The Art of Science Learning

WP4 Assessment Analysis of Goal 3
UK Case Study

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BRISTOL CASE STUDY - *Fairfield Field High School*

GOAL 3: TRANSVERSAL SKILLS

Methodology

As a way to explore how the workshops approached GOAL 3 (i.e., promoting the acquisition of transversal skills amongst students), we assessed the impact of the learning process on three different types of transversal competences: i) learning to learn skills, ii) communication and collaborative skills, and iii) sense of initiative and entrepreneurship (see sections below for a description of each competence). More specifically, our analysis has been oriented towards exploring to which extent PERFORM workshops have facilitated learning spaces to train and put in practice students' transversal competences, and what aspects facilitated or hindered such practice. Therefore, our aim is to characterise the participatory learning process according to its capacity to foster students' transversal competences, and not to assess students' individual achievement related to these competences.

We present below results from students' inputs provided in the surveys (first quantitative approach) and researchers' observations of the workshops complemented by students', teachers' and ECRs' inputs (qualitative in-depth approach).

We first explore students' self-perceptions about aspects related to transversal skills through a pre- and a post-questionnaire answered by 19 students (7 girls and 12 boys) of those attending the workshops. We only include responses of those students answering both the pre- and the post-surveys to be able to compare changes before and after their participation in the workshops, but when reporting answers of questions only included in the post-questionnaire we show the results of the 22 students who provided answers. Due to the small sample size, results are shown in absolute frequencies (percentages could lead to misunderstandings). We compare these answers to those from 13 students (5 boys and 8 girls) from a control group and explore potential associations by using logistic regressions. We also examine potential gender-related associations. Results from these statistical analysis showing significant associations should be taken with caution due to the limited sample in this case study.

Students' answers are then further explored through learning charts they filled in after each workshop and a focus group conducted with a reduced but representative group of students who participated in the workshops (6 girls and 2 boys). Finally, in order to explore how the pedagogical context and related factors of the workshops could have fostered such learning outcomes, we analyse the transcription of our observations during the whole process. To complete such analysis we explore both involved teachers' and the 7 ECRs' perceptions on students' acquisition of these transversal skills.

HIGHLIGHTS:

- 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.**

LEARNING TO LEARN

Concept and approach

Learning to learn skills refer to students' ability to pursue and organize their own learning in accordance with their needs, as well as students' awareness of learning methods and opportunities. These skills include: *understanding the value of learning*, as students' awareness of their learning process; *learning autonomy*, as students' ability to pursue and persist in science learning (e.g. organising their learning, effective management of time and information, both individually and in groups); and *reflective thinking*, as the ability to gain, process, and assimilate new scientific learning and related life experiences through reasoned thinking and/or discussion, in order to use and apply this learning in a variety of contexts.

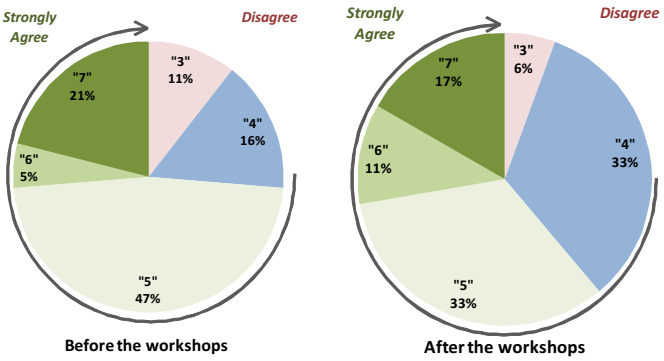
Learning to learn skills were first approached in the survey by exploring students' perceptions of the value of science and their perceived capacity to formulate research questions, a key aspect of doing research that was emphasised during the workshops. Learning charts, observations and interviews enriched these data and provided qualitative insights about the process. Specifically, researchers' observations of the workshops (PW1-2, PW3-4, PW5) explored to which extent and how the different sessions fostered the *mise-en-place* of learning to learn skills, focusing on reflective thinking and learning autonomy (e.g., students' capacity to ask questions, reason and argue, their ability to reframe scientific concepts and develop ideas, their capacity to assess or reflect about their peers' performance, and their ability to autonomously organise their time during the sessions to do the tasks). The teachers' on-line interview and the ECR group interview contributed with data on their perceptions about the impact of the workshops on the students' learning, including learning to learn skills.

