Interactive Music Science Collaborative Activities
Team Teaching for STEAM Education

Deliverable 5.6
First Version of Usability validation of iMuSciCA toolkits

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Executive Summary

This deliverable reports on the usability validation of the iMuSciCA activity environments. Usability testing has been performed on students and teachers during the Phase A of the pilot testing in schools in Greece, France and Belgium and incorporated the execution of tasks in six Activity Environments; responses in questionnaires were collected while biometrical data were gathered from some participants. According to the responses, specific directions have been summarised for improving specific aspects of some Activity Environments.

The primary goal of the usability tests was to inform the designers and the developers of each environment about potential deficits in the design, the functioning logic and the overall feeling of the environments. To this end, usability scenarios have been developed by developers in collaboration with pedagogical partners that assigned tasks to the students which they needed to carry out. Questionnaires were filled in by students after their tasks in each environment were completed, while informal conversations between students the researchers who were coordinating the experiments were noted down, giving valuable additional insights about possible directions for improving the environments. In addition, in a number of activity environments biometrical data that involve eye tracking, Galvanic Skin Response (GSR), Electroencephalography (EEG), camera and audio capture of students, as well as screen capture of the students' interactions were also collected through the iMotions platform.

The results from the questionnaires and the informal conversations with the experimenters indicate that the overall usability value of the environments is satisfactory, however, specific elements need to be improved that have to do with the graphical elements of the user interfaces. Most environments would benefit from an accompanying user manual or a help tool that would provide information about elements on the interface. Performance improvements have also been suggested and are planned for the CPU-intensive environments.

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LIST OF ABBREVIATIONS

Abbreviation	Description
STEAM	Science, Technology, Engineering, Art, Mathematics
3D	3-dimensional
AE	Activity Environment
DrawME	Drawing Canvas Activity Environment
UI	User Interface
UX	User Experience
GSR	Galvanic Skin Response
EEG	Electroencephalography
WP	Work Package
ATHENA	ATHENA RESEARCH AND INNOVATION CENTER IN INFORMATION COMMUNICATION & KNOWLEDGE TECHNOLOGIES
UCLL	UC LIMBURG
EA	ELLINOGERMANIKI AGOGI SCHOLI PANAGEA SAVVA AE
IRCAM	INSTITUT DE RECHERCHE ET DE COORDINATION ACOUSTIQUE MUSIQUE
LEOPOLY	3D FOR ALL SZAMITASTECHNIKAI FEJLESZTO KFT
CABRI	Cabrilog SAS
WIRIS	MATHS FOR MORE SL
UNIFRI	UNIVERSITE DE FRIBOURG

1. Introduction

The primary goal of the activity environments is to give students an enjoying learning experience, where the User Interface (UI) elements of the learning tools are as easily accessible, intuitive and as audio-visually pleasing as possible. To this end, usability tests were carried out in one school Belgium, one school in France and two Schools in Greece that produced some basic feedback from students. During those tests and for each testing environment students were given a usability scenario and a questionnaire, while researchers conducting the tests were engaged in informal conversations with the students, keeping notes about remarks that were not accounted for in the questionnaires. The results of the usability tests analysed in this deliverable indicate that the tools in their current form satisfy their goals, while there are very specific aspects that need to be clarified (mainly including clarifications about the icons in specific UI elements). Section 2 describes the methodology of the usability tests in more detail, giving links to the actual usability scenario documents and the questionnaires given to the students. Section 3 gives an analysis of the results, which are given in the Appendix, while Section 4 summarises the content of this deliverable.

2. Methodology

During the usability tests the first versions of six activity environments were evaluated in terms of the the following aspects:
- *Functional integrity*: are all routines functioning as intended?
- *User Experience (UX)*: are the visual and audio responses of the environments informative, intuitive and accurate in when and how they appear (seen or heard)?
- *User Interface (UI)*: how easy is it for the students to find which UI elements they should use in order to carry out specific tasks?

The activity environments (see deliverable D5.5-Initial Demonstrators of iMuSciCA workbench toolkits) that were tested are the following:
1) 3D Musical Instrument Design,
2) 3D Musical Instrument Performance,
3) Drawing Canvas for Music Creation,
4) Geometry and Algebra Tools,
5) Kinect Guitar Performance and
6) Sonification of Mathematical Equations.

The developers of each activity environment, in collaboration with educational partners, formulated activity scenarios that were intended to allow students to explore many aspects of the user interface and functionality of the environments. Goal of this exploration by the students was to reveal potential weaknesses of the UI or misinterpretations related to the functionality of the tools. The usability scenario for each environment can be found in the following links (localised translations for French, Belgian and Greek were also prepared - available upon request):

- 3D Musical Instrument Design Usability Testing Scenario:
https://docs.google.com/document/d/1G27Dx4LmJYA8C9pcP1i1kBfQUfHW-t-hqa77plh0XOE/edit

- 3D Musical Instrument Performance Usability Testing Scenario:
https://docs.google.com/document/d/1-uKIKPzhLOEsUK7T5PpFcKwvJiiTElzc4iYJFCYpXio/edit

- Drawing Canvas for Music Creation Usability Scenario:
https://docs.google.com/document/d/1XtOv6zG7CnppZ5EQ6iK8Ow0jPXOOouVyeJOarTFIQEo/edit

- Geometry and Algebra Tools Usability Test:
https://docs.google.com/document/d/1tFHa89M1zCY8F4i6iXhQoRMas-rmNg8Ks7dwp6ranWI/edit

- Kinect Guitar Usability Scenario:
https://docs.google.com/document/d/1tM-JDXwQ_YsQqvd_vu4eyfPgwdO5KP3YSg_VMirBIpY/edit

- Sonification Usability Test:
https://docs.google.com/document/d/1FUkMHS-0p6Yjnew-trOARWRWv9gH-CTFTHjScuX3F30/edit

Questionnaires were also prepared that the students had to fill in after they had executed the tasks described in the usability scenario of each environment. The questionnaires were made by the developers in collaboration with educators and included questions that aimed to provide information about how the students perceived the quality and functionality of the environments. The questionnaires that correspond to each activity scenario for each environment can be found in the following links (again, localised translations for French, Belgian and Greek were also prepared - available upon request):

- 3D Musical Instrument Design Usability Testing Questionnaire:
https://docs.google.com/forms/d/1J_IP-HzY-5pdBWLYzJSn9Uzy01rj0mZGaZdmupV9QUE/edit

- 3D Musical Instrument Performance Usability Testing Questionnaire:
https://docs.google.com/forms/d/1gj8JfJOTvN4AK6txXLei0j0h_L11BQa7HYvoFyUV6V4/edit

- Drawing Canvas for Music Creation Usability Questionnaire:
https://docs.google.com/forms/d/1gj8JfJOTvN4AK6txXLei0j0h_L11BQa7HYvoFyUV6V4/edit

- Geometry and Algebra Tools Usability Questionnaire:
https://docs.google.com/forms/d/1F1KkhJlXI6Vcu2oKu3MkfApWOs5WrRgr93_t9lDH9sA/edit

- Kinect Guitar Usability Questionnaire:
https://docs.google.com/forms/d/1OZabReWcyJUHFbT-K80cCsRg699DFI-FmI5HZDfH8ws/edit

- Sonification Usability Questionnaire:
https://docs.google.com/forms/d/1UirOAZPhS71MucTR4Ag2yK7GNR3KvUxigFpKPL2qHPo/edit

In parallel with the questionnaires, researchers of the iMuSciCA project were observing the students, having also conversations with them, especially after the tests have ended. Through this process comments were documented that allowed the extraction of qualitative insights about possible

improvements outside the context of the scenarios and the questionnaires (discussed in Section 3). During usability testing in four of the aforementioned environments, biometric data from students, whose parents have signed the necessary consent forms (see deliverable D8.4-NEC - Requirement No. 4), were also captured through sensors and the iMotions software (see deliverable *D6.1* - *Pilot Testing Action Plan*). Specifically, data from eye tracking; Galvanic Skin Response (GSR); Electroencephalography (EEG); camera and audio capture of students while using the environments as well as screen capture of the students' actions. For the activity environment of the Drawing Canvas, data have been also captured from a digital pen, which the students were using during the usability testing scenario.

3. Analysis of results

In this Section qualitative remarks as gathered from the results in the usability tests for each Activity Environment (EA) will be presented, with accompanying references to quantitative data in the Appendix when necessary. The usability tests took place in schools in three countries, one school in Belgium, one school in France and two schools in Greece. Different numbers of participants were involved in tests of different environments according to the availability of each tool that mainly depended on the time it took the students to complete the scenarios and fill the questionnaires of each environment. As a general figure:

- In Belgium, the participants varied from 11 to 25, with an age range of 13 to 16.
- In France, 10 students participated (giving 9 to 10 answers), with an age range of 14 to 15.
- In Greece, participants ranged from 17 to 35 within the ages of 13 to 16.

Participants in all countries had a mixed background in playing and/or learning music.

3.1. 3D Instrument Design Activity Environment

3.1.1. Description of the activity task

In this task the students were asked to experiment with the strings of the instrument and especially how the length of the string affect the sound. Apart from zooming, rotating the point of view and changing the size of the whole instruments, the students were asked to divide each string into two equal parts by moving the bridge and verify that the sound produced of the two parts is the same. In a similar manner, the students had to move the bridge of both strings to the same position and verify that the corresponding equal substrings sound the same. Afterwards, the students were asked to freely change the frequency of one string without changing its size (i.e. experiment with the material, thickness or tension).

3.1.2. General remarks from observations and analysis on the questionnaires

The questionnaires provided to the students were focused on the overall navigation of the interface, the easiness of manipulating the instrument and the quality of the sound. Although most of the students were not familiar with a 3D environment (see Q.1.1 in the Appendix), the navigation of the viewpoint to the 3D world seem to be handy for the majority of the students (Q.1.2). However, some of them reported that it was difficult to understand which instrument to choose when asked to choose the monochord. Regarding the functionality of the instrument manipulation (Q.1.3), although

the students answered that it was easy to manipulate the instrument, many of them were not able to generally accomplish the tasks related to sound, such as producing equal sounds when asked to (Q.1.4 and Q.1.5). Many of them experienced difficulties to control the position of the bridge (Q.1.6). Moreover, a numerical precision issue regarding the length of the strings confused some of the students (Q.1.6). Two strings may appear to have equal length (due to the precision of the length shown in the 3D world), but their actual length is different. This has the negative effect that two identical strings do not produce identical sounds. Regarding the sound quality of the instrument, the feedback was generally positive (Q.1.7), with the remark that the sound can be louder.

3.1.3. Usability Suggestions

- The precision issue of the length of the strings must be corrected.
- It is easier for the student to understand the term bridge, if the string(s) of the instrument is already divided (half or random) in its(their) initial state.
- The sound produced must be louder.
- The icon selection selection can be improved.

3.2. 3D Instrument Performance Activity Environment

The 3D Instrument Performance AE is split into two sub-environments. The first is the actual integrated AE that involves the use of the Leap Motion Sensor, and the second is the air-guitar interaction which is not yet integrated in the iMuSciCA Workbench.

