The Art of Science Learning

WP4 EVALUATION RESULTS INTERNAL SUMMARY

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SUMMARY OF WP4 EVALUATION RESULTS

This document is a summary of the data analysis of the second implementation round in Barcelona, conducted as part of **WP4 assessment** led by UAB. It shows data gathered from Broggi and Consell de Cent (CNd100) schools through systematic observations of every workshop, 2 students' surveys (one before and one after the project), formative evaluation exercises, 2 focus groups with selected students from each school and 1 group interview to teachers and researchers (ECRs) participating in the project.

The document has been organised according to the four analysis dimensions of the assessment framework implemented: i) RRI process requirements integrated in the workshops (design and facilitation); ii) contribution to train transversal competences; iii) contribution to enlarge students' perceptions of science; and iv) contribution to foster scientific vocations and interest towards STEM careers. Before that, we introduce the general characteristics of PERFORM's educational approach implemented in the case study of Barcelona.

The Barcelona case study

General Methodological Approach. The artistic practice chosen in Barcelona was **stand-up comedy**. Throughout 7 workshops, students developed short monologues in which they combined story-telling, theatrical sketches and humor to explain scientific contents to an audience. The first part of the session was dedicated to one reflection activity, while during the second part students worked on their scientific monologues, bringing to the creative work the reflections and contents previously approached. Students worked at home on the development of their script, which they improved and rehearsed with the science communicators.

The sessions were led by two science communicators with experience in stand-up comedy and supported by 4 to 5 early-career researchers (ECRs) in each school. Teachers also took part in the workshops with a more active or passive role depending on the teacher.
ECRs had a clear role in the workshops, as 'the scientists' who help students develop the contents of the scientific monologues. Each ECR was assigned to one small group and provided support in the guided activities and with the development of their monologue. Teachers had a more secondary role, mainly as active observers. However, in Broggi, one of the teachers also closely followed one working group, having a role similar to that of the ECRs. Both actors – teachers and ECRs, expressed feeling engaged and generally comfortable within their roles and the development of the project.

1. RRI DESIGN: PROCESS REQUIREMENTS

Initial research efforts were put in the design of **science education participatory workshops** in which different **RRI values** could be embedded into an **inquiry-based approach integrating the performing arts.** Three different RRI values were highlighted while designing PERFORM's educational approach: ensuring participants' **inclusiveness and engagement**, integrating the **social and human dimension** of science (ethics integration) and fostering **critical thinking** among students.

This dimension of the analysis approaches the integration of such values, which we identify with process requirements that are integrated in the workshops. It is based on researchers' systematic observations of every workshop and interviews to students', teachers and ECRS.

INCLUSIVENESS AND ENGAGEMENT

Evaluation data suggest that PERFORM's educational approach was especially successful in engaging students and ensuring inclusiveness. **The combination of different types of activities within the session** (i.e. plenary discussions and role-plays/theatrical presentations, small group reflective activities, monologue creation) facilitated the **inclusiveness of different profiles** of students, both in terms of personality and of interest towards science. This was especially relevant in CNd100 because boys tended to dominate the spaces of plenary discussion, and the diversity of activities **encouraged the participation of girls**. This gendered difference in participation was softened through the workshops.

> *'Chica 6 hacía teatro el año pasado, pero en cambio las ciencias, buf, es la peor asignatura que tiene, la física y química... En cambio, a nivel expresivo es muy buena y a (ese) nivel también he visto una evolución. Hay alumnos que la ciencia les gusta pero les cuesta más la expresión y otros que la expresión les va muy bien pero les cuesta más la ciencia y aquí he visto que los dos han aprendido, los dos lados. Y esto es muy bueno.'*
> *Quote from teachers' interview, CNd100*[1]

The active and cooperative methodology in which students could choose the development of their own PERSEIA, was also key. Students felt that they worked all together in a quite unique and active way (i.e. mixing different students with science communicators and ECRs), generating a playful space of exchange that fostered a sense of belonging:

> *'Chico 26: L'ambient de classe és que era molt bó, a mi m'encantava perquè les activitats que tots feiem, eren interactives, tots participaven, tots feiem tot. Era com que no et sents diferents als demés, no només el fet de fer coses diferents, sino que tothom ho feia. A classe no t'aixeques per "agafar els tormells a algú" i era això…'*
> *Quote from focus group at Broggi*

> *'Chico 9: (En esa actividad) éramos más... más todos, todos los grupos juntos y era más o menos jugar con todos. Que eso por ejemplo en una clase normal no se puede hacer.*

[1] Our text contains participants' quotations in order to illustrate and support some of the analysis conclusions. Quotations have been kept in the original language to respect the content.

(…) Y aquí estábamos jugando con el de aquí, con el de allá, con los científicos que vinieron... Y eso ¿no es innovar? ¿Se puede decir así?'
Quote from focus group, CNd100

With the guidance and support of the science communicators and ECRs, students chose and developed the topic of their PERSEIA, the questions and contents they wanted to approach and the role they wanted to play. According to students in both schools, this was key to foster their interest and willingness to work on the monologue and learn more about the topic, as they felt it was 'more personal':

'(What I enjoyed the most was…) Tindre cert punt de llibertat a l'hora d'escriure i interpretar el monòleg del meu grup. Poder escriure el que a mí personalment em semblava adient.'
SP3101, survey post-PERSEIA, CNd100

Furthermore, the presence and role of ECRS was key to foster students' engagement in the process and their participation in small groups. ECRs connected personally with the students, shared their personal stories, listened to them and made them questions that invited students to engage further with the topics. They also helped each small group with the development and writing of their story. Students from both schools equally identified the presence of ECRs as one of the best things of the project.