Main highlights

- Majority of students perceived themselves as **able to formulate research questions**, both before and after the workshops.
- Significant differences were found between students attending workshops and the control group, both before and after workshops, in their ability to formulate questions suggesting that **PERFORM participants perceived themselves as more able to formulate research questions than their peers**. However it is possible that those more skilled were involved in PERFORM.
- **There were significant differences between boys and girls** in their self-perceived ability to formulate research questions. **Boys felt more able to formulate research questions than girls** both before and after workshops.
- One of the teachers observed that **students developed problem-solving skills** by participating in discussion activities during workshops.
- It was observed **students engaged more in reflection, reasoning and argumentation when working in subgroups than during activities in the large group session.** Some students noticed they learnt through **discussions and videos**.
- There were some pupils who **looked disengaged during activities**, which might be explained by the fact that **these activities were not always designed by considering the skills level of the students**.
- One of the teachers perceived that discussion activities during **workshops generated interest about science amongst students. Students themselves** mentioned at the beginning of the workshops **they were motivated to learnt about scientific topics and that they ended up knowing more about their busks' topics.**

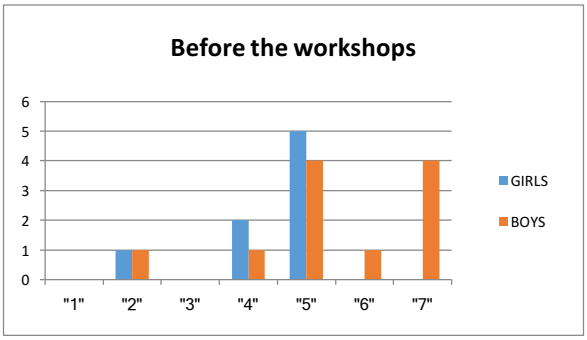
Results description

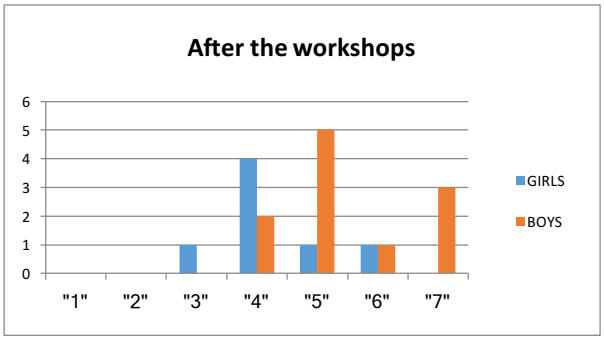
Before the workshops, **when asked for their self-perceived "*ability to formulate research questions*", the majority of students (14 out of 19) provided a positive answer** whereas two students (one girl and one boy) disagreed with the statement. After the workshops, neutral answers increased from 3 to 6 students, 12 of them agreed and only 1 (a girl) disagreed. Interestingly, **statistical tests between students attending workshops and the control group showed that there was a difference between both groups**, as those attending the workshops agreed more with the statement than the others (Z=1.96, p<0.1). Thus, **it seems that students involved in workshops perceived themselves as more able to formulate research questions than those in the control group**. However this difference can be explained by the way students were selected to participate in PERFORM. Teachers explained they selected the students according to their potential interest in the project, that is, in science. Therefore, it is possible that those more skilled were the ones who got involved in the workshops.



"I am able to formulate research questions"

Interestingly, **there were significant differences between boys and girls**, as boys tended to provide a higher proportion of strongly positive answers than girls in both surveys (pre-survey: Z=-1.80; p=0,07; post-survey: Z=-2,12, p=0,034), thus suggesting **boys felt more able to formulate research questions than girls** both before and after workshops.





When asked for writing in their corresponding learning charts what they learnt during workshops, one of them explicitly mentioned he learnt to do research –which relates to the formulation of research questions-, and explained he learnt about it through creating the busk:

"We learnt about our topic by performing our busk and conducting research about our topic by performing our busk and conducting research about it. We also learnt by watching other busks. We looked at different articles and compared them to ours. It increases our knowledge of general things."