3.2.1. Description of the activity task

3.2.1.1. Leap Motion Sensor

The main task in this activity was to try and evaluate two modes of interaction with the virtual string instrument: the free interaction mode and the gesture interaction mode. Apart from this, the students were also asked to experiment with the various features of the AE, i.e. by using tools and visualization, to explore other functionalities of the environment, such as the gesture interaction recorder and the audio recording tool.

3.2.1.2. Air Guitar with the Kinect Sensor

The tasks in the usability scenario for this activity environment were intended to reveal whether the students felt like they were having control over the basic gesture scheme. Therefore, the students were asked initially to get acquainted with the gestures and then try to play all notes of the air guitar with different levels of intensities.

3.2.2. General remarks from observations and analysis on the questionnaires

3.2.2.1. Leap Motion Sensor

The students answer positive for the general usability and appearance of the activity environment (see Q.2.3 and Q.2.4 in the Appendix). Regarding the free interaction mode with the virtual instrument, students reacted from moderately to positive (Q.2.5). Regarding the gesture based interaction, students had difficulties to understand and perform, however they answered more

positively compared to the free interaction since they found this type of interaction more interesting (Q.2.10). Regarding the sound, most of students answered positively (Q.2.6) for the sound quality of the instrument, but a mismatch among the students from the different countries was observed regarding the "responsiveness" (Q.2.7) of the instrument. This might be due to different hardware used in each validation setup, since the hardware (CPU, memory, video card) can greatly affect the performance of the environment. Regarding the various tools and visualizations that were asked to use, students find it difficult to measure the tone produced by the string (Q.2.8), had a moderate reaction to the spectrogram visualization (Q.2.9), and found relatively easy to record their gestures and the audio of a session (Q.2.11 and Q.2.12).

3.2.2.2. Air Guitar with the Kinect Sensor

Even though many students had not heard of, or had not used the Kinect sensor before the testing session (see Q.5.1 in the Appendix) and several of those students did not know how to play any musical instrument (Q.5.2), the overall usability of the air guitar gesture scheme was generally rated positively (Q.5.3). Additionally, a strong agreement was observed in rating the sound quality produced by the Modalys string instrument (Q.5.5); in some notable exceptions of negative comments, students referred to the sound as too 'electronic' or too 'empty' (possibly because no instrument body reverberation is used in this version of Modalys). On the other hand, the responsiveness of the instrument was rated as moderate (Q.5.6) because of two reasons (explained during informal conversations with researchers): latency in Modalys and inaccuracies of gesture capturing. Moderate to negative feedback for the accuracy in gesture capturing is also evident by the questions concerning the ability to play specific notes (Q.5.8) and diverse intensities (Q.5.9). Furthermore, during informal conversations with researchers many students suggested that additional visual feedback regarding the position of the virtual air guitar in relation with the user's body would improve the interaction experience.

3.2.3. Usability Suggestions

3.2.3.1. Leap Motion Sensor

- Modalys latency should be improved.
- The whole environment is computationally heavy. Users must be aware of hardware requirements.
- The free interaction mode should be improved. Smoother sound should be produced.
- The gesture based interaction is nice, but must be more accurate.
- A recorded gesture performance explaining the gesture interaction might be helpful.
- The tuner tool must be more accurate.
- The 3D Spectrogram may be improved.
- Some small bug fixes.

3.2.3.2. Air Guitar with the Kinect Sensor

- The latency of sound needs to be improved for the next versions.
- Reverberation options would be provided, or a tool with audio effects could be developed that would make the sounding instrument more impressive.
- The addition of visual feedback indicating the position of the instrument in relation to the user's body would improve the user experience.

3.3. Drawing Canvas (DrawME) Activity Environment

3.3.1. Description of the activity task

The usability scenario for the DrawME environment was intended to lead the students to draw specific shapes (e.g. a rectangle); listen to those shapes; listen to different timbres by changing the stroke color; find out ways to delete their drawings (by clearing canvas or deleting specific strokes); and "lock" the drawing canvas to specific frequencies (and then draw lines corresponding to given notes).

3.3.2. General remarks from observations and analysis on the questionnaires

Regarding the questions for this activity that were around the overall friendliness of the environment, the students were generally satisfied with the information provided by the UI and the time it took them to complete the tasks of the scenario (see Q.3.1, Q.3.2, Q.3.5 and Q.3.7 in the Appendix). Regarding questions around the clarity of the UI elements in terms of how accurately they convey the meaning of the actions they trigger, answers included mixed feedback: some elements were very clear (i.e. the fact that colors correspond to timbres (Q.3.3), identification of the visualisations area and use of playback controls), while others were unclear (i.e. right-click erasing of lines and lock-to-grid icon) (Q.3.4). At some extent the role of each visualisation panel was correctly identified, even through several students lacked the necessary background to identify the mapping properties of each visualisation tool (e.g. what is depicted on a spectrogram) (Q.3.8). Comments by the students, gathered during informal conversations with the researchers conducting the usability tests, were along the lines that this environment is very enjoying to use and informative but there are also some functionalities (e.g. right-click deletion) that the students could not infer.

3.3.3. Usability Suggestions

- The meaning of the "clear canvas" and "lock-to-grid" buttons needs to be clarified.
- The "right-click deletion" functionality needs to be mentioned explicitly to the user (very useful feature that cannot be inferred).
- The aforementioned points can be tackled either by setting up a user manual or incorporate a help tool on the interface.

3.4. Geometry and Algebra (Cabri Express) Activity Environment

3.4.1. Description of the activity task

In the first task for the Cabri Express Activity Environment the students were asked to draw a triangle, then measure the angles of the triangle and validate that their sum is equal to 180 degrees by using the calculator tool. The second task involves the construction of two graphs (lines) and their intersection.

3.4.2. General remarks from observations and analysis on the questionnaires

Students were asked to rate how handy was the activity environment (see Q.4.2 in the Appendix) and if it was easy to find the piles containing the various tools (Q.4.3). Although the students answered positively, the observation of the teachers was rather different. Teachers reported that many students were not able to open the piles, and experienced difficulties finding the appropriate tools (such as the angle tool that were requested). Moreover some students experienced difficulties using the graph tool. Regarding the calculator most of them tend to use the keyboard instead of the digit buttons of the calculator.

3.4.3. Usability Suggestions

- The whole interface should be either simplified or provide tooltip help text of the various buttons on the functionalities.
- The calculator can be manipulated with the keyboard as well.
- The calculator when opened covers the piles. The calculator and the piles should not overlap at least in the entering web page.

3.5. Sonification of Mathematical Equations Activity Environment

3.5.1. Description of the activity task

The usability scenario for the Sonification of Mathematical Equations tool directed the students to use the graph drawing area for creating basic shapes (i.e. line, circle and rectangle) and sonify them. Afterwards, the students were asked to clear the graph area, open the math editor and handwrite a given mathematical equations, which they afterwards visualise and sonify in the graph area.

3.5.2. General remarks from observations and analysis on the questionnaires

The students generally responded positively to questions concerning their understanding of what the UI elements were related to (see Q.6.1, Q.6.2 and Q.6.3 in the Appendix). Some concerns were raised (according to the questionnaires and comments made during informal conversations with the researchers) about the clarity of the icons used for drawing, deleting content on the graph area and for opening the Math Editor (Q.6.4, Q.6.5 and Q.6.9). Students also rated the tool as mostly effective in terms of its ability to recognize drawn geometric shapes (Q.6.6) and handwritten math equations (Q.6.7). There were some minor misinterpretations of the relationships between the y-axis and the frequency of the produced sound (Q.6.8).

3.5.3. Usability Suggestions

- The icons for drawing, deleting content on the graph area and for opening the Math Editor should either change or a help functionality should be added that clarifies what the role of the buttons with those icons is.
- A user manual clarifying the interpretation of the y-axis to the frequency of the produced sound would be very helpful.