'Chico 26: A mí lo que me ha fet sentir-me molt a gust ha sigut lo del tema dels investigadors, sobre tot... que un investigador esté per tú, que una persona que saps que controla molt del tema, et pot ajudar molt, perquè no és lo mateix que un professor que et pot ajudar moltíssim, pero clar, un "Investigador", "científic"... ja son altres paraules que ho entens millor, perquè ves una meta per arrivar, an on tu pots arrivar amb la ciència. I veus lo que és, les persones que son'.
Quote from focus group, Broggi

Students also acknowledged that the presence of young researchers helped them feel comfortable, as they found them very friendly and close. One girl mentioned that she liked the fact that there were many female researchers, in contrast to the greater visibility of men in science.
Having the final goal of presenting a performance was also highlighted by teachers as a methodological factor motivating students to participate.

Similarly, different data points that **the facilitation of the science communicators helped students feel comfortable** in the workshops **and motivated them to participate**. In both schools, science communicators created a relaxed atmosphere and a sense of connection with students through the games and theatrical exercises proposed and their use of humour. Such playful attitude was identified by students not only as catching their attention, and consequently motivating them to get involved, but also as a permission to contribute without judging themselves or others:

'Chica 9: Jo per mí, considero molt important també que van normalitzar el fet de que si t'equivocavas no passava res i que de fet si t'equivocavas valía més que no si encertaves perque aixi sabías diferents formes'.

'Chico 13: jo crec que el fer això (games) t'ajudava molt, ja que un cop que ja havíes entrat més a la classe i ho havíes fet com que perdías una mica de vergonya i això també a l'hora de participar t'ajudava perquè encara que t'equivoquessis et donava igual, no surtías amb

vergonya, sino que surtias allà en plan bé. O sigui, em va molar molt això, la cohesió social entre tota la classe, va estar molt guay...'

Quotes from 2 students, focus group at Broggi

Science communicators prompted students' participation in the workshops in an horizontal way, engaging them in conversation-like interactions. Students in both schools appreciated such close relationship as they felt supported and recognised. Whenever any student expressed anxiety about performing, the science communicators talked to them and reassured them.

SOCIAL AND HUMAN DIMENSION OF SCIENCE: ETHICS INTEGRATION

The social and human dimension of science was introduced in the workshops by: i) specific activities connecting STEM topics with societal challenges (magic cards game) and communication of research with ethical issues (stations game); ii) the direct contact with ECRs: sharing science as a process (what it means to do research); and iii) the creation of the monologues as contextualizations of the scientific topics into every-day life situations

Through workshop activities science communicators shared a discourse about science that emphasized elements connected to its **social benefits** (science as aimed at tackling social and environmental problems), its **collaborative dimension** (science as a collaborative practice in contrast with science done in isolation), and to **critical thinking** while processing scientific information (interests in research communication).

Both the **contact with researchers and the monologues**, provided an opportunity to approach scientific topics and contents through **examples and direct applications in real life** (e.g. ECRs research, contextualization with social problems), which was appreciated both by students and their teachers. **The degree to which students contextualized the STEM topic within the monologues actually depended on the group, the topic chosen and their focus during conversation**.

Specifically, the teachers appreciated that the project could bring science and research in a **closer way to students, enhancing their understanding of what** it means to do research and the **social implications of science**. ECRs also perceived that bringing the science topics into everyday-life situations helped them reflect with students about real impacts and their own actions.

CRITICAL THINKING

Critical thinking was one of the learning dimensions introduced through specific workshop activities and the contact with ECRs. In both schools, critical thinking was approached by science communicators by focusing on the **critical assessment of scientific information** and the way research is communicated (e.g. assessing evidence under different criteria such as: origin of the source, authors, potential interests and conflicts, etc.). Some ECRs expanded this scope and introduced other aspects as well, like being critical with technocratic solutions, taking into account environmental impacts or thinking in complex terms (e.g. historical relationships, power). ECRs felt they **contributed to fostering students' reflective and critical thinking when working in small groups** by questioning students' interventions and 'myths', helping them think further, and supporting them in the search of information. See for instance:

'(…) in the end the actual result is not as important as the process of going through all these things and learning the methods by which to do them. Like, even this thing with the google (…) the point was, you search in google but then is more important to look at the website name, can you trust where is it coming from? what sources has the thing inside? So this was to me much more important. And I hope at least (...) a little bit of this thinking was left with them.'

Excerpt from ECRs group interview, Broggi

This was identified by teachers as one of the added values of PERFORM approach:

'M: ¿cuál crees que sería el valor añadido de un proyecto como el PERFORM?

P: Bueno una forma diferente de saber recopilar información, de ser crítico con la información que se utiliza y esta al abasto de todos. Tot aquest procés de buscar la informació, utilitzar-la, validar-la. aquella sessió que es va fer es molt útil, és molt útil i fa reflexionar molt. (...) Penso que això ha anat bé perquè els alumnes vegin això que informació n'hi ha molta però és això, quina és la bona, on l'has de buscar i no quedar-te nomes amb els titulars que és una cosa que passa contínuament. I això és una que valoro especialment.'

