



The Art of Science Learning

WP4 Assessment Analysis

Overall Highlights and Recommendations

UK Case Study

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GENERAL INFORMATION:

School: Fairfield High School

Participants: 27 students in one group, 2 teachers, 8 ECR, 2 facilitators.

Setting: The school had the participatory workshops in blocks of two at a time, which meant that participants, facilitators, teachers and ECRs shared a gymnasium space for 4 hours. This made the workshops rather intense, all the students were in a same space for an elongated amount of time, but also enabled a good amount of contact between students and FETs.

OVERALL HIGHLIGHTS

GOAL 1: STUDENTS' INTERACTION WITH ECRs and TEACHERS

- Students interaction with ECR depended on the subgroup and ECR skills for engagement. Since students wanted to get on with their busk they appreciated those ECR who helped with the busks, although some of them felt ECR could not help them at all. While a minority of students wished to have had more interaction with ECR, most students did not mind or not wish to have increased their interaction with ECR. Those students who did not enjoy interacting with ECR argued ECR talked about useless things and were not interested or not able to help them with their busks. Students' perceptions towards ECR role might be related to students' previous contact with science and scientists outside school: most of them had never or hardly ever visited a research centre and seldom visited science museum, and therefore might have low interest in science and do not be used to deal with scientists (association to be tested in further analysis).
- Although teachers' participation was moderately low during workshops because one was not very interested and the other only attended one session, half of the students perceived teachers helped them doing the tasks during the workshops. Both of them kept committed with the project, doing paperwork and supporting facilitators with logistics, and also met together with students to rehearse their scripts before the performance.
- ECR showed a very enthusiastic attitude throughout the sessions. Their interaction with students was higher when working with subgroups (in which ECR could participate fully with them by leading discussions, supplying information and ideas, asking questions) than during collective activities. Interaction between ECR and teachers was not observed.
- Differently than teachers, ECR were requested to get involved in implementing workshop activities by facilitators since the beginning which promoted their involvement. However, ECR were not clear on the objectives of PERFORM and the workshops as the information given during the training was not enough. Such lack of understanding, together with their reduced experience in working with students at schools, challenged their first interaction with students. Also, some ECRs were not properly introduced and hence their role may have gotten slightly mixed up by students.
- Although ECR enjoyed working alongside students and watching them performing the busks which they considered as an empowering experience for students, some of them expected to contribute more based on their own experience as a researcher and work more on science contents because they thought it would have been more scientific content in the workshops.

GOAL 2: THE CREATION OF THE PERSEIA

- The use of original props was key to engage the audience through creating surprise and laughter.
- Some groups used a 'roll up roll up' style, moving around the hall, to invite larger audiences while others preferred to create a more intimate atmosphere to capture the attention of small groups of people. Both approaches had a good effect in engaging people.
- The busk about sound was challenging because people had to be closer to be able to participate on it.
- Discussion between students performing and the audience was reported to be achieved in more than a half of the busks performed.
- Scientific topics were generally addressed with rigour as well as clearly communicated by the students through their busks.
- Despite laughter and collaboration was reported in many of the busks, some students reported in their surveys, learning charts and focus group they did not enjoy performing in front of their peers because they felt ignored.

GOAL 3: TRANSVERSAL COMPETENCES

- Overall, it seems that workshops did not have an effect on students' perceived ability to formulate research questions since no significant differences were found between student's answers before and after the workshops. Interestingly, there were significant differences between the PERFORM and control groups. PERFORM students perceived themselves as more able to formulate research questions than the control group (maybe because teachers selected the most skilled students to participate in PERFORM).
- There is a gender gap in students' ability to formulate research questions and it seems that workshops were not able to address it: boys perceived themselves more skilled in formulating research questions than girls, both before and after the workshops.
- Discussion activities and videos were identified as particularly promoting students' acquisition of problem-solving skills, engaging them in reflection, reasoning and argumentation, and generating interest about science. However, these activities were not always designed by considering the reflective or critical thinking skills level of the students.
- Students mentioned they were motivated to learn about scientific topics at the beginning of the workshops and that they ended up knowing more about busks' topics.
- Workshops promoted collaborative skills among some students whereas others remained more passive: more than a half actively participated in all tasks and shared different tasks within their subgroup, and used to help each other and respect others' ideas. Gender- related tasks were not clearly observed.
- Students seemed to improve their communication and performance skills when working in subgroups during workshops and when rehearsing and performing busks. Particularly, busks helped students to foster their verbal communication skills and their abilities for communicating about science, having a potential impact on their self-confidence. However, some students were not used to work with scripts