3.6. Usability testing of learner monitoring sensors

Biometric data were collected from a group of students in Belgium and Greece, who have signed consent forms, in four Activity Environments (3D Instrument Design, DrawME, Geometry and Algebra Tools and Sonification of Mathematical Equations) using sensors and the iMotions software. Specifically, data from eye tracking; Galvanic Skin Response (GSR); Electroencephalography (EEG); camera and audio capture of students while using the environments as well as screen capture of the students' actions. Students who contributed biometrical data answered a questionnaire with two questions, see Figures 3.6.1 and 3.6.2; responses show that students were mostly unaware of the sensors (except from the Web camera) and they were not feeling uncomfortable with wearing mainly the EEG sensor, to lesser extend the GSR and the eyetracking, whereas they were familiar with the web camera.
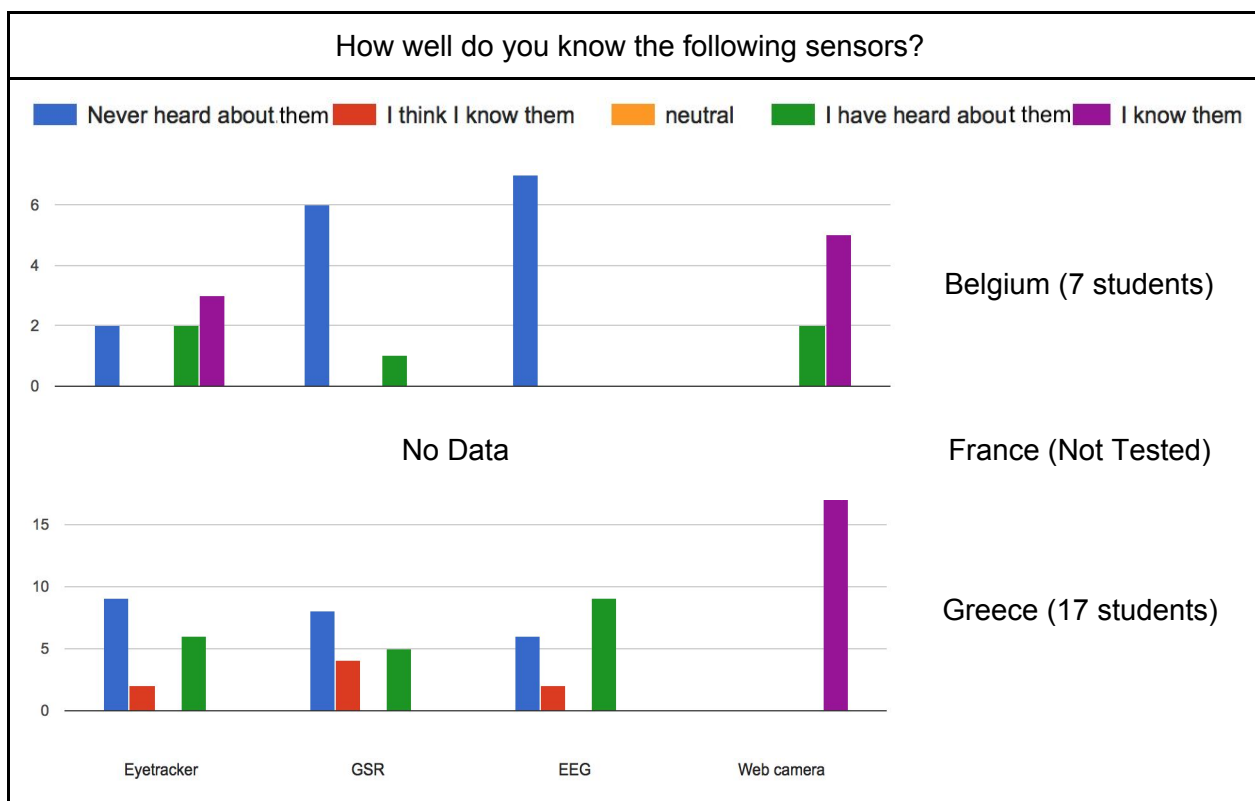
Figure 3.6.1: Answers to Question 1 in the "Sensors Usability Questionnaire".
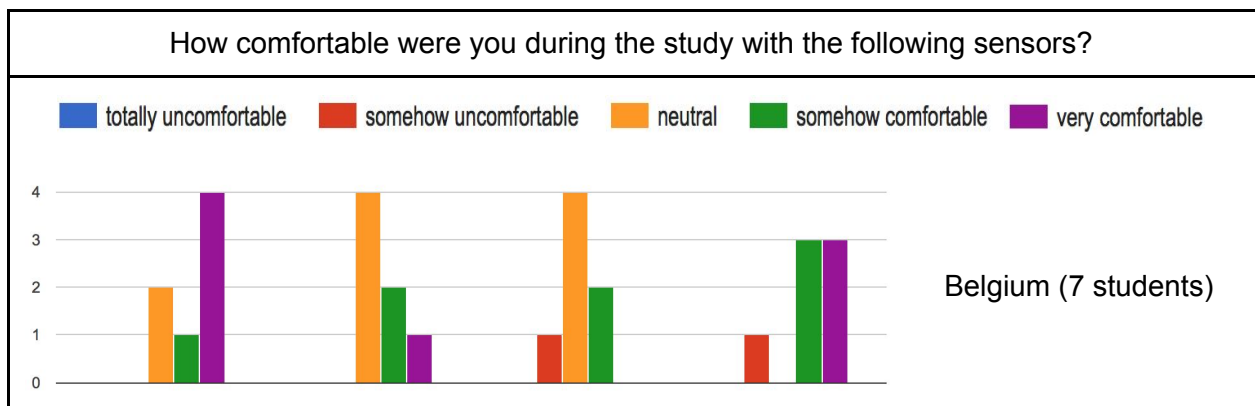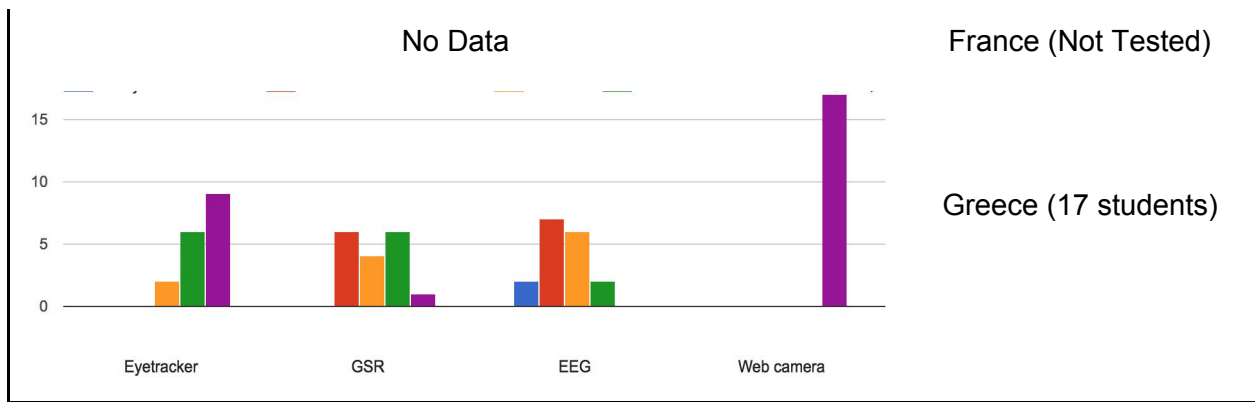
Figure 3.6.2: Answers to Question 2 in the "Sensors Usability Questionnaire".

4. Conclusion

According to feedback obtained by the students during the usability tests some targeted corrective interventions need to be made on specific elements of the User Interfaces (UIs) of some tools. The possibility to make a central "iMuSciA Workbench" manual, or separate manuals for each environment will be examined during the next period, along with the option for each tool to incorporate a help menu or tooltip instructions for each UI element.

Appendix: Students Analytic Answers to the Questionnaires

A.1 Answers to the 3D Musical Instrument Design Usability Testing Questionnaires

Q.1.1 Have you ever used any 3D design environment?

Legend: Yes (blue), No (red)

Belgium (25 students): Yes 44%, No 56%
France (10 students): Yes 60%, No 40%
Greece (17 students): Yes 17.6%, No 82.4%

Q.1.2 How handy was the navigation (manipulating the viewport)?

Belgium (25 students): 1: 1 (4%), 2: 0 (0%), 3: 2 (8%), 4: 13 (52%), 5: 9 (36%)

France (10 students): 1: 1 (10%), 2: 1 (10%), 3: 2 (20%), 4: 4 (40%), 5: 2 (20%)

Greece (17 students)

1: Very hard to navigate - 5: Very easy and intuitive

Q.1.3 Did you find the right parts to manipulate the instrument?

Belgium (25 students)

France (10 students)

Greece (17 students)

1: I could not find the appropriate parts - 5: It was very easy to find them

Q.1.4 Have you succeeded with the tasks related to tones?

- I didn't find how to make the sound
- I did find the control but I couldn't hear the sound
- The sound was not what I expected
- The sound was clear and in line with my expectations

1 (4%)

0 (0%)

11 (44%)

14 (56%)

Belgium (25 students)

0 (0%)

3 (30%)

1 (10%)

6 (60%)

France (10 students)

0 (0%)

0 (0%)

1 (5.9%)

16 (94.1%)
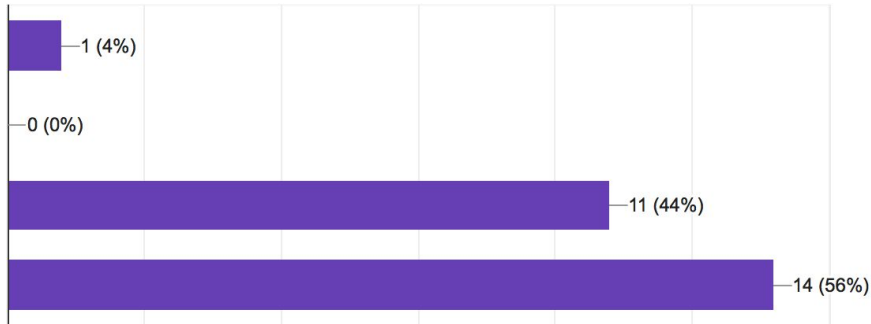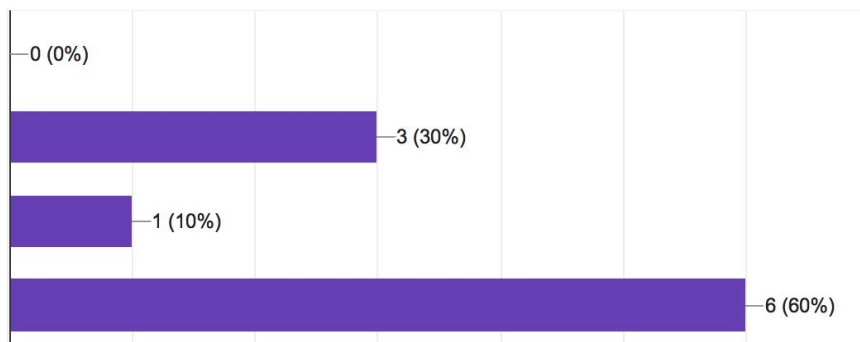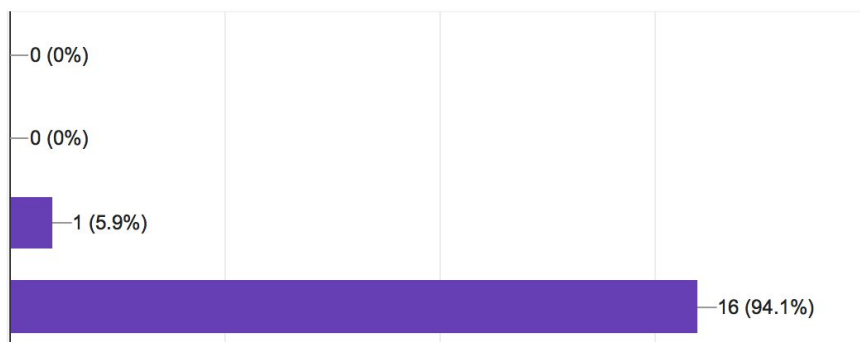
Greece (17 students)

Q.1.5 Could you produce similar sounds when it was requested?

- I could make equal sounds
- I could make similar sounds but not equals
- I couldn't produce sound at all
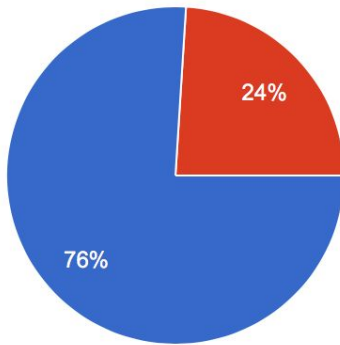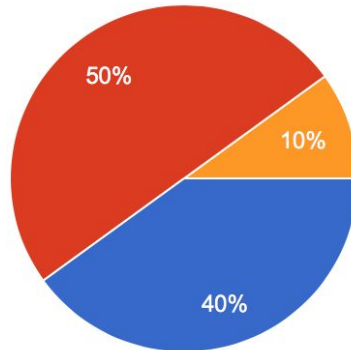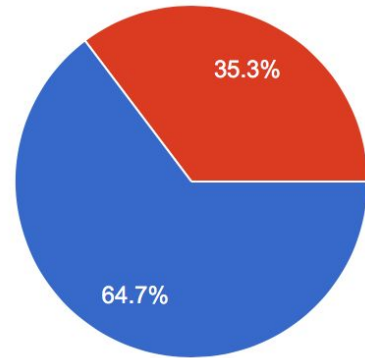
Belgium (25 students)   France (10 students)   Greece (17 students)

Q.1.6 How did you produce different sounds in the last step?

