The Art of Science Learning

WP4 Assessment Analysis

Overall Highlights and Recommendations

Barcelona Case Study

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GENERAL INFORMATION:

Schools: INS Santa Eulàlia (Terrassa) and IES Castellbisbal (Castellbisbal).

Participants:

- **INS Santa Eulàlia:** 48 students distributed in two different groups of 24 students, each of them supported by 1 PERFORM facilitator, at least 1 teacher and 1 and 2 ECRs, respectively.

- **IES Castellbisbal:** 28 students distributed in two different groups of 14 students, each of them supported by 1 PERFORM facilitator, at least 1 teacher and 1 ECR. Two sessions were supported by 3 extra ECRs.

Setting: 6 workshops were conducted, of two hours each. Each group was placed in a different room, both of them indoors, except for the last session of rehearsal. In the case of Castellbisbal, two sessions took place in the afternoons and one meal with the students and ECRs was organised before these session.

OVERALL HIGHLIGHTS

GOAL 1: STUDENTS' INTERACTION WITH ECRs and TEACHERS

- Inputs from the different actors involved suggest that the interaction between students, ECRs and teachers has not reached its full potential despite the fertile ground to foster it, suggested by participants' willingness to participate and their generally appreciative stance towards the project. Such interaction could be fostered through a greater engagement of ECRs and teachers, both before and during the workshops.

- Overall, the teachers were feeling positive about having had PERFORM in their school and showed their willingness to continue with the project in the future, if adapted and with the support of PERFORM facilitators. Teachers provided punctual support to the facilitation in several activities (e.g. the critical thinking stations, the gender role-play) and pointed to the lack of a specific role assigned as a limitation sometimes hindering their involvement during the workshops, especially in Terrassa. In Castellbisbal teachers got generally involved more actively during the debates and the work in small groups than in Terrassa. Students shared the same perception: while in Castellbisbal most of them consider teachers helped them during the workshops (81%), in Terrassa in Terrassa only 46% of the students agreed with this statement and a third of them provided a neutral answer.

- Teachers found the workload generated by the project as compatible with their work. In Terrassa, the tutors of the two groups dedicated time of their own classes to support students with PERFORM homework in-between sessions.

- Teachers' interventions were not always synchronised with the discourse of the facilitators (e.g. regarding gendered stereotypes in Terrassa or in their reaction to students' interventions in Castellbisbal). ECRs also identified this as an aspect to improve.

- ECRs were generally very enthusiastic during the workshops and seemed comfortable with the students. They all reported enjoying the experience, which they generally perceived as 'worth'. Similarly, students seemed curious and attracted by the figure of the ECR and respected them in their interaction. They all appreciated the interaction with ECRs as they do not often have the chance to meet young researchers. They identified the young researchers with highly motivated and hard-working people, committed to their jobs.

- ECRs mainly tried to adopt an assisting role during the workshops. When able, they actively supported the facilitators in the facilitation of the activities (e.g. providing guidelines and making questions to the students to prompt participation, solving doubts, intervening in the plenary discussions). Students especially appreciated ECRs' involvement and engagement with them during the sessions. However, some of them had difficulties to differentiate them from PERFORM facilitators and expressed that they lacked more personal sharing related to the ECRs' day-to-day life and research. Many of the students reported they wish they had had more interaction during the workshops. Similarly, ECRs perceived their role was not clearly defined and missed having more opportunities to interact with the students and more guidance through the process. They considered that their interaction with students had a positive impact in fostering students' motivation and curiosity towards science, but that such impact could have been enhanced if they had participated in a more active way.

- All students considered the topic of the PERSEIA as one of their main motivations to participate and argued that they should be given a choice, in any case. However, many of them thought it would be interesting to link their topic to the ECRs research and made different proposals (see below).

- The use of social media did not seem to work well in any of the schools. Students expressed they found face-to-face contact easier and more motivating, and ECRs considered that the openness of the channel hindered the participation of some students (e.g. shy students, students affected by peer-pressure) and dispersed the focus of the conversation. ECRs also reported difficulties in engaging with this kind of technologies and even ethical issues. However, they did not identify an alternative communication channel outside school, except via email.

- ECRs thought that the training had contributed to critically reflect about doing research and to frame their own work, and in this sense, it was useful and needed. However, they also perceived that it lacked connection with the practical work conducted in the schools and sometimes they lacked training skills.

GOAL 2: THE CREATION OF THE PERSEIA

- Differences were observed in both schools regarding the performing context and general atmosphere. While in Terrassa a stage was provided with audiovisual support (music in-between PERSEIAs and a projector) and students were generally enthusiastic, in Castellbisbal students' mood was more polarised and their performances were not supported with audiovisuals.

- In both schools, a strength of the PERSEIAs was their humouristic dimension, which was successfully achieved by students and clearly managed to engage the audiences.