Boy, UK1129

Students' learning about how to do research is connected as well to reflective thinking skills. As mentioned by the female teacher who attended only the second workshop (PW3-4), **students developed problem-solving skills** by participating in discussion activities during workshops. In general, it was observed that **students engaged in reflection, reasoning and argumentation** when working in subgroups in different moments: when defining the topic for their busks, when looking and critiquing journalistic articles addressing science-related ethical issues by, and afterwards when watching the unconscious bias video, as well as when using articles related to their topics to create breaking-news stories. Some students, particularly girls, referred to these activities in their learning charts:

"I have learnt that we subconsciously judge people based on looks, gender, and body language"
Girl, UK1130

"W*e've read different articles about sound; and looked at different sources, increasing my knowledge"*
Girl, UK1103

"I like learning through discussion based activities. Learning other people's opinions and views on topics can be useful"
Girl, UK1121

In this regard, some of them mentioned that **videos and discussions were useful tools for learning.** In the workshop on gender, students in subgroups guided by facilitators and ECR discussed four questions on the "science is a girl thing" video and were able to get conclusions. For instance, one of the groups argued that the video aimed to engage more girls in science and, even though it was well edited, its final message resulted into a different one because it showed female scientists having fun with make-up and not doing science. Another group of students agreed and added the video showed only women, so it was like if men and women worked separately in science, which they argued it was not the reality.
Also, one of the ECR highlighted **students developed other skills related to learning autonomy**, and linked to creativity, when working on the busk:

"*When they just randomly picked something and started talking about it. I was amazed, I was so amazed with their ability to just create something by themselves*."
ECR, Bristol

These activities, and specifically working in subgroups, **seem to have had a positive impact** in the self-perceived ability to formulate research questions and their ability for reasoning, argumentation and reflection, as well as other problem-solving skills and regarding their learning autonomy. However, **this was not the case when they worked in the large group session** in which it was observed that students rarely asked questions to facilitators and only a small number of students, mostly boys, contributed to discussions.

Furthermore, both in the large group and in subgroups, there were some pupils who **looked disengaged during activities**. As noticed by a couple of ECR, this might be explained by the fact that **these activities were not always designed by considering students' level of learning skills**. ECRs perceived many students lacked skills for reasoning and argumentation to contribute to some of the activities because they were not used to put in practice these skills at science classroom, as one of them argued:

"*When we did the session on giving them the papers and asking them to critically evaluate them. Their inexperience of doing that sort of thing before, so they didn't have*

critical thinking or ability to debate or ways to assess evidence really because that's not how science is taught."
ECR, Bristol

The female teacher also perceived that discussion activities during **workshops "*generated interest about scientific issues*" amongst students**. Indeed, in their learning charts, students in general mentioned at the beginning of the workshops **they were motivated to learnt about scientific topics and they ended up knowing more about their busks' topics**. As a girl wrote when asked for their motivation to participate in the project at the end of the first workshop and afterwards when asked for what she learnt in the last workshop:

(First workshop) *"So that I can improve my knowledge about food to use so that it can help me in later life. Sot that I can learn new facts and information"*
(Last workshop) *"That miracle berries were found in West Africa in 1725. That coke cans make loud noises when blown into them"*
Girl, UK1110.

SOCIAL AND CIVIC COMPETENCES

Concept and approach

Social competences generally refer to those personal, interpersonal and intercultural skills and forms of behaviour that equip individuals to participate in an effective and constructive way in social and working life. Among them, we address two broad groups: i) *collaborative skills*, referring to behaviours that help two or more students work together in the science learning process, including respect for others' opinions and the ability to approach conflict within the group in a constructive manner; and ii) *communication skills*, associated to students ability to communicate ideas about science effectively by using verbal, visual and written tools as well as body language.

Students' answers to the surveys mainly addressed the acquisition of collaboration skills while learning charts, researchers' observations, students' focus group, and teachers and ECR's interviews enriched and complemented these data in relation to communication skills. Observations during workshops provided data on collaboration skills by looking at: students' sharing of tasks and roles during the activity, students' willingness to ask for help and to help others, students' respect towards others' ideas and students' ability to manage difficulties within the group (if any). Observations also provided information on communication skills: students' ability to elaborate and share ideas verbally and written and students' use of the body to express ideas and convey meanings. Students' focus group examine their perceptions on work organisation, students' participation and decision-making within the groups. The teachers' and ECR' interviews also provided data on their perceptions about the impact of the workshops on the students' improvement of their collaboration and communication skills.