maybe because they lacked some writing skills, which hindered the development of their busks' contents, a limitation that should be considered in the design of the activities.

- Some students took the leadership in different tasks during workshops; gender patterns were not observed. When creating the busks students seemed to share the responsibility, being able to manage their projects without many busk references since they only saw the facilitator once doing a busk. It is, thus, suggested by the ECRs that facilitators should perform busks more than once so students could have more experience on that and get more inspired to create theirs.
- Students' feelings during the workshops were difficult to address by using surveys. When asked if they felt confident while participating in workshops, around half of the students agreed but when asked for describing their feelings during workshops only 4 chose the option "confident". Gender differences were not significant.
- Performing the busks was a big challenge for most students, only 6 of them felt prepared to perform them. Students felt uncomfortable when busking because their peers did not pay attention to their busks and suggested that busks should be performed in science class to receive the attention of their peers. Despite that, students put in practice their entrepreneurial skills to create the busk and increased their self-confidence when performing it.

GOAL 4: RRI VALUES

Students' general perceptions and attitudes towards science

- STEM related subjects were perceived by students as enjoyable ways to acquire new knowledge, being science and design technology the most preferred and mathematics the less enjoyable. Learning on IT and computing was more enjoyable for boys than girls.
- Students in general perceived positively science education activities and reported feeling comfortable when doing them. Girls felt less comfortable than boys before workshops, a difference that was not found after the workshops, suggesting that workshops could have reduced such gender gap.
- The majority of students perceived that science is related to real-life problems and could help them understand worldwide problems. Boys agreed more with such perceptions than girls.
- Students also perceived that scientific jobs are important for having a better society and disagreed that men are better scientists than women and that scientific jobs are mostly for boys. Students participating in the workshops perceived the research profession as more gender balanced than their peers in the control group.
- In general students did not have a clear idea about their future studies. Around half of them perceived learning science as important for their future success, science classes as helpful to get a job and would like to study a STEM related career.

- Boys perceived learning science as more helpful to get a job than girls, a difference that was not found after workshops. But workshops did not have an impact on reducing the gender gap in this regard since boys were more willing to study a STEM career than girls both before and after the workshops.
- Around half of the students saw themselves doing science in the future. Boys agreed more with this idea than girls.

RRI values

- Students enjoyed working together through group tasks and practical activities. Overall, they felt part of the group, with some exceptions highlighting difficulties in achieving a balanced participation within subgroups.
- Students' interaction was diverse: some students' asked whatever they wanted to the facilitators whereas the others did not or provided neutral answers. Gender differences in students' involvement in discussions or asking questions were not clearly observed.
- Around half of students agreed they could make decisions about the topic, the research question and the content of their busk, but to a lesser extent on acting during the busk. A similar number of students could choose how they wanted to participate in their busk. Gender differences were not clear.
- Few students felt their work was recognized by the teachers.
- Few students really wished to have had more interaction with ECR. Students complained that ECR talked about useless things and were not interested or not able to help them with their busks. ECRs in turn noticed that workshops had a rigid structure that did not allow for moments of interaction with the students.
- Facilitators and ECR promoted both cognitive and emotional engagement amongst students during the workshops.
- Some students really enjoyed the activities while others were uncomfortable or disengaged. Their interest and enjoyment increased from the first to the final workshop.
- Most students enjoyed contributing with ideas to the design of the busks and practicing or performing them, although they were really nervous about performing in front of an audience. Others enjoyed the most talking to the ECRs and doing research by themselves, as well as engaging in reflective and discussion activities during workshops
- Some students enjoyed the least to perform the busk in front of other students because they felt uncomfortable. Others did not enjoy doing the initial tasks and activities because they were not related to the busks and interacting with the ECRs because they were not helpful with their

busks.