- By moving the bridges
- By changing the length of the instrument
- By changing radius of a string
- By changing tension of a string
- By changing material of a string
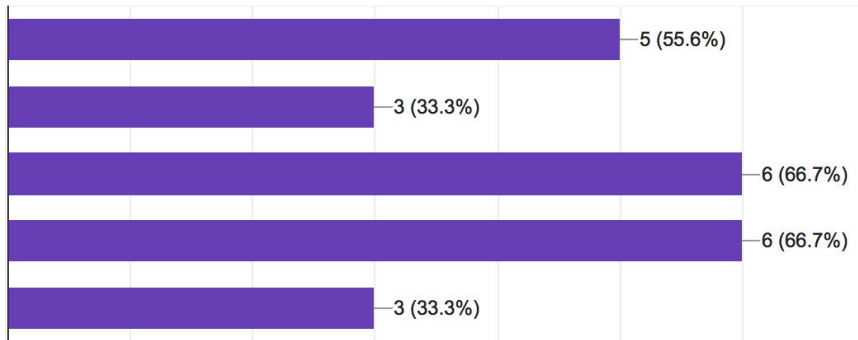
5 (20%)
4 (16%)
5 (20%)
16 (64%)
1 (4%)

Belgium (25 students)

France (9 students)
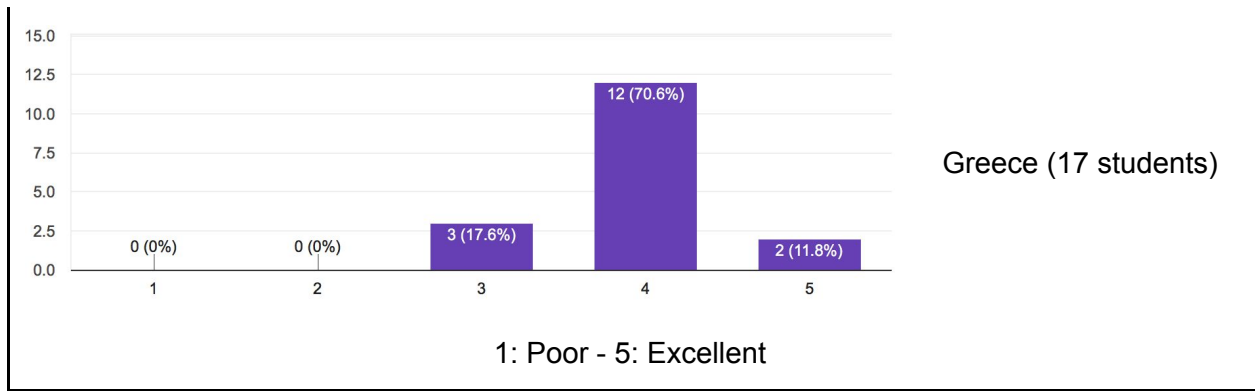
5 (55.6%)
3 (33.3%)
6 (66.7%)
6 (66.7%)
3 (33.3%)

Greece (17 students)

0 (0%)
0 (0%)
6 (35.3%)
12 (70.6%)
7 (41.2%)

Q.1.7 How would you rate the sound quality of the instrument?

Belgium (25 students)

0 (0%) | 0 (0%) | 4 (16%) | 15 (60%) | 6 (24%)

France (9 students)

0 (0%) | 2 (22.2%) | 3 (33.3%) | 2 (22.2%) | 2 (22.2%)

Greece (17 students)

1: Poor - 5: Excellent

A.2 Answers to the 3D Musical Instrument Design Usability Testing Questionnaires

Q.2.1 Did you know the Leap Motion Sensor?

- Never heard about it
- Heard about it
- I have seen someone using it
- I have used it in the past

Belgium (11 students)   France (10 students)   Greece (29 students)
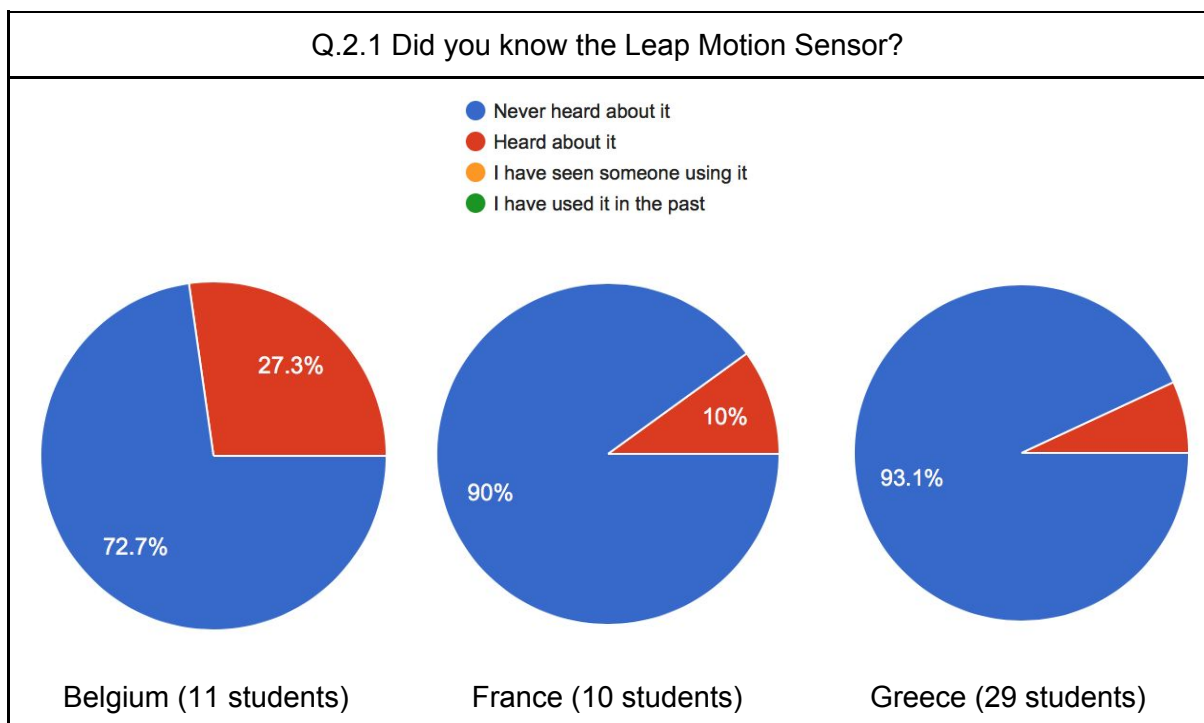
Q.2.2 How familiar are you with playing a musical instrument?
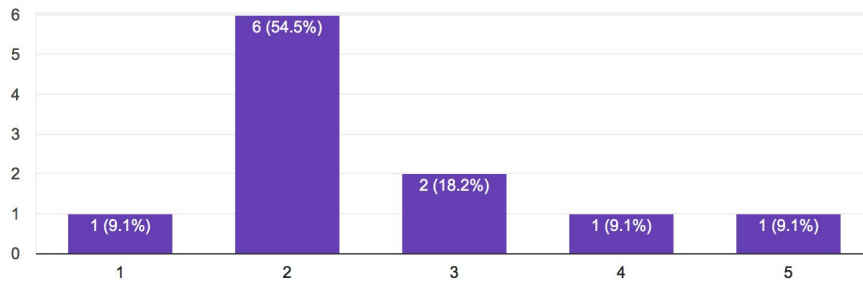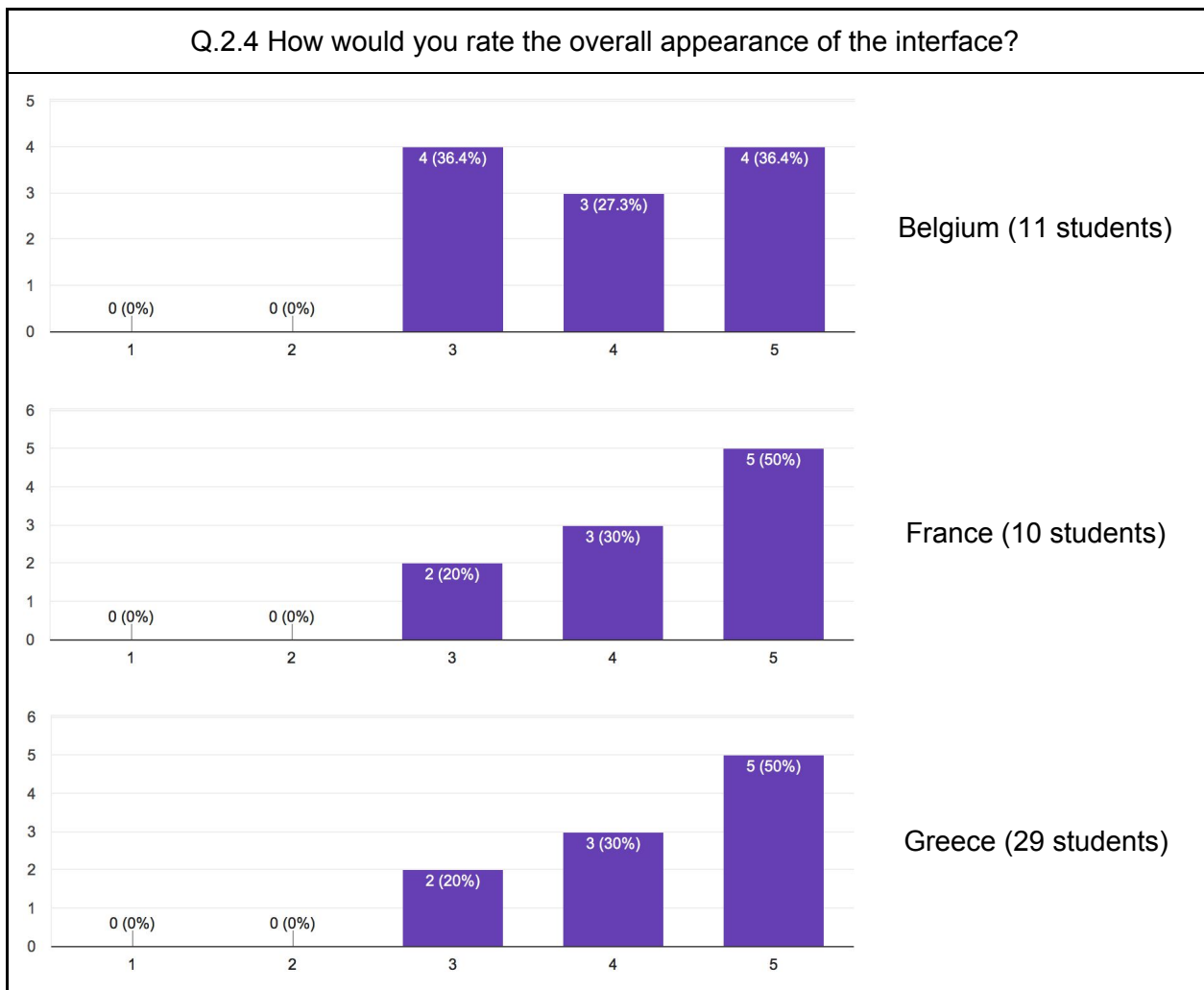