Main highlights

- In general **students worked well together** during workshops. **Around half of the students considered they had actively participated in all tasks and they had shared different tasks within their subgroup** during the workshops. Coherently, observations identified **more active and more passive students**. **Gender-related tasks were not clearly observed**.
- **Only two students** mentioned they did not participate in teamwork activities, and complained about **the way teachers formed the groups, arguing** that working with their friends would have allowed them putting more in practice their skills for collaboration.
- **Students in general used to help each other and respect other's ideas** during group discussions.
- **Students practiced written and oral communication skills** when working in subgroups during workshops and when rehearsing and performing the busk.
- The ECR and **teachers perceived that students improved their communication and performance skills as a result of their participation in the workshops.**
- The ECR also perceived that **busks helped students to foster their verbal communication skills and their abilities for communicating about science**, which they related to an increase of students' self-confidence that made ECR felt proud of them.
- However, the ECR noticed that **some students were not used to work with scripts** maybe because they lacked writing skills**, which made difficult they could develop the content for the busk** and this limitation should be considered in the design of the activities.

Results description

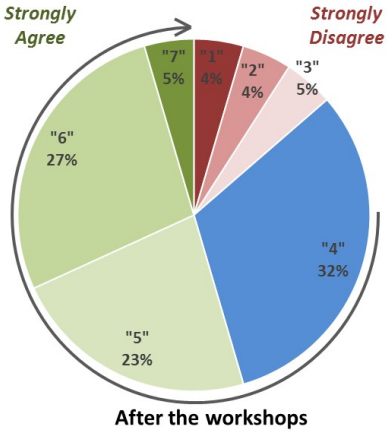
Both teachers and the ECR perceived that **students "*worked well together*"** during workshops, also when working in subgroups. Some students reported in the learning charts **they enjoyed working in groups because they learnt from each other**. As these two students, they learnt:

"Also from other people sharing to the group"
Boy, UK1112
"Doing a little presentation to present our topic and reading/understanding it in our groups"
Girl, UK1120

However, two students in the focus group discussed about **how the subgroups formed by teachers hindered their collaboration with their peers**. They argued that working with their friends would have allowed them putting more in practice their skills for collaboration:

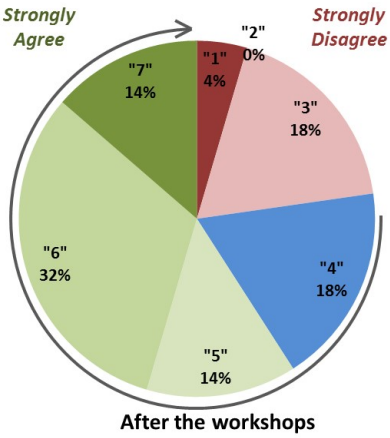
"*When you work with people you don't know, you are not friends with...it's like some people tend to take a back seat, more confident kind of go for it*"
(Boy UK1123)
"*Yeah, but if it was like to work with our friends I think it would be a lot more confident"*
(Girl UK1118)

These contrasting views related to their involvement in teamwork were also found in students' responses to the surveys. **Around half of the students (12 out of 22) considered they actively participated in all tasks during the workshops**, **2 did not agree with the statement** and 7 of them provided neutral answers. There was not any significant difference between boys and girls.



"I have actively participated in all the group tasks during the workshops"

Around half of the students (13) reported in the survey they shared different tasks within their subgroup during the workshops. **Five of them answered they did not share tasks** within their group and 4 gave neutral answers. No significant differences were found between boys and girls.



"During the workshops we shared different tasks within our group"

Observations during workshops support these survey answers. Even though in general students were actively involved in activities and they collaborated to create and practice their busks, when working in subgroups **there were more active and more passive students**. **Gender-related tasks were not clearly observed**.

During group discussions **students used to help each other and respect others' ideas. Only one exception was observed**: one girl was booed by some students when she said that disability is a trait for which people judge other people.