- Most students reported they improved their learning on the scientific topics of their busks, although a few students mentioned that the scientific level of the workshops was lower than science lessons. Observations showed that learning about scientific literacy was not well supported by the activities, which also lacked links to the curriculum.
- Workshops scheduling within the students' timetable negatively influenced their engagement since students missed important science and maths lessons. Negotiation between facilitators and teachers could prevent similar situations in the future.
- ECRs suggested giving the props earlier to the students to generate excitement and engagement and linking the science busking with students' experience in drama.
- Teachers and ECRs suggested to shorten workshops which did not involve practical activities, to spend more time in preparing students for the busks, to reduce the gap between learning the basics of busking and performing, and to shorten the time between the busks performed by facilitators and the workshops.
- Teachers highlighted that having an ECR with each subgroup helped in fostering students' engagement. One of the ECRs linked the broad topic chosen by the students with her research topic to be able to work on it and make it more attractive for the students.
- ECR would have liked to contribute more to the science level of the workshops and to have more time to better prepare STEM explanations during workshops so as to make them fun to students.
- Students were able to understand the nature of science both before and after the workshops so workshops did not have an effect on it. Most students perceived human imagination and creativity are needed for producing scientific knowledge, scientific knowledge is not always certain, and good scientists can fail while doing science.
- According to the teacher, workshops provided a good opportunity for students to debate ethics in science, which was not part of the curriculum. But ECRs noticed that some of these activities could have had the opposite effect than the one desired on students understanding of science and suggested more discussion on the failure of scientists and more reflection on how to reduce the stereotypes.
- Students and ECRs perceived there was a disconnection between the ethics content of the workshops and the performance aspects and suggested it would be valuable to establish more links. Also, more efforts should be done to connect activities with students' daily life experiences, as well as to include ECRs' personal stories so as to reinforce the human dimension of science.

Overall Recommendations

- **SELECTION OF TOPICS** – Students value the opportunity of selecting topics but complained about how they were selected (lack of consensus with their peers led to select less preferred topics). Selecting topics by finding links with ECR research topic could help in this regard.
- **WORKING GROUPS AND SCHEDULE** – It would be good to check whether students feel comfortable within the groups made by the teachers or not at the beginning of the workshops. Also, negotiate with teachers how workshops fit within the students' timetable so they do not miss important lessons.
- **GROUP ACTIVITIES AND USE OF VIDEOS** – The use of activities when students work in subgroups engaged more in reflection, reasoning and argumentation, and improve problem-solving skills and learning autonomy than those activities conducted with the big group. Keep using the videos since they foster discussion.
- **MORE EXPLICIT CONNECTION WITH SCIENCE LEARNING** – The learning process could benefit of more direct connections between activities' scientific content and ECR own research, as well as to the creation of the busk.
- **ECR AND TEACHER INTERACTION** – Provide workshops with a less rigid structure to promote informal moments of interaction between ECR, teachers and students.
- **COGNITIVE LEVEL OF THE ACTIVITIES** – Activities should be adapted to students' level of learning skills (e.g., reasoning and argumentation, writing skills) as well as to the school curriculum.
- **GENDERED APPROACH** – Pay special attention to gender differences within the group regarding learning to learn skills (e.g., ability to formulate research questions), both in the design of the activities and during the facilitation and reflections. Pay special attention to girls' disenchantment for studying scientific careers.
- **ETHICS INTEGRATION** – Make the link between the ethics content of the workshops and the performance aspects. 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.
- **BUSK REFERENCES** – Provide more examples of specific busks to students (this could be connected with ECR's creation of small busks during the training)
- **PERFORMANCE OF THE FINAL BUSKS** – Students did not feel comfortable performing the busks in front of their peers, so the where (place and context) and the who (audience) should be rethought and potentially, jointly decided with the students.