Belgium (11 students)
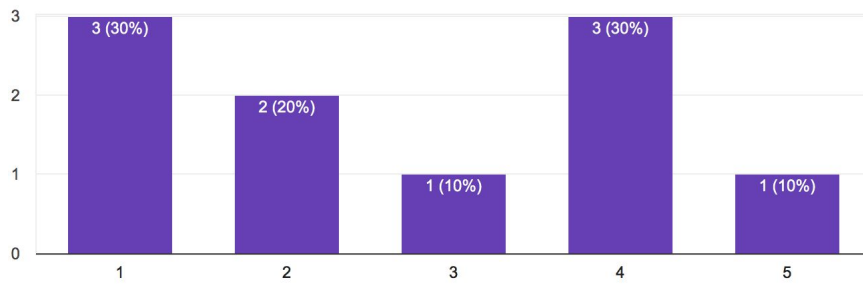
France (10 students)
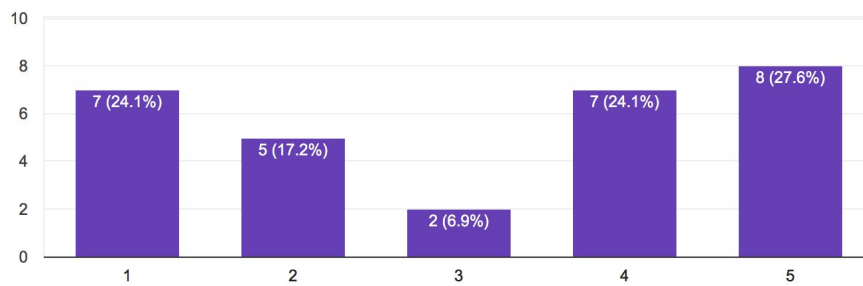
Greece (29 students)

1: I don't know any instrument - 5: I consider myself a musician

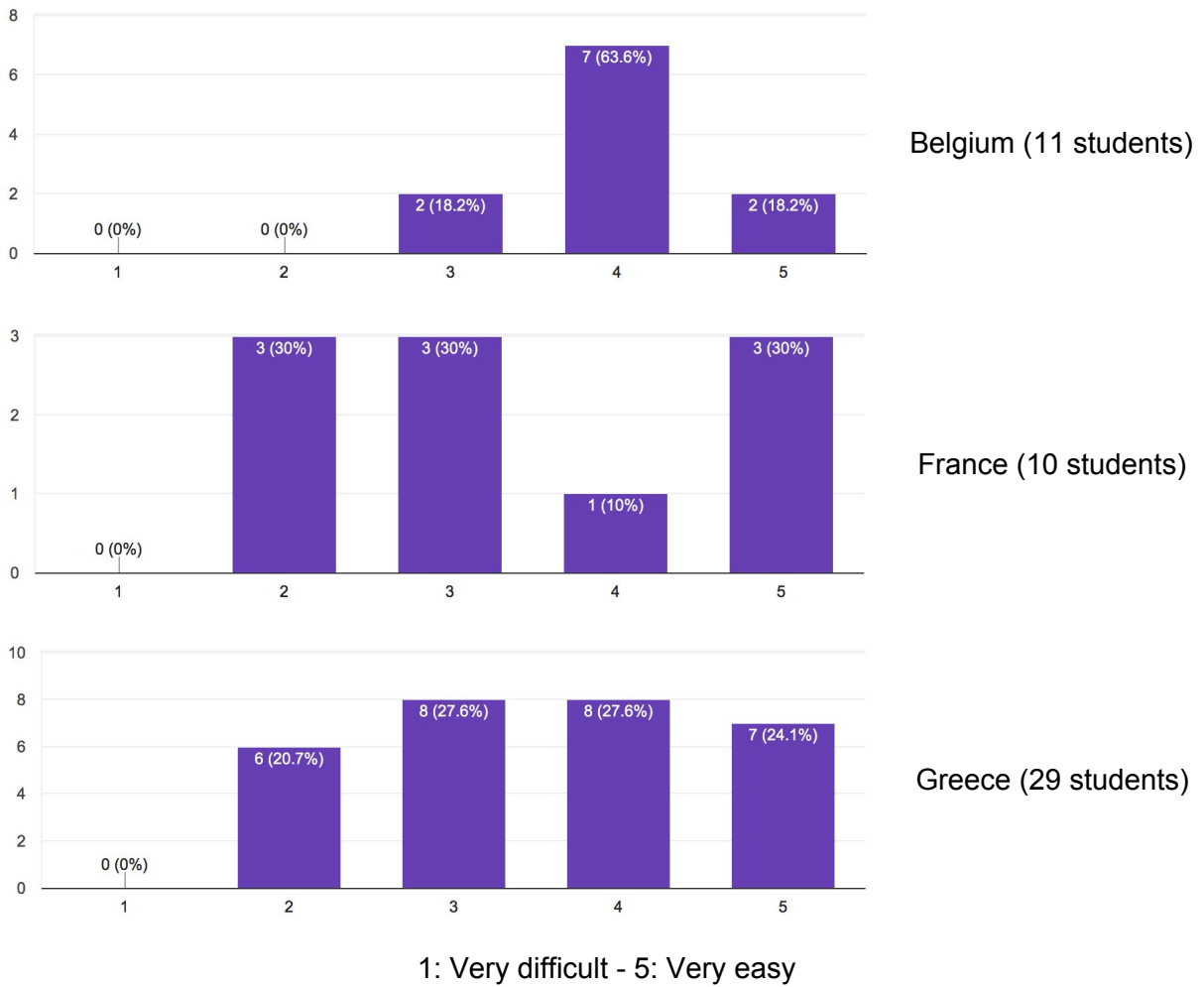## Q.2.3 How would you rate the overall usability of the interface?

Belgium (11 students)
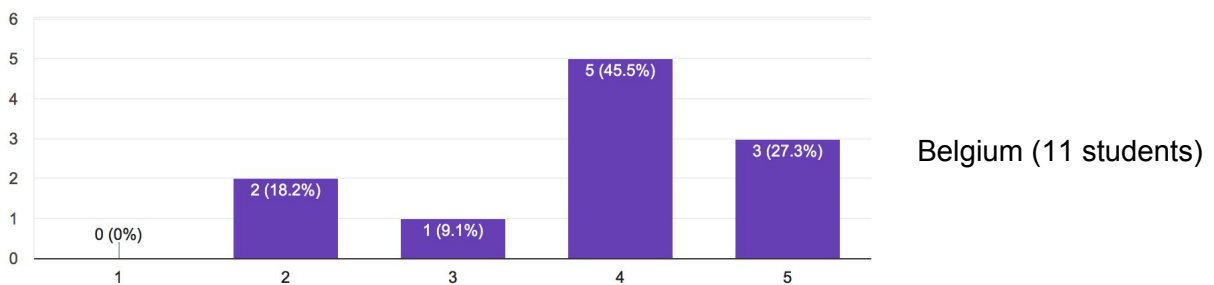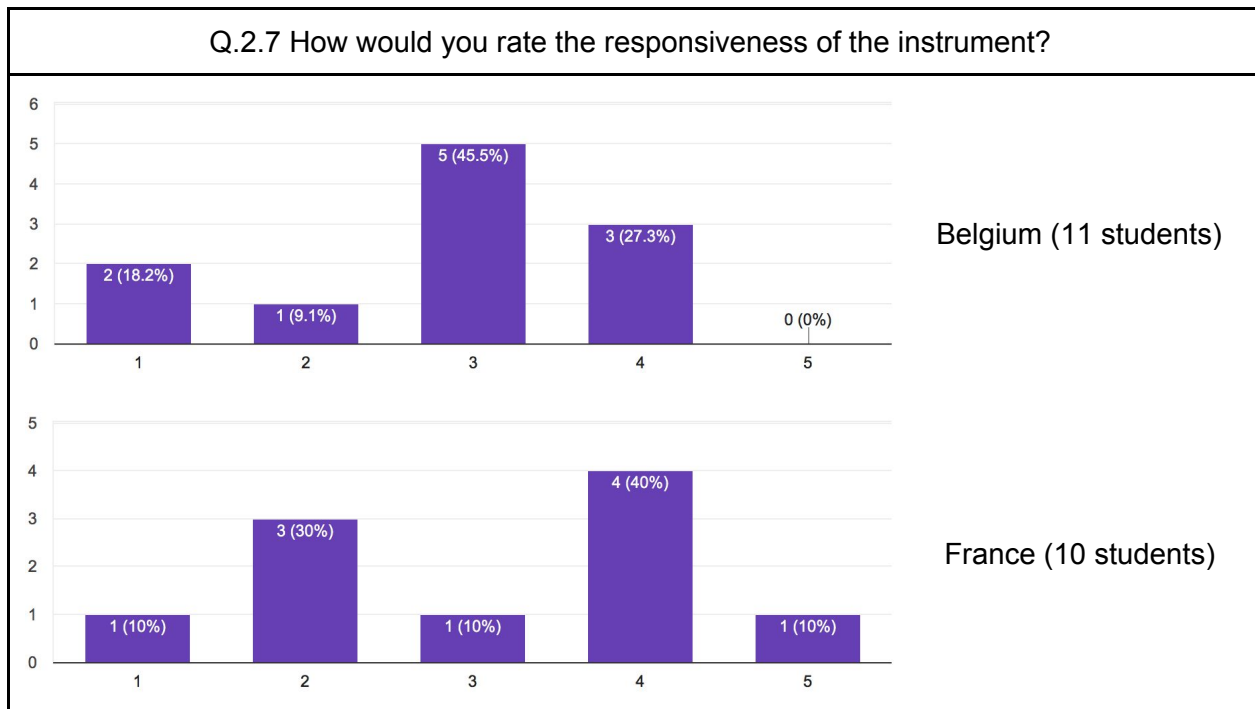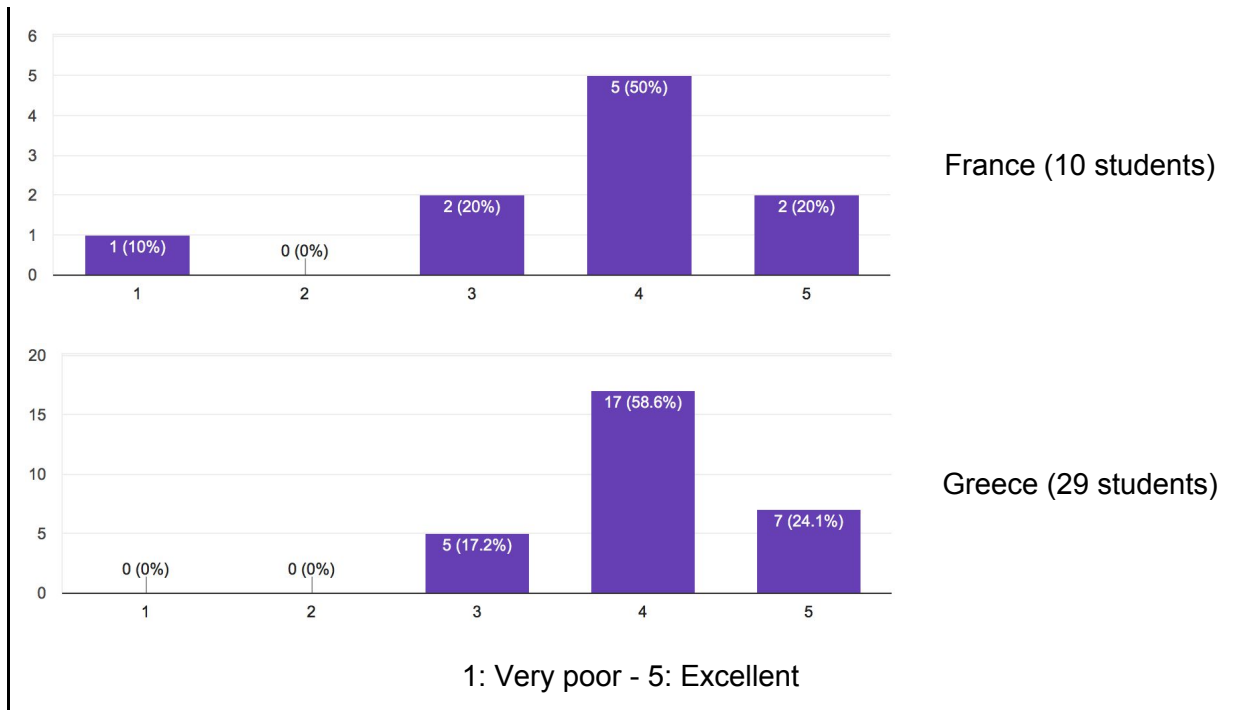
5 (50%)