Regarding **communication skills, it was observed that students practiced them not only when rehearsing or performing the busk, but also when working in subgroups previously during workshops**. For instance, when presenting the breaking news exercise and the story of the object they invented. Two subgroups also used their body to perform their breaking news exercise: a girl performed as a plant and a boy was moving as a wave (in 2 different groups). In another activity, four subgroups used their body when explaining the story of the object. The female **teacher referred to how they improved their communication and performance skills** during workshops:

> "*Students developed a variety of skills such as problem-solving and communication as well as performance based skills*".
> Female teacher, Bristol

The ECR also referred to different aspects of students' acquisition of both written and verbal communication skills. They perceived that **at least two subgroups of students were not used to work with scripts, which made difficult they could develop the content for the busk**, as one of them explained:

> "*I think the group that I had they weren't very good at focusing on writing things down. I think they would have been a lot better just trying things out.*"
> ECR, Bristol

Besides this challenge, most ECRs agreed that **busks helped students to foster their verbal communication skills and their abilities for communicating about science**, which they related to an increase of students' self-confidence that made ECR felt proud of them. As a two ECRs explained:

"So when (Girl, UK1113) walked away and started engaging random people by herself, she was busking then. And she was explaining the science and that was I think – my proudest moment was when Nino was like – I was like, she's going herself! And she's talking to as far as I can tell people outside of her friendship group, and she's taken straws and she's talking to people about vibrations and sound. And like that was it for me, I was, yeah, that was a busk in my mind."

ECR, Bristol

"I think my group was also – I could hear flow going like, "Do you know how this works? Can you explain how this works?" And then she was also trying to explain how – like when you hold a hand it still makes a full circuit, so I think there was a bit of science there, yeah."

ECR, Bristol

SENSE OF INITIATIVE & ENTREPRENEURSHIP

Concept and approach

Sense of initiative and entrepreneurship globally refer to the ability to turn ideas into action. This group of skills includes, thus, students' *leadership*, their *sense of responsibility* towards and ownership of the outcomes, the *ability to plan and manage projects* in order to achieve objectives, and *creativity and innovation*. From an emotional dimension, we also included students' *self-confidence and esteem*, approached as students' perceived capability to effectively accomplish a certain level of performance in science learning.

Students surveys' provided data on students' feelings of *self-confidence* throughout the workshops and when performing the busks. Researchers' observations complemented these data by focusing on students' behaviours during the workshops and whether they suggested *initiative and ownership of the learning process*, and specifically: students' leadership and/or responsibility over the group activity and final outcomes, and students' affective responses related to self-confidence and personal initiative. Students' focus group provided data on their individual involvement in the group, as well as on their participation and their role when working within subgroups. The teachers' and ECR' interviews also provided data on theses aspects.

Main highlights

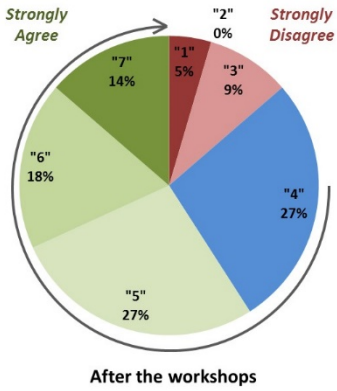
- Observations show that **some students took the leadership in different tasks during workshop activities. Gender patterns were not observed.**
- **Students seemed to share the responsibility over the creation of the busk,** being able to manage this project without many busk references since they only saw the facilitator once doing a busk. The ECR suggested **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 workshop were difficult to address by using surveys. When asked if they felt confident during workshops, around half of the students agreed,** 3 disagreed and 6 gave a neutral answer. But **when asked for describing their feelings during workshops only 4 (one girl and three boys) chose the option "confident" whereas most of them (9) chose the option "indifferent"**. There were not significant differences between girls and boys in this regard.
- **Performing the busks in front of an audience was a big challenge for many students**. Only 6 of them felt prepared to perform their busks. There were not significant differences between girls and boys in this regard.
- Students in the focus group mentioned that they **felt uncomfortable** when busking because their peers did not pay attention to their busks. They would have felt more comfortable busking in science class to receive the attention of their peers.
- Even though performing was a challenge, **students put in practice their entrepreneurial skills to create the busk and increased in their self-confidence when performing it.**

Results description

In general, when working in the different subgroups, observations show that **some students took the leadership in different tasks during workshop activities.** For instance, in one of the subgroups, a girl took the leadership in writing the script for the breaking news exercise whereas the two boys took the responsibility of performing it. Despite this example, we did not observe a gendered pattern in the distribution of leading roles within the groups.