Excerpt from teachers' interview, Broggi

According to ECRs from both schools, being critical with their own work and perceptions was hard for students and offered some resistance. In this regard, teachers also mentioned that in order to foster cognitive engagement, **a closer follow-up of each group could be done, complementing the knowledge of the monologues**:

'I després una hora... saps? per acabar de mirar i anar fent un seguiment mes paulatí del que van fent. Que no es vegin tan deixats. Que no ho estaven eh de deixats, però m'enteneu? Es que és difícil. (...) Però si vas fent i vas posant-te a sobre i així doncs pots anar ajudant-los, millorant també. També pots veure quines mancances tenen de coneixement i llavor no? explicar-ho a la resta del grup. No se, fer una miqueta més de complementarietat dels coneixements que surten en el monòleg.'

Excerpt from teachers' interview, Broggi

2. TRANSVERSAL COMPETENCES

Globally, regarding the impact of the project in students' transversal competences, PERFORM's approach allowed students to work from their own level of knowledge and skills, as acknowledged by the teachers and researchers' observations. The project seemed especially suited to promote inquiry skills and to provide new expressive resources and tools to students. The format of the workshops facilitated students' work in collaborative ways, and students applied their communication skills both among themselves and with the final audiences.

On the other hand, the evaluation suggests that students need more guiding when engaged in discussion and reasoning activities, while they show more autonomy when involved in physically active activities, such as the creation of images and theatrical sketches. Students' self-confidence would also benefit of more time for rehearsal and training of performance skills. Still, the creative format of writing and performing a monologue showed its potential to encourage students' understanding about the topics approached and help them overcome their shyness.

LEARNING AUTONOMY AND REFLECTIVE THINKING

Different degrees of learning autonomy were observed in each school (i.e., in Broggi students worked more autonomously than students at CNd100). However, a common pattern in both schools is that students seemed to need **more external guiding** when engaged in **reasoning and thinking activities**, while they showed **more autonomy when involved in embodied and creative activities**, such as the creation of images and theatrical sketches.

The lack of focus was the main element observed as hindering students' learning autonomy. Sometimes, students had also difficulties to understand the guidelines of some activities or the texts given to them (e.g. stations activity). In these cases, the presence of an ECR or one of the science communicators was key to help them focus, connect with the discussion and dig deeper in the topics.

In terms of reflective and critical thinking skills, the workshops seemed to have contributed especially in terms of fostering inquiry skills, as suggested both by observations and participants' inputs. Thinking critically about information sources was an aspect highly emphasized by science communicators during the workshops and key for the development of the scientific monologues, as they were mostly based on secondary data found in the internet (see section below). Teachers from both schools especially acknowledged the training of competences for searching and critically assessing information:

'Por ejemplo, se me ocurren las competencias digitales que (…) desde vuestro punto de vista científico son… ¿cómo buscar información? ¿dónde creerte lo que lees? (…) Porque si no van a parar siempre a la Wikipedia o al foro de coches... Eso se nota, trabajo de competencias de indagación, de investigación. Después les va muy bien que hayan trabajado esto, porque en clase cuando les haces preguntas científicas o del tipo que sean, (responden) 'sí, porque van más rápido', 'es más no sé qué...'. Vale, pero a ver, '¿quién? ¿cómo? ¿cuándo?' 'La frase hazla más larga', 'y quién lo hace, quién lo dice... cómo...' Este enriquecimiento de conceptos y de expresión ha ayudado mucho.'
Excerpt from teachers' interview, CNd100

Students from both Broggi and CNd100, also acknowledged this when asked about their learning through the project in the written surveys. See for instance:

'(I've learnt to) No fiarme de tot el que publiquen sobre la ciència, ja que poden tenir raons com vendre o promocionar un producte'
SP3114

Beyond the discussions fostered through activities in plenary, **the creative format of writing a monologue** showed as well its potential to **encourage students' understanding about the topics approached and not just memorise it**:

'Chica 7: (….) havies d'entendre el que estaves explicant. Si és com una idea bàsica pues no pots començar a escriure lo que vulguis, o sigui no, ho havies d'entendre i a partir d'allà escriure el que creus que és lo més important però sempre pensant en el públic al que et dirigeixes, si realment ho entendrà, cóm fer per a que li entri més la idea'
Excerpt from focus group, Broggi

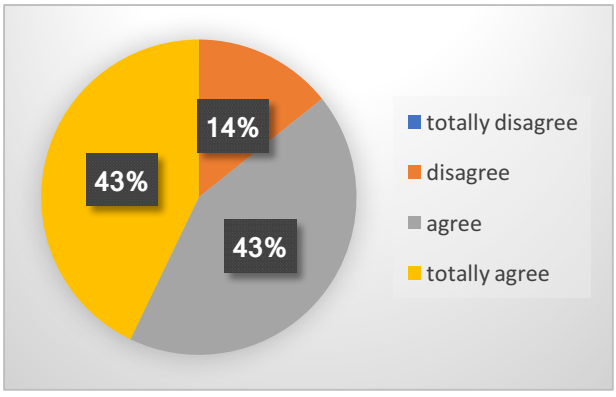
'María: "Para poder representar mi monólogo he tenido que entender el tema"…
Chica 6: Hombre, yo creo que sí...
Chica 22: Yo sí...
Chico 1: Bueno, en verdad no, para entenderlo sí, pero para representarlo no, es un guión.