3 (30%)   France (10 students)

0 (0%)   1 (10%)   1 (10%)

1   2   3   4   5

15 (51.7%)

10 (34.5%)   Greece (29 students)

0 (0%)   1 (3.4%)   3 (10.3%)

1   2   3   4   5

1: Not usable at all - 5: Very easy to use

Q.2.4 How would you rate the overall appearance of the interface?

4 (36.4%)   4 (36.4%)

3 (27.3%)

Belgium (11 students)

0 (0%)   0 (0%)

1   2   3   4   5

5 (50%)

3 (30%)

2 (20%)   France (10 students)

0 (0%)   0 (0%)

1   2   3   4   5

5 (50%)

3 (30%)

2 (20%)   Greece (29 students)

0 (0%)   0 (0%)

1   2   3   4   5
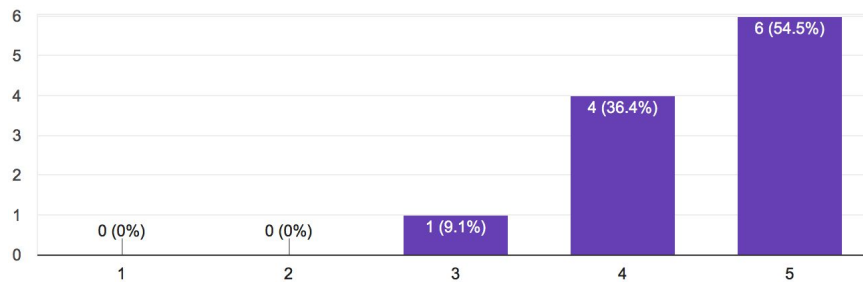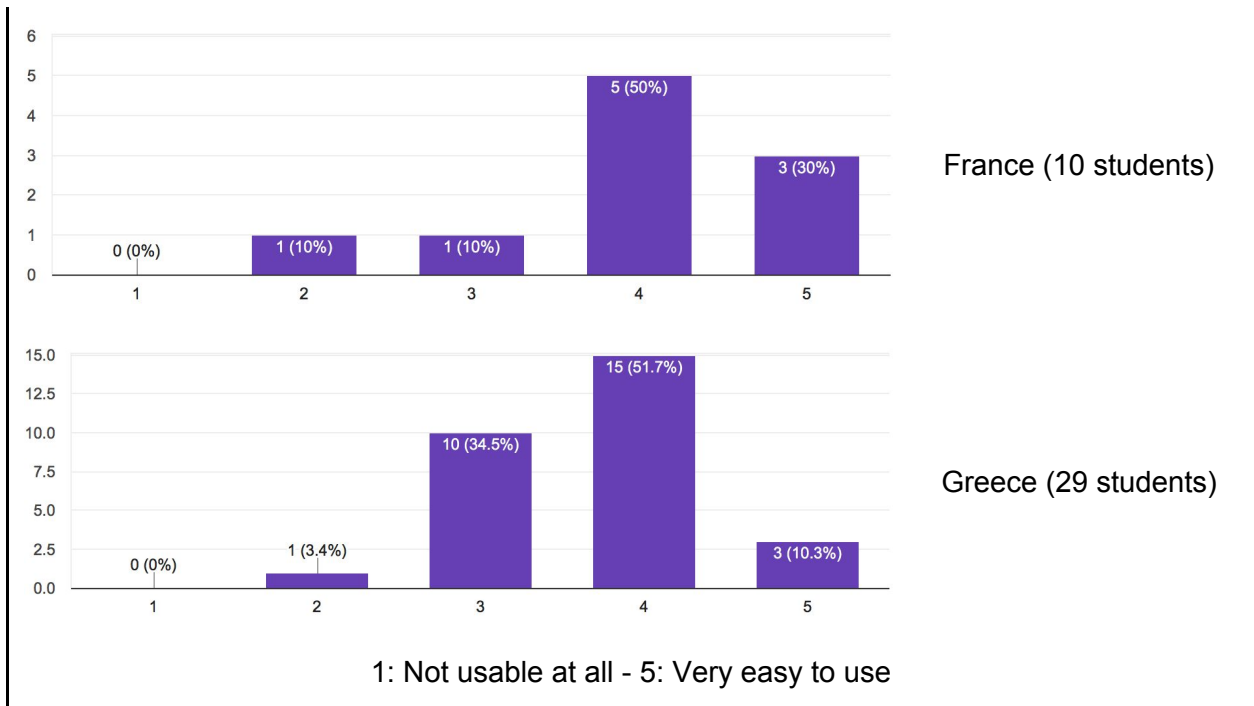
Q.2.5 How would you rate the free interaction mode with the instrument?

Belgium (11 students)

France (10 students)

Greece (29 students)

1: Very difficult - 5: Very easy
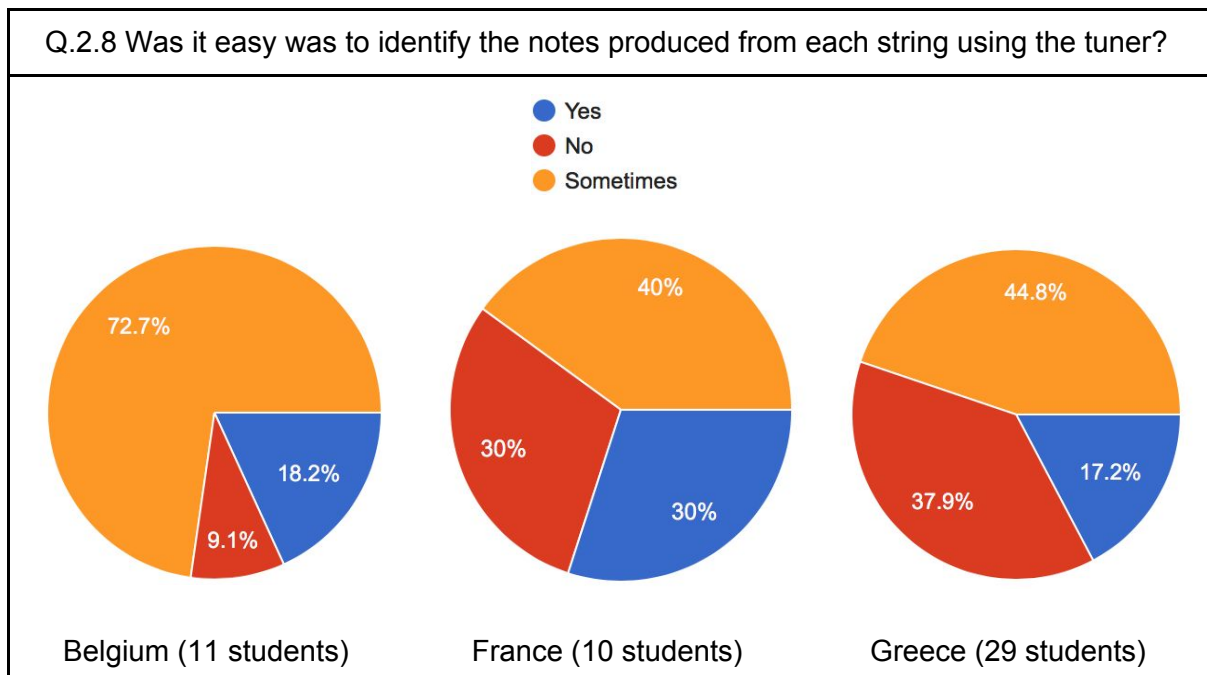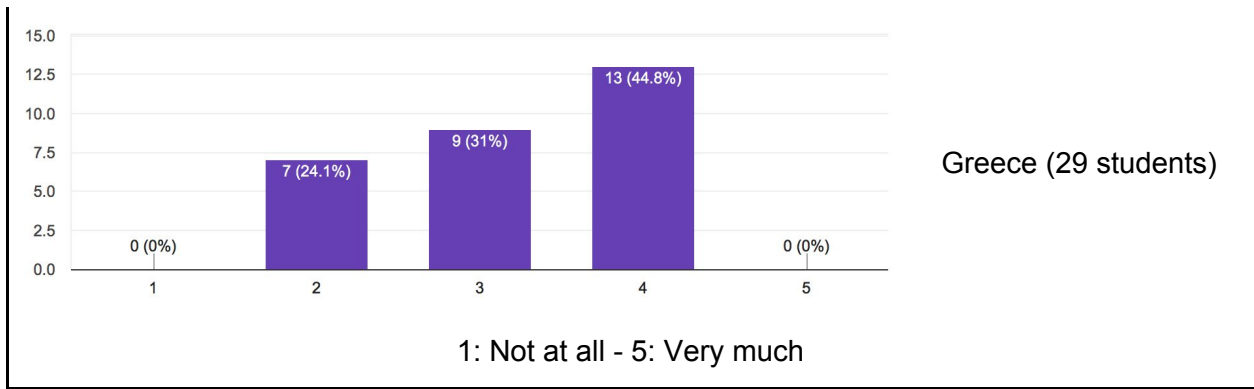
Q.2.6 How would you rate the sound quality of the instrument?