- In both schools, an aspect to improve was the integration and development of scientific content (beyond the introduction of definitions). In some cases, the scientific information provided also lacked rigour.

GOAL 3: TRANSVERSAL COMPETENCES

Learning to learn skills

- Students in both schools did not seem to generally value science learning as important for their future success as less than half of them agreed with the statement. In both cases, the workshops did not seem to provoke significant changes on such perceptions, (although they agreed more with the statement afterwards). Similarly, students in both schools reported motivations to learn that related more to interest towards the topics and curiosity about the project than to a personal value (e.g. professional value or applicable in their daily life).

- Around half of students perceived themselves able to formulate research questions both before and after the workshops. In Terrassa such perception significantly increased in a 20% after the project.

- Regarding reflective thinking, in the two schools we observed differences in students' capacity to make questions, elaborate and reframe concepts and discuss, but students in Castellbisbal did it more often. However, in both cases, students' difficulties to engage with reflective thinking through the process were observed, mostly related to specific aspects of the workshops' design and the contents approached (e.g. students' lack of knowledge about some of the topics, technical vocabulary, lack of an in-depth approach to research topics).
- Workshops fostering more reframing and discussion amongst students were PW2 and PW4 in Castellbisbal and PW3 in Terrassa. In both schools, students seemed to engage more in discussion when a space facilitated by an adult was provided, as questions digging deeper on the scientific contents or in specific reasoning were less often raised spontaneously by the students.
- Teachers highlighted learning autonomy as a skill clearly put in practice by students in Terrassa, through their capacity to improvise and manage to have their monologues ready for the performance. Students in this school also reported learning outcomes related to skill. This was not highlighted in the same way in Castellbisbal.

Social and civic competences:

- In both schools, students seemed to be satisfied with their participation, as most of them considered that they actively participated in the workshops, especially girls who did not report any negative answer and shared tasks.
- Students also highly appreciated the collaborative approach of the workshops and the conviviality fostered by the facilitators. In this regard, peers were supportive and respectful to each other and no major difficulties among them were observed during the sessions. When conflict occurred the last day of the performance (Terrassa, group 2) students were resilient and managed it by collaborating among them.
- However, such collaborative approach did not seem to permeate when sharing the PERSEIA working tasks (specially homework): there were some students concentrating the work and performing the main roles, mostly girls in the case of Terrassa. Some students in both groups expressed their upset about it. This dynamic was more emphasised in Terrassa, where in most subgroups leadership was assumed by 1 or 2 students. In Castellbisbal this was mostly observed in one of the groups.
- Regarding students' communication skills, students generally showed an easiness to share their ideas and thoughts (although these were not much elaborated), which was more emphasised in Terrassa. In this school, they also seemed more keen to and comfortable with sharing ideas verbally than in a written format.
- The body as expressive means was not generally applied throughout the sessions and it was more consciously used in Castellbisbal, in which three groups used small sketches to set the context, share ideas or introduce concepts.

Sense of initiative and entrepreneurship:

- Each group in each school showed different aspects of leadership and sense of initiative. While in Terrassa leadership was commonly assumed by 1 or 2 students in each group (again, mostly girls) in

Castellbisbal the pattern was more variable. In group 1 students showed a generally shared sense of initiative and rotational leadership, while in Group 2 several students seemed to lead the creation process, but these students were not necessarily the same who took the lead at the end of the process.

- In both schools, many students showed a sense of responsibility towards the work conducted and the final outcome, and particularly those students leading the process within their groups. In Terrassa teachers emphasised students' capacity to take ownership of the process towards the end and to improvise as some tense situations were emerging, through their capacity to creatively adapt to new situations and be innovative.
- Regarding feelings of self-confidence, students in Terrassa felt globally more prepared to perform than students in Castellbisbal (where 68% didn't feel ready). Coherently, in Terrassa they generally appreciated more the final performance, as suggested by students' answers highlighting "the monologues" and "the acting" as the most enjoyable aspects of the workshop, and some students reported overcoming shyness and gaining self-confidence as a learning outcome from the project.

GOAL 4: RRI VALUES

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.**

Overall Recommendations

- DEFINE A CLEAR AND SPECIFIC ROLE FOR ECRs AS YOUNG RESEARCHERS. The workshop guidelines should define more clearly the specific role of ECRs' as young researchers (differentiated from the role of the facilitators) and provide more spaces in the workshops for mutual sharing about science and research between the ECRs and the students. Such guidelines should also be jointly discussed among facilitators and ECRs with time before the workshops to make more explicit what is expected from them and allow them to prepare their interventions in advance, so they can orientate them towards showing a more personal and critical perspective of science.

- LINKING THE PERSEIAS TO ECRs' RESEARCH TOPICS could potentially enhance their contribution as researchers and increase their interaction with students. Also, having more time for face-to-face sharing with the facilitators in-between workshops could help ECRs reflect about their interventions and better understand the process.