Chica 6: pero no vas a representar una cosa que no sabes, que no entiendes.
Chico 1: se puede fingir que lo sabes.
Chica 22: (…) todo el mundo había escogido un tema, tu escoges un tema del que sabes ya un poquito, por eso lo escoges... Pero en mi caso yo llegué tarde y entonces sí, he tenido que entender.
María: Entonces tú dices que sí...
Chica 6: Claro porque para representarlo... ¿si hay una cosa que no entiendes cómo la vas a representar?
Chico 9: A ver tienen razón los dos. Puede ser, si lo entiendes, puedes hablarlo con más soltura, más seguro. En cambio, si no lo entiendes, te has de ceñir bastante al guión, porque si no, la vas a cagar bastante.
Chico 1: Es más profesional si lo entiendes. SI no lo entiendes, es como tú dices, te sientes como cortado, coartado, no sabes expresarte bien.
Chico 9: Claro, en cambio si lo entiendes es más... todo."
Excerpt from focus group, CNd100

COMMUNICATION AND PERFORMING SKILLS

Social competences haven been often mentioned when asking the participants about the benefits of participating in PERFORM. In both schools, when asked about their learning in the post-survey and the focus groups, students highlighted the training of communication skills (see figure below). These were acknowledged on the one hand as enhancing their capacity to make oral presentations in front of others and to explain scientific concepts in a more accessible and attractive way. On the other hand, such communication capacity is expressed not only with the audience but also as facilitating exchanges and communication among them during the workshops. Indeed, in both schools, students generally shared and expressed their ideas and thoughts in a clear and articulated way. Teachers in CNd100 especially appreciated the impact of the project on students' expression of concepts, being much more accurate and detailed than usual. They related it to listening to the researchers and also to developing a written script.

During the workshops, I could improve my communication skills
(aggregated results from both schools)



Furthermore, students also appreciated gaining body awareness, expressed as being **more aware of the role of the body in both communicating content and motivation** to an audience. Some students recognized as well, being inspired by the project and the possibility to use theatre in future presentations:

'María: ¿Creéis que por vuestra cuenta podríais repetir la experiencia, que vais a volver a usar los monólogos para presentar cosas en clase... ese formato más artístico?
Chica 22: Sí.
Chica 10: A lo mejor sí.
María: ¿Os veis capaces?
Chico 1: Salir de ese punto convencional de clase monótona... me encantaría. Cualquier día lo podría hacer de nuevo, sí.
Chico 9: Sí, claro.
Chica 22: O sea es captar la atención... mola, eso de captar la atención del público y explicarles un tema científico...
Chico 1: nos da la vida.
Chica 22: La mayoría de personas dicen "ciencia, qué complicado", pero es divertido'
Excerpt from focus group, CNd100

Teachers in Broggi also emphasized the relevance of the artistic approach and its **valuable contribution in providing different expressive resources to students** since they considered that their group of students was already trained on more conventional communication skills:

'P: L'únic que si que han guanyat evidentment son eines, eines de posada en escena, acabar de perfilar coses que en el dia a dia no fem però que van tenir aquestes tècniques que evidentment, sense professionals com l'Helena i l'Oriol no hauríem fet. Aquesta posada en escena realment en el monòleg que després quan fan les exposicions a classe es nota que s'ho miren, que s'autocorretgeixen, que ho tenen en compte això'.
Excerpt from teachers' interview, Broggi

At the same time, all of the participants (students, teachers and ECRs) acknowledged that **more time could have been devoted to work on the performing aspects of the project**. They expressed that dedicating more time to rehearse their text would have allowed students to improve the final *mise en scene* of the monologues, learn performing skills from the science communicators and also feel more confident on the stage.

'Chica 22: Y que no hemos trabajado tanto los monólogos, yo pienso que se podría hacer aún mejor...
Chica 6: Sí.
Chica 10: Más ensayos.
Chica 22: Y a la hora de actuar, lo podríamos hacer mejor, creo.
Chica 6: Pero es que lo de actuar, es que no lo habíamos practicado... Lo hemos practicado una mañana, ni una hora todos los grupos.
Chico 1: Faltó movimiento corporal, de expresividad en el escenario.
Chica 22: También.
Chico 1: Yo creo que porque no hubo tiempo
Chica 6: Sí'

Excerpt from focus group, CNd100

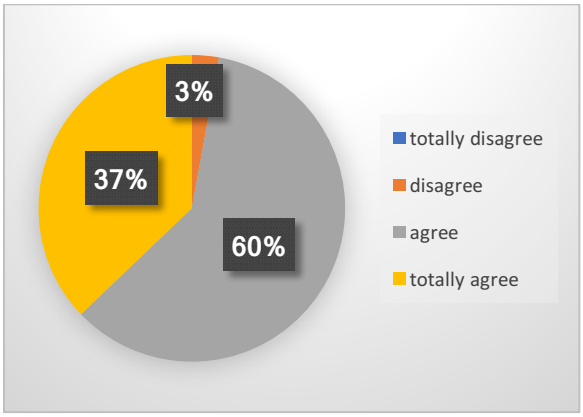
Students in CNd100 also suggested grounding more the warm-up games into acting games, in order to make them more meaningful.

COLLABORATIVE SKILLS

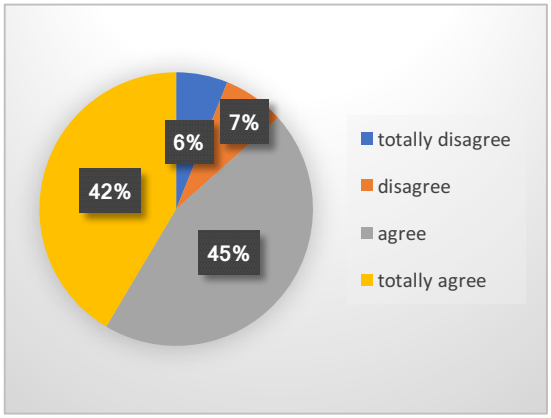
In both schools, there was generally **a relaxed and respectful atmosphere**. **Students tended to share tasks and roles in small group work throughout the workshops**: they generally provided ideas and proposals and discussed them. Similarly, students from both schools expressed in the focus groups being happy with the sharing of tasks during the workshops, which was also reported in the post-PERSEIA survey (see Figures below). While performing, all students participated and helped each other in the scene, when needed.