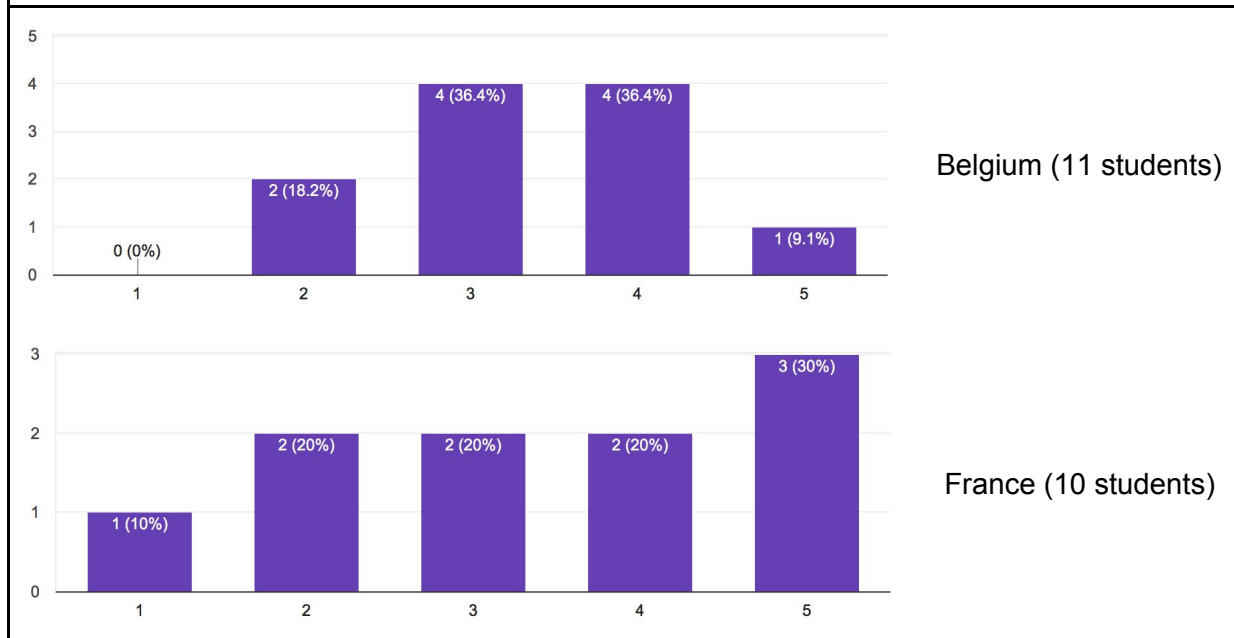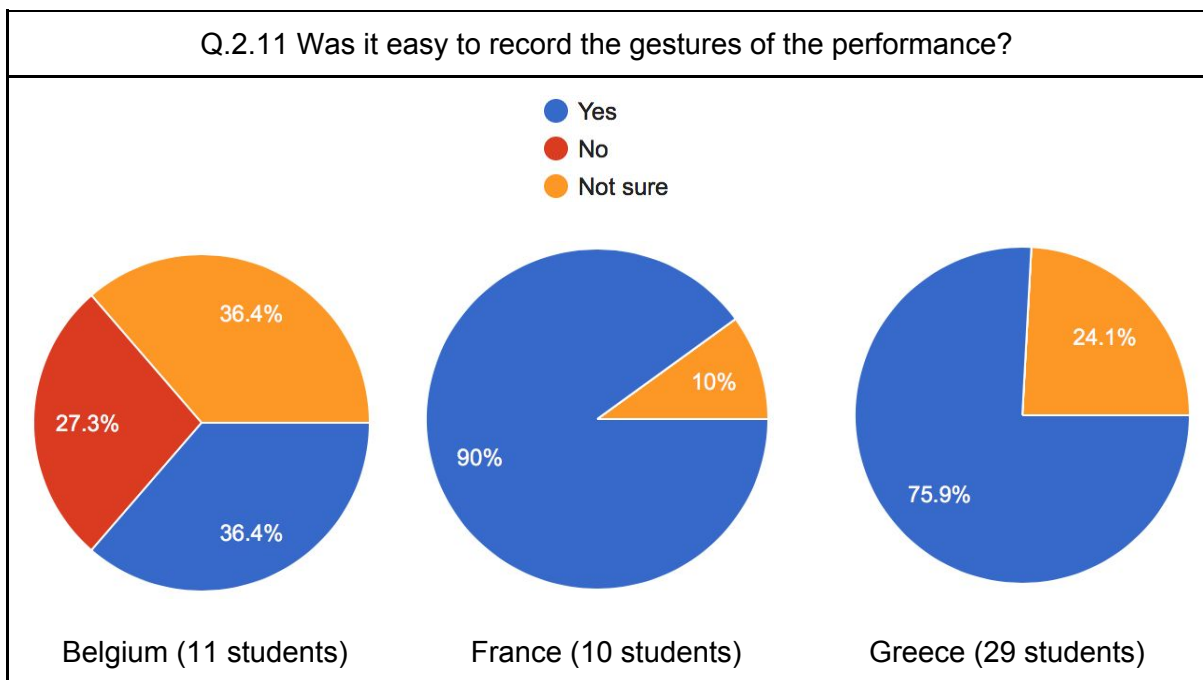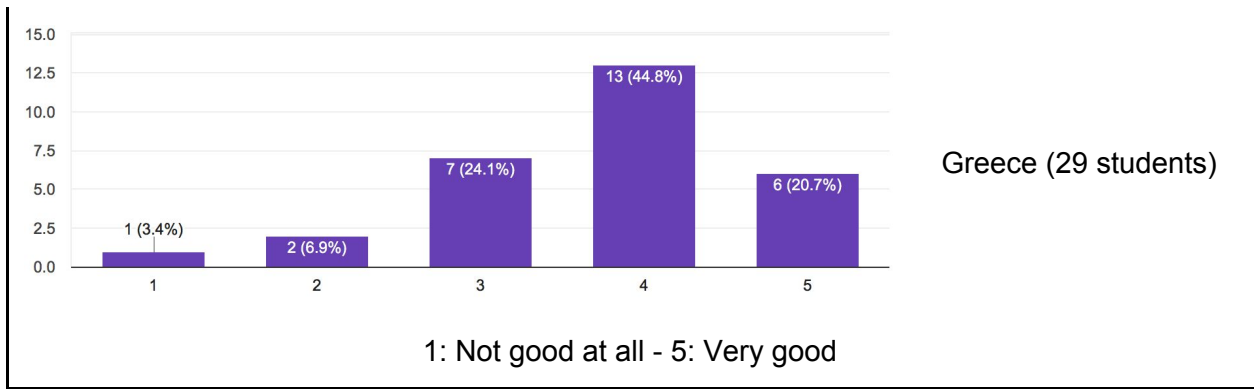Belgium (11 students)

France (10 students)

Greece (29 students)

1: Very poor - 5: Excellent

Q.2.7 How would you rate the responsiveness of the instrument?

Belgium (11 students)

France (10 students)

Greece (29 students)

1: Not at all - 5: Very much

Q.2.8 Was it easy was to identify the notes produced from each string using the tuner?

- Yes
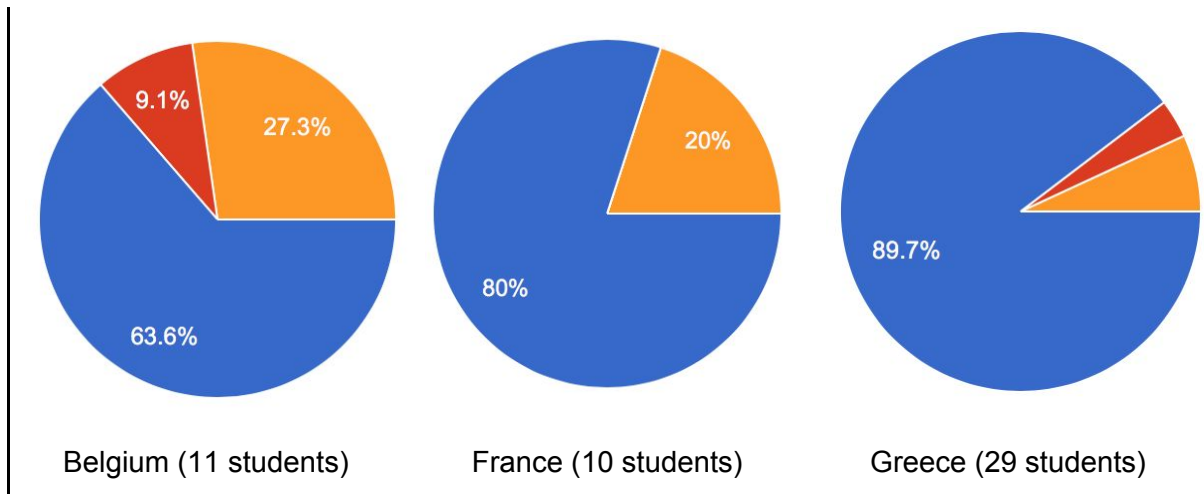- No
- Sometimes

Belgium (11 students) France (10 students) Greece (29 students)

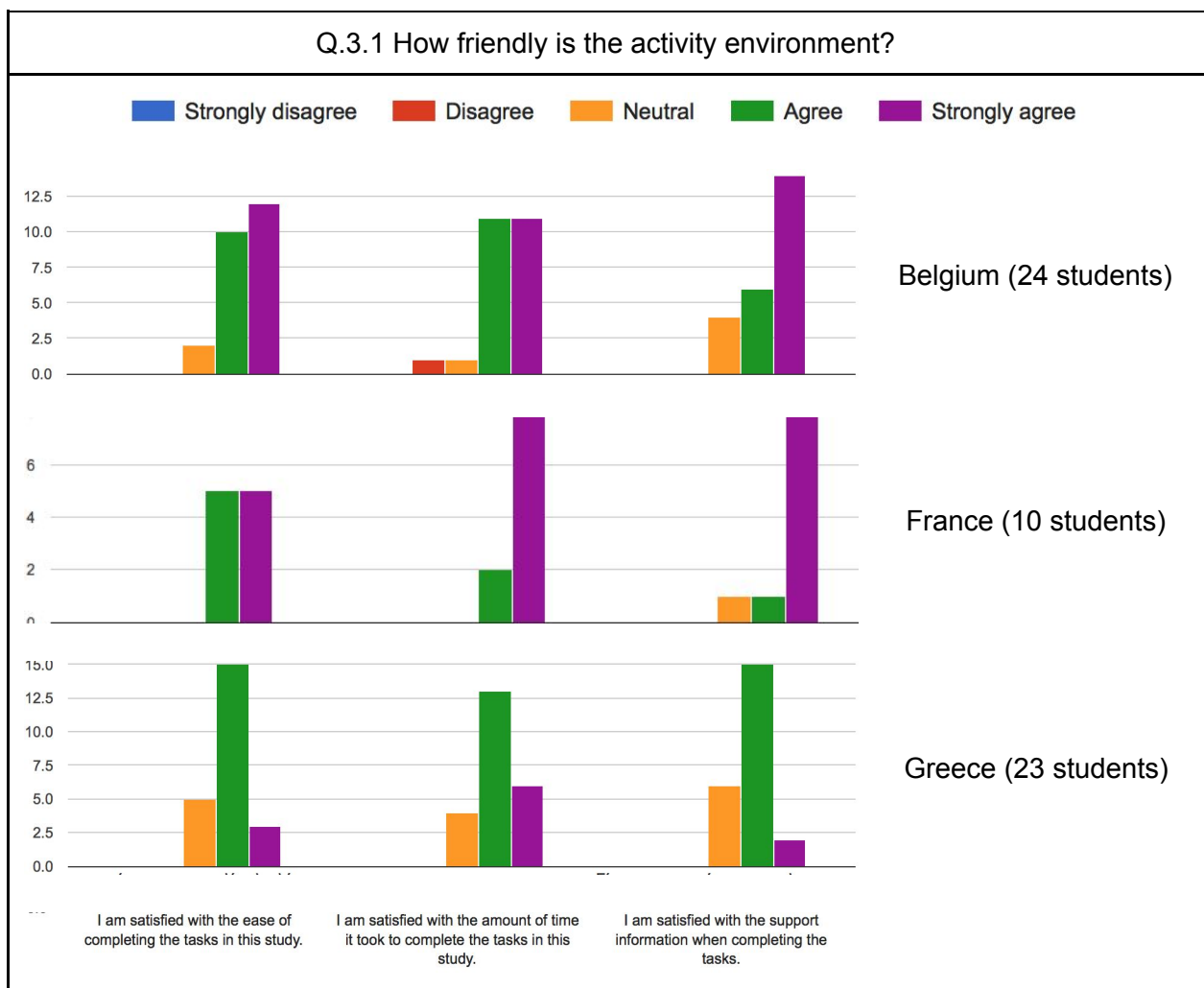**Q.2.9 Was it easy to observe the different frequencies produced by the different strings in the 3D spectrogram?**