Students also seemed to share the responsibility over the creation of the busk. In this regard, the male teacher mentioned that "*at the end students managed to do their busks very well*", suggesting students' were **able to manage this project**. An ECR also noticed that students in general **took the lead and created their busks without many external references** since they only saw a busk once and it was a long time ago. He suggested facilitators should perform busks during the workshops so students can have more experience on that and get more inspired to create theirs.

Regarding students' self-confidence, around half of the students (12) felt confident during the workshops whereas 6 of them gave neutral answers (4 were girls) and 3 of them provided negative ones. No significant differences were found between boys and girls.



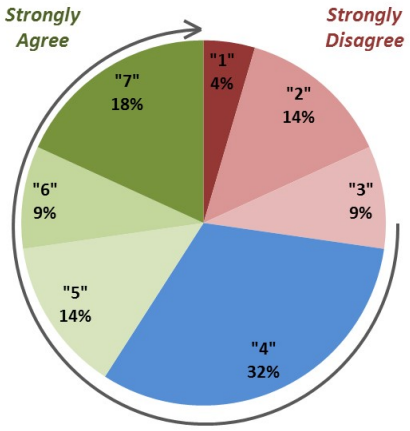
"I felt confident during the workshops"

The female teacher referred to this issue by using the example of a usually quiet, passive student who grew in self-confidence as the project progressed:

> "*I witnessed her participating and offering ideas to her group towards the end of the project*".
>
> Female teacher, Bristol.

However, students' answers to the survey changed **when asked to identify their feelings during the workshops. Only 4 of them (one girl and three boys) chose the option "confident" whereas most of them (9) chose the option "indifferent"**. Such difference could be related to the different nature and structure of the questions: the first one directly asked for confidence and was a Likert scale to which students had to answer according to their level of agreement and the second one was a multiple-choice item providing different feelings and confident was only one option out of six.

Performing the busks was a big challenge for many students, as highlighted by themselves, their teachers and ECR. When asked if they felt prepared or not to perform the [PERSEIA] despite the rehearsals during the workshops, **almost half of students (9 out of 22) agreed they did not feel ready to perform their busks and 7 provided neutral answers**. Only 6 of them felt prepared to perform. There were not significant differences between girls and boys in this regard.



After the workshops

"Despite the rehearsals during the workshops I did not feel prepared to perform the busk"

The **male teacher noticed that most students were reluctant to do their busks**. Similarly, in the focus group students mentioned that they **felt uncomfortable** when busking because their peers did not pay attention to their busks. They noticed it was not a good idea to perform when people were having lunch because they felt they were not willing to pay attention to them, which was perceived as demotivating for some of them. As this girl said:

"No one really cared because it was their lunch so they didn't want to be listening to us talk about science. I guess it's not that interesting."
Girl, UK1118.

Some of them mentioned in the focus group that it **would have been better to perform in a science lesson** since they would have had the attention of their peers. The ECRs also discussed some possibilities to reduce the stress of students due to performing in front of their peers, such as:

"*Performing in a science oriented event because the people are there, they're more actually engaged with it*" and "*performing at their school fete*".
ECR, Bristol

Even though most students felt uncomfortable when performing in front of their peers, one of them in the focus group **noticed that such experience was also good to reinforce their self-confidence**:

"*They* (facilitators) *kind of prepared us to do it, like before we were scared but it got better because we did more confidence things (…) I think the bit about performing in front of like classmates and stuff and trying to get us feeling less worried about doing it was helpful*"
Boy, UK-1123

The ECRs also noticed it. They mentioned that students **put in practice their entrepreneurial skills to create the busk and increased in their self-confidence when performing it**. As one of them said:

"*The kids were really nervous but they had plenty of ideas and it was really nice to see them growing their ideas and trying to devise their content*".
ECR, Bristol

This view was also shared by the male teacher, who mentioned that **students' confidence could have increased after performing in public**.