Only when they were required to write, some students tended to do the task more often than others. In Cd100, for instance, towards the end of the workshops when they had to write their monologues, some students started to concentrate more weight in the process. This was regretted by a couple of students during the focus group, who acknowledged taking home the writing of the script and assuming most of it. In Broggi this pattern was less observed but still, in some groups, some students concentrated more tasks than others.

I actively participated in all the group activities during workshops (both schools)



Within my monologue group, we fairly shared the different tasks (both schools)



Students argued that **being grouped by topic affinity facilitated their engagement with the monologue and their willingness to work**. Teachers in Broggi also perceived that the creation of the scientific monologue required 'real' collaboration among students, which was appreciated as they recognized that they sometimes fail to encourage such true cooperation in the classroom.

SELF-CONFIDENCE AND STEEM

In Broggi, several students mentioned the contribution of the workshops to build **self-confidence by training expressive and performing skills**. Indeed, students across schools appreciated the **support of the science communicators** who helped them and reassured them when they expressed concerns or difficulties and the **different performing exercises**:

'Chico 13: Jo el que he notat també, jo per exemple, amb la gent que conec no soc tan tímid, pero per exemple, això de fer tanta expressió gestual i tal, això sí que al principi donava una mica de corte però jo crec que el fer això t'ajudava molt, ja que un cop que ja havíes entrat més a la classe i ho havíes fet com que perdías una mica de vergonya i això també a l'hora de participar t'ajudava perquè encara que t'equivoquessis et donava igual, no surtías amb vergonya, sino que surtias allà en plan bé'

Excerpt from FG, Broggi

'Chico 26: Si que es algo que mo m'agradava molt i sí que la Helena ens va ajudar molt a preparar-ho, sobre tot, a mí, a explicar-me millor, perquè em costa bastant, explicar-me bé... I tinc aquesta por... I aquí, el que deiem abans, la proba i error, ajuda i ho vam acabar bastant bé'
Excerpt from FG, Broggi

Similarly, teachers in Broggi expressed that the methodology managed to encourage the participation of students whose self-confidence to perform was lower, especially girls. This was a positive surprise for them:

'P: bueno quedé muy sorprendida porque hubieron alumnos que ya de entrada dijeron que no harían monólogo, que no saldrían a actuar, que no no no...se pusieron un poco como de culo. Pero justamente estos fueron los que luego salieron al escenario y se agrandaron muchíssimo cosa que, yo como su profe, me sentí muy orgullosa de ellos porque algunos habian superado su timidez...i bueno jo em vaig quedar molt contenta especialment d'aquestes, aquestes alumnes que ja van dir d'entrada que no..
I: Eren noies la majoria?
P: Eren tres noies.'
Excerpt from teachers' interview, Broggi

This said, in both schools students also acknowledged that more time dedicated to the rehearsal of the monologues and more attention to some of the artistic aspects could have enhanced their performing skills and in turn, their confidence in performing in front of an audience. Indeed, performing was challenging for some of them:

'María: ¿algo que no os haya hecho sentir bien en el proceso?
Chica 30: Salir a actuar.
María: ¿Salir a actuar?
Chica 30: Es que a mí lo de salir a actuar no es algo que me haga mucha gracia, como algo incómodo... (….) O sea, yo preferiría quedarme en mi pequeño espacio (risas).
María: Y es del palo "salgo y me siento mal, pero luego merece la pena..."?
Chica 30: A lo mejor es más el momento de salir, de decir, "ay, me toca..." y te juro que tenía ganas de ir a vomitar, no es broma (ríe). Yo antes de salir decía "aquí me muero o algo...". Luego cuando sales es bueno, ya lo has hecho y no pasa nada, pero, en el momento de decir "me toca" es...
Isa: Durillo.
Chica 30: Sí.'
Excerpt from FG, Broggi

This challenge was echoed during the formative evaluation activity about emotions, in which despite the generalized enjoyment of the approach, some students expressed anxiety towards performing (Cd100) or doubts about the quality of the final outcome (Broggi). Similarly, in the survey post-PERSEIA some students mentioned the final performance as one of the least enjoyable aspects, due to feeling shy or doubting about their acting skills.

On the other hand, students' interventions also suggest a **sense of initiative and resolution,** since despite feeling a lack of enough work in the performance part, they all participated in the final monologues with their groups.

