knowledge is always correct and therefore does not change with time",

In the same line, before the workshops, there were no students in disagreement with whether **"Scientific knowledge production requires imagination and creativity",** 5% feeling neutral and the remaining 95% in agreement. No significant changes were found after the workshops, although students perceptions shifted a bit towards disagreement and neutrality (10% of students in disagreement, 19% neutral and 81% of students in agreement).



"Scientific knowledge production requires imagination and creativity"

Regarding the integration of social and ethical aspects of research in the activities, the workshop activities developed included both practical examples (e.g. introduction of ECR's research) or the social contextualization of some of the topics approached (e.g. cards' game, role-play). The introduction of the ECR research seemed to provide a clear and comprehensive example of research application and personal motivations behind. PW1 was the only session observed in which the story of the ECR was explicitly introduced for group 2 and it seemed to have a positive effect on students, who reacted showing interest and some, admiration. In group 1 there was the introduction of a first ECR in session 1, another in session 2 and a last one in session 4. In contrast, **the cards game seemed a bit too complex in terms of information and support provided to reach its full potential** (e.g. exploring different approaches to science and providing contrasting perspectives) and the gender activity lacked contextualisation on the field of research practice and science. The monologues were also an opportunity to contextualize scientific topics in societal contexts. This was unevenly achieved though, as some pieces did not contain much scientific information (see GOAL 2).

Ethics integration in the discussion seemed to be differently approached in the two groups. Group 1 had quite **an intense discussion on ethics and research** in PW2, with the activities of the information stations to determine whether news are or not true, verifiable and how to spot fake information. In this workshop through questioning the funding behind research and how a research had to be published, who publishes, what does it claim, the difference between headlines and article, a small group of students

had quite an intense discussion on the ethics of science and reporting scientific experiments and they debated among them **around ethical issues like the right to report and funded research.** It was moderated by the teacher, however, not all students were made aware that these were ethical issues and I don't know if all the PERSEIA groups had the same discussion upon being at the station.
For group 2, **no general reflections about ethical behaviour in research practice were observed in the three sessions observed, but there were two interventions of the facilitator oriented towards reflecting about the impact of the monologues**. One took place at the end of PW3, while mentioning the reproduction of macho stereotypes in scientific monologues; and the second during the last rehearsal, as a feedback to one monologue which made fun of the Holocaust and was offensive against Jewish people. These reflections revolved around their responsibility, as science communicators through stand-up comedy, in not reproducing this kind of patterns.

The topics of the monologues were connected to students' interests as they were chosen by them without any constraint and all of them were very socially-oriented (e.g. drugs, sexual orientation, environmental pollution).

Overall, **teachers could not put a finger on whether PERFORM had or had not contributed to a significant change in students' way of relating to science**, notably the female teacher that was the science teacher at the school. **They argued that the overall scientific content of the PERFORM was not developed enough and it felt quite superficial at some points**, they said there might have been an issue with the amount of time the project had.

Students also reflected about this when asked if PERFORM has changed their perspective on Science during the focus group. One student (Boy SP2107) said that not in his case, but because it was not in the needed direction for the shift to happen. Other students said it did, but more an impact on what it entailed (that is, science as a process) rather than on Science as content:

> *"Yes, for me for example, I knew that in Science it was all about being applied and investigate every day, but it ain't the same thinking it than seeing scientists in person that were there, they had done research and stuff..."*
> *Girl SP2104*