- CLOSER INTERACTION WITH TEACHERS. The project should ensure a closer interaction and collaboration between facilitators and teachers both during the design and implementation, including more synergies between PERFORM contents and school curriculum, more guidance to teachers directly participating in the project and a broader involvement of the body of teachers (not only those attending the workshops). This implies guarantying face-to-face meetings before the project, the sharing and joint discussion of workshop materials in advance and the facilitation of spaces to follow-up the process during the implementation.

- EMPHASISE THE VALUE OF LEARNING SCIENCE: enhancing the motivation and interest towards science beyond those motivated students might require more emphasis on the personal dimension of science and doing research (e.g. interventions of the ECRs), so as to bring science as a practice and a valuable experience closer to students.

- ENSURE REAL COLLABORATION AMONG STUDENTS IN WORKING TASKS: different strategies should be put in practice in order to avoid and/or minimize the concentration of working tasks in few students within the group. A starting point could be to significantly reduce the workload allocated at home, so that students could develop their monologues in an environment supported and followed-up by the facilitators.

- COMMUNICATION SKILLS: the process would benefit of a bigger weight of the work on performance, both to train students performing skills and to foster their self-confidence and willingness to perform. Due to the narrative format of the monologues in Barcelona, there is also a special opportunity to train students' writing skills (a need identified through the process) in a way that is engaging for them and that can be synergic with the school curriculum.

- A DEEPER INTEGRATION OF THE RRI REFLECTIONS IN THE PERSEIAS SHOULD BE ENSURED: the activities during the workshops should be designed to directly address students' topics of research and/or research questions grounded in scientific contents, and be integrated as part of the creation process of the PERSEIAS. This would reinforce students learning process by grounding the reflections into specific topics they can approach and by emphasizing the transfer of knowledge, critical thinking and other reflections to the creative process.

- EMPHASISE ETHICS IN RESEARCH. Such integration includes as well the link between the ethics content of the workshops and the performance contents and research. Also, link ethics content to student's daily life experiences and ECR personnel stories to reinforce the human dimension of science. More discussion on the failure of scientists and more reflection on how to reduce the stereotypes could help students to understand the nature of science.

- DEEPER APPROACH TO SCIENTIFIC ISSUES. The points above might help to approach the scientific issues more deeply through the workshops, so as to provide students with a minimum background needed to trigger higher-order thinking processes (e.g. critical thinking, elaboration of ideas, reframing of concepts). The connection to the school curriculum could be a strategy to take advantage of and trigger synergies with science learning, together with the careful adaption of the activities to the cognitive level of students and schooling skills (e.g. technical vocabulary, clear guidelines, external support). In both cases, the coordination with teachers is crucial.

- RETHINK THE APPROACH TO GENDER AS A TOPIC – The focus on stereotypes and women discrimination might in some cases reinforce such stereotypes and discourage (girl) students. Other approaches should be also included in order to enrich the discourse about gender and foster critical reflections (e.g. go beyond binarisms –male characteristics vs. female characteristics).

- CLEARER COMMUNICATION WITH STUDENTS ABOUT THE PROJECT. Students should **be more clearly communicated since the beginning the different steps of the project and their participation in a final event** performing in front of an audience. Such information should be also coordinated with other actors (e.g. teachers and what they tell the students). Opening the choice of the audience could encourage students' participation and appropriation of the process.

- CLOSER ATTENTION TO STUDENTS WITH SPECIAL NEEDS. Those students with special needs should be followed more closely in order to ensure a proper accompaniment is facilitated through the process. This issue should be explicitly included in the agenda at the teachers' meeting before the implementation of the workshops and also should be followed-up during the workshops. Collaboration with school orientation departments (e.g. Aula d'acollida) while designing and implementing the project could foster PERFORM's attention to diversity and special needs and potentially provide a follow-up through the implementation.

Regarding the PERSEIA

- Those PERSEIAs using theatrical sketches or some acting enhanced their communicative and engaging potential. It could be, thus, an aspect to maintain and encourage during the creation process.

- The final PERSEIA would benefit of a **deeper work of research and integration of scientific content into the monologue. All scientific contents should be carefully revised** before the performance and **with enough time** to both ensure its rigour and alignment with RRI values (messages communicated), and to allow students introduce facilitators' feedback and memorise the tex**t.**

- Since the PERSEIA deeply relies on the narrative developed, ensuring the students **have the monologues in a written format previous to the performance** would clearly facilitate this task of review and would help ensure contents are accurate and clearly communicated. This could also promote students' writing skills, which was identified as a competence to improve and a synergic aspect with the school curriculum.

- More time could be devoted to **rehearsing students PERSEIAs and training performing** skills, in terms of their charisma and performer attitudes, to make sure students feel ready to perform and to avoid the overuse of a more conventional oral-communication format (emphasise the stand-up comedy format).