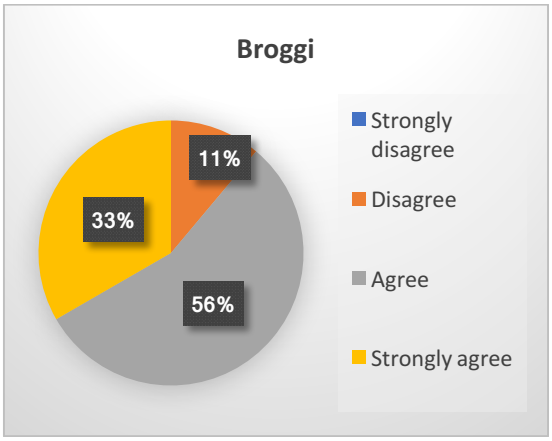
3. STUDENTS' PERCEPTIONS OF SCIENCE

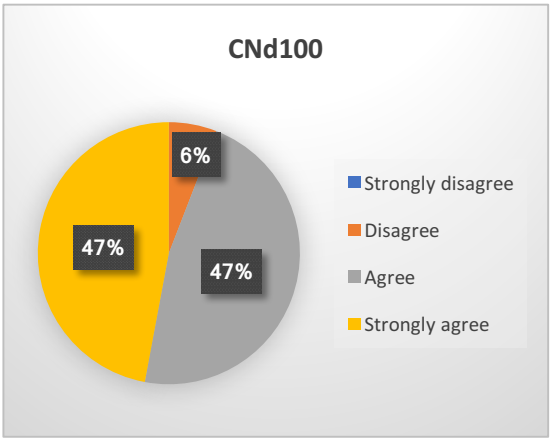
Generally, **surveys across schools show little statistically significant changes** in most items reflecting students' perceptions of science. However**, in CNd100 the project seems to have had a stronger impact on students' perceptions of science and specifically in girls**, since more items changed significantly towards more positive responses after the workshops.

This way, after the project, girls in CNd100 agreed more with the statements that scientific jobs are important for a better society, that science will help them understand more about global issues and that science not only has good impacts on people. Similarly, after the workshops, both boys and girls reported more disagreement with the fact that they do not expect to use science much when I get out of school, suggesting a change in their perception of the value of learning science.

Indeed, after the workshops, the majority of students in CNd100 responded in the **affirmative when asked if the PWs helped them to think differently about things they previously believed to be right or true in science** (94%). This was also the case for Broggi students (89%):

This project helped me to think differently about things that I previously believed to be right/true in science





When asked to explain these changes in the focus groups and in the open question about changes of perceptions in the survey, students from both schools acknowledged that **the project helped them think more broadly about science** in terms of:

i) **the diversity of scientific topics and types of research**, beyond what they normally study at the school

'Chico 26: ahora mi percepción de la ciencia no es tanto de "científico-ciencia-estudiar-estudiar-centrarse", sino que hay otros modos de estudiar la ciencia como investigaciones que no son tan aburridas como pensamos hoy en día, de hacer pruebas, de estudiar esto… sino que son más de interactuar o ir a otros sitios como por ejemplo ha sido vuestro caso que va unido a estudiar ciencia, y cambia el sentido la ciencia. Hay unos científicos que se supone que tienen que hacer un experimento con niños, no en un laboratorio, es un cambio de percepción de ver…

María: …otras formas de hacer ciencia.
Chica 7: sí, és això, veure que basat en pelis que has vist o simplement la percepció que tu tinguis de com es fa la ciencia o de com portar a terme la investigació…
Chico 26: sí, (veure) una cara com més experimental.'

Excerpt from FG, Broggi School

ii) **the diversity of scientists' profiles and career pathways in science**

'He vist que hi ha moltísima varietat de profesionalitat i això m'ha ajudat a obrir la ment. També m'ha ajudat a encaminar-me sobre els estudis que vull fer ja que si tinc illusió i ganes per fer-los m'anirà millor.'
SP4108, Broggi, survey post-PERSEIA

iii) **science learning as something fun**

'He après coses de la ciència de una manera divertida i pràctica per mi, que a vegades em costen algunes coses de ciència, s'em fa molt millor aprendre així.
SP4112, Broggi, survey post-PERSEIA

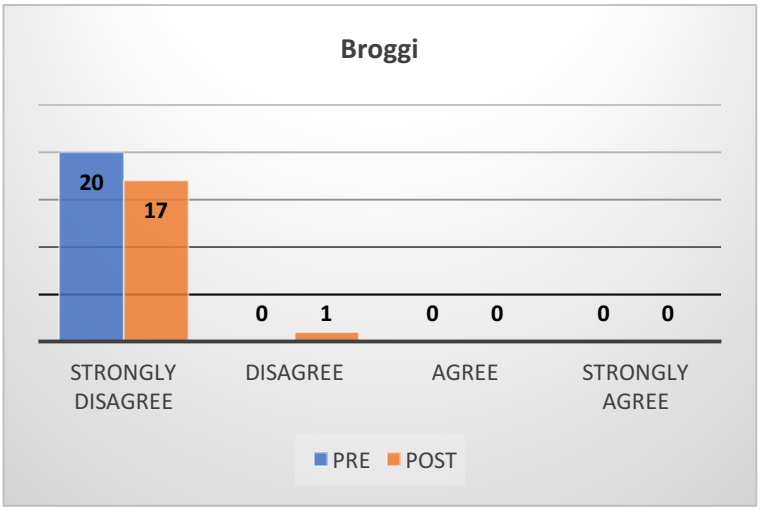
Interestingly, several students mentioned that despite not changing their perception, the workshops still helped them increase their motivation in science and find out new things related to scientific studies:

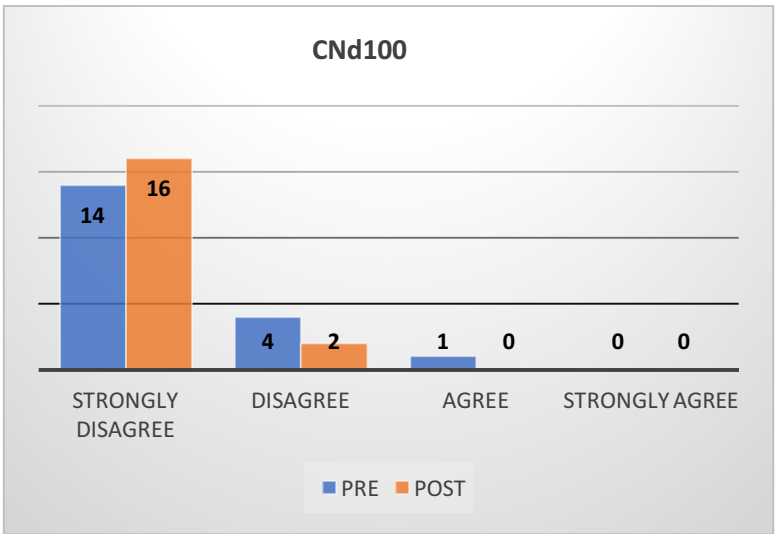
'No, pero sí he trobat coses bastant interessants, perquè abans no sabía que existeixen carreres universitaries com la nano-tecnologia, la bioquímica'
SP3113, CNd100, survey post-PERSEIA

'No l'han canviat, pero m'han motivat: m'han fet veure que vull estudiar alguna cosa relacionada amb la ciència'
SP4124, Broggi, survey post-PERSEIA

In terms of perceptions of gender, in both schools, students generally agreed that men were not more intelligent than women and that the unequal situation of women in science/jobs is due to different responsibilities, social roles and opportunities. Similarly, when asked in the pre- and post-PERSEIA survey, most of the students showed strong disagreement and disagreement towards the item "*scientific and technological careers are mostly for boys*". As the figures below show, disagreement was stronger in Broggi school than in CNd100:

Scientific and technological careers are mostly for boys





4. SCIENTIFIC VOCATIONS

Science learning as something fun: increasing motivations to learn

In both schools, students highlighted the capacity of the workshops' educational approach, combining humour with interactive activities and performance, to **enhance their motivations to participate and learn science**. Most specifically, students appreciated: i) the diversity and interest of topics and the way of approaching them ('curiosities' and real-life applications vs. 'fundamental topics' like the ones approached in class), ii) the exploration and communication through the scientific monologues which helped them better understand the contents and connect more easily, and iii) the direct contact and sharing of personal experiences with the researchers:

'Chica 6: Pues yo, gracias al taller, he visto muchos más temas y han captado más mi atención y he visto que sí, que me gusta, me lo paso bien. Yo creo también que es una forma de enseñar. Que en las clases normales, algo me puede parecer interesante y tal, pero... Yo creo que eso es muy importante, saber llamar la atención del alumno, eso, cómo enseñar.'
FG excerpt CNd100

In this regard, **discovering that learning science and science can be fun**, was one of the most reported learning outcomes of students in the post-PERSEIA survey.
Observations also support this and especially point to the dynamic format of the artistic approach and the contact with researchers. In Cd100, teachers mentioned observing an **evolution in the students and their interest** in the topics, especially in some students initially less interested towards science. Teachers in both schools considered that key to fostering such motivation was working on topics of students' own interest, connecting them with direct applications in real life and generate personal relationships with the ECRs.

This connects with another recurrent theme in students' accounts of their learning experience: **the importance of the presence of ECRs**.

Breaking students stereotypes about scientists and research

Both students' and teachers' inputs in the evaluation suggest that **the relationship with the ECRs contributed to motivate students to learn science throughout the process**. During the focus group in Broggi, students further explained how: sharing what research means in daily life,; explaining complex topics in a comprehensive and motivating way; making them feel comfortable through their close relationship; or encouraging them to be proactive:

'Chica 26: A mi el que em va agradar molt és que l'Anna, que era nuestra investigadora, ens donava les eines, en plan, ens ajudava, ens explicava i tot això, ens donava les eines per a que després nosaltres desenvolupessin tota la notra idea. (…) I aixó em va agradar, havíem de ser espavilats.'
FG excerpt Broggi

'Chica 7: en el nostre cas (…) ho ha fet molt bé i ens sentíem molt a gust. Al explicar un procés bastant difícil d'entendre, ho va fer molt bé i va com aconseguir que nosaltres ho poguessim entendre en poques sessions'
FG excerpt Broggi

Furthermore, students in both schools mentioned that the direct contact with young researchers helped them reframe their views about scientists, especially in terms of their personality (e.g. being fun vs. serious and boring), their gender (most of researchers were women) and also about who can do science (normal people with passion and dedication vs. only very intelligent people):

'And then in the project, you find young specialists, very open-minded, who know how to explain things well and even better, with sense of humour and gracefully and of course… your view changes (…). If society is showing you all the time a scientist isolated in his house, very competitive, most of the times a man, because we rarely see women, well… Coming here just blows your mind, with such a variety of scientists and at the same time all so human…'
FG excerpt Cd100

'Un "Investigador", un "científic"... ja son altres paraules que ho entens millor, perquè ves una meta per arrivar, an on tu pots arrivar amb la ciència. I veus lo que és, les persones que son, que no son bojos com a tots ens sembla (se ríen)'.
FG excerpt Broggi

'(I've learnt) Que la ciència no és només un laboratori, que hi han moltes coses més darrere i que és important estar motivat a l'hora de investigar, ja que així tens una meta i et dona més ganes d'arribar-hi.'
SP4124, survey post-PERSEIA

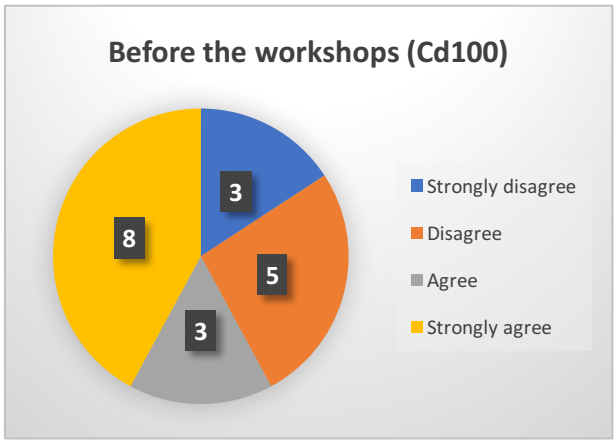
'Chica 22: De científicos, yo cuando (antes) me imaginaba, me venía a la mente que es una persona muy trabajadora, que en los estudios han sacado excelentes y tal... Por eso a mí me inspira, me han inspirado bastante.
María: ¿te inspira porque te puedes sentir reflejada?
Chica 22: Porque yo cuando veo a una persona que ha conseguido la meta que quería, o la meta que yo quiero, digo "si ella ha podido conseguirlo, yo también puedo". Y ya está.'
FG excerpt Cd100

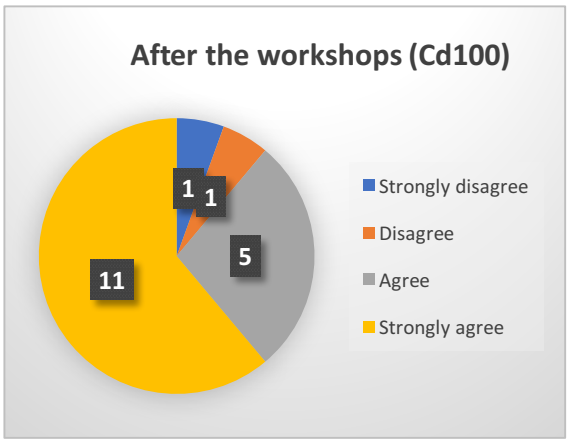
The presence of ECRs helped students not only to break some stereotypes and feel more identified but also provided them with the opportunity to ask questions about scientific careers and listen to their personal experiences and motivations to study science. This was highlighted by students in Cd100, both as an inspiring element and as very useful to think about their own future, suggesting the potential of such interaction to inspire scientific vocations:

'Chico 1: Y ahora que estamos con el tema del futuro laboral y qué hacer... Escuché un ejemplo, no me acuerdo cómo se llamaba, que nos dijo que "yo no tenía claro mi futuro, sé que me gustaba la ciencia y tiré por un camino, vi que éste no me gustó y tiré por otro y encontré la solución". Pues ése es un ejemplo que me ayuda.
(…)
Chica 22: Y también yo, como que estamos trabajando esto de nuestro futuro, pues a veces tenía dudas de qué hay que hacer para esto, o qué nota, o si en Bachillerato... tenemos la opción de qué materia elegir... pues se lo preguntaba.'
FG excerpt Cd100

Indeed, in this school, students' responses changed significantly towards more agreement about studying a scientific career after the workshops. While before the intervention students' responses were more diverse and slightly less than a half of the class did not think about studying a career related to science (8 students), after the intervention this number dropped to 2 students (see Figure below; Prob > |z| = 0.1098).

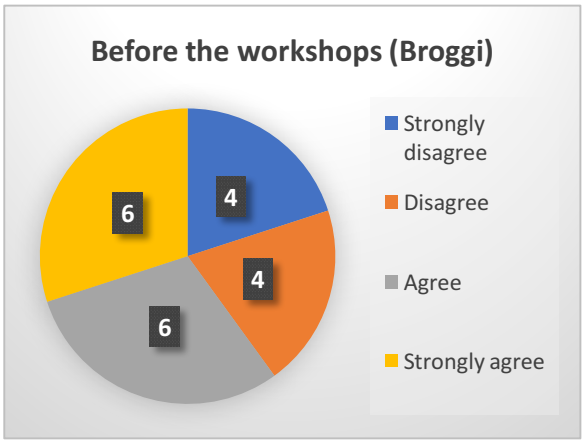
'I would like to study a career involving science'

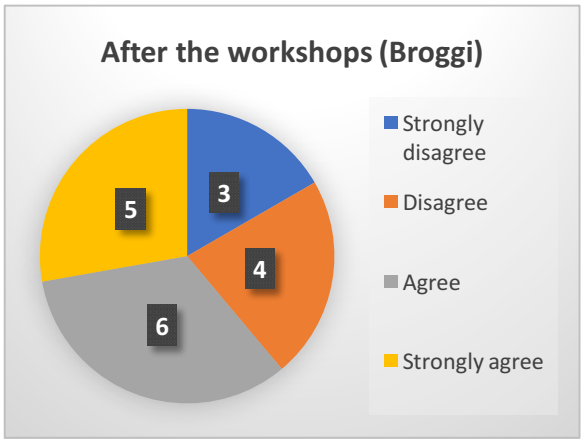




In contrast, in Broggi school, students' answers did not change significantly after the workshops and they remained divided with slightly more agreement towards studying a scientific career both before and after:

'I would like to study a career involving science'





Although the willingness to study a career related to science did not change significantly for Broggi students, they reported during the focus group that projects like PERFORM are helpful in their career choice, by providing a non-stereotyped view of science.

All in all, participants' feedback and researchers' observations suggest that the **contributions of having ECRs within a creative learning environment as the one proposed went way beyond being providers of knowledge**, **offering different roles models of scientists** which contributed not only to affect students' perceptions of scientists and of scientific research, but also their relationships with science.