Legend:
- Yes
- No
- Sometimes

Belgium (11 students): Yes 63.6%, No 9.1%, Sometimes 27.3%

France (10 students): Yes 10%, No 30%, Sometimes 60%

Greece (29 students): Yes 51.7%, No 20.7%, Sometimes 27.6%
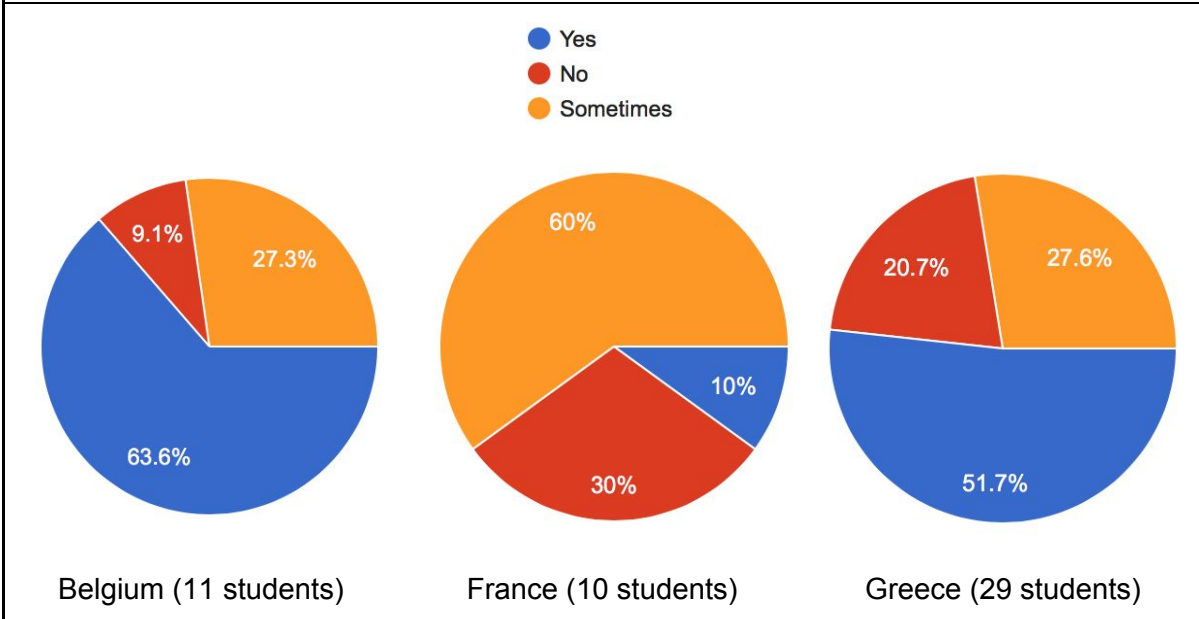
Q.2.10 How would you rate the gesture based interaction mode with the instrument?

Belgium (11 students):
- 1: 0 (0%)
- 2: 2 (18.2%)
- 3: 4 (36.4%)
- 4: 4 (36.4%)
- 5: 1 (9.1%)

France (10 students):
- 1: 1 (10%)
- 2: 2 (20%)
- 3: 2 (20%)
- 4: 2 (20%)
- 5: 3 (30%)

Greece (29 students)

1: Not good at all - 5: Very good

Q.2.11 Was it easy to record the gestures of the performance?

- Yes
- No
- Not sure

Belgium (11 students)　　　France (10 students)　　　Greece (29 students)

Q.2.12 Was it easy to record the audio of the performance?

- Yes
- No
- Maybe

Belgium (11 students)   France (10 students)   Greece (29 students)

A.3 Answers to the Drawing Canvas for Music Creation Questionnaire

Q.3.1 How friendly is the activity environment?

Belgium (24 students)

France (10 students)

Greece (23 students)

I am satisfied with the ease of completing the tasks in this study.

I am satisfied with the amount of time it took to complete the tasks in this study.

I am satisfied with the support information when completing the tasks.

Q.3.2 Was it clear for you, that the environment is composed of three parts, the drawing canvas in the middle, the control buttons at the bottom and the visualization views on the right?

Belgium (24 students)   France (10 students)   Greece (23 students)
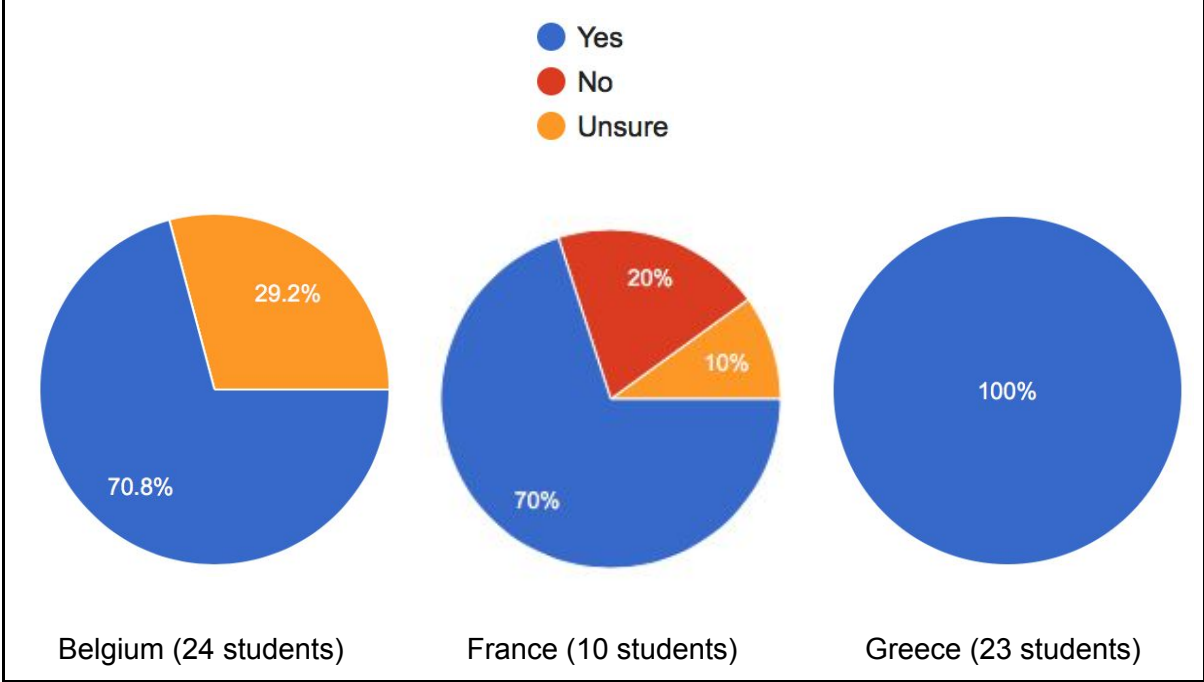
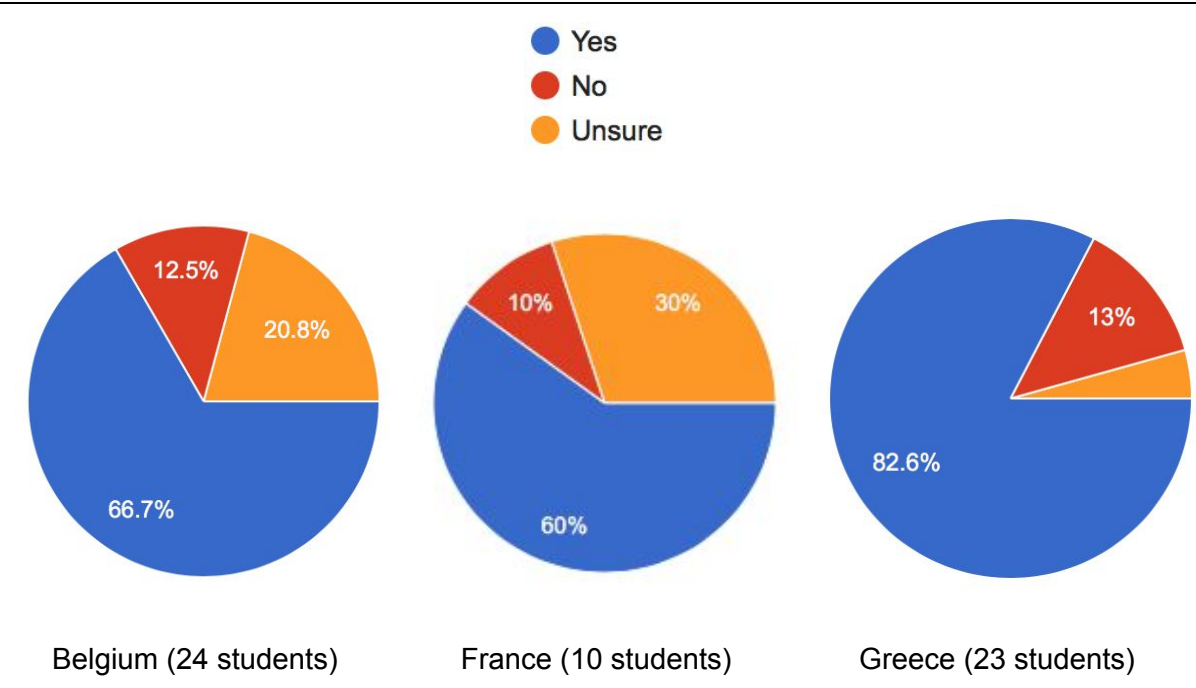Q.3.3 Was it clear for you, that the different colors that are available for drawing, correspond to different timbres?

Belgium (24 students)   France (10 students)   Greece (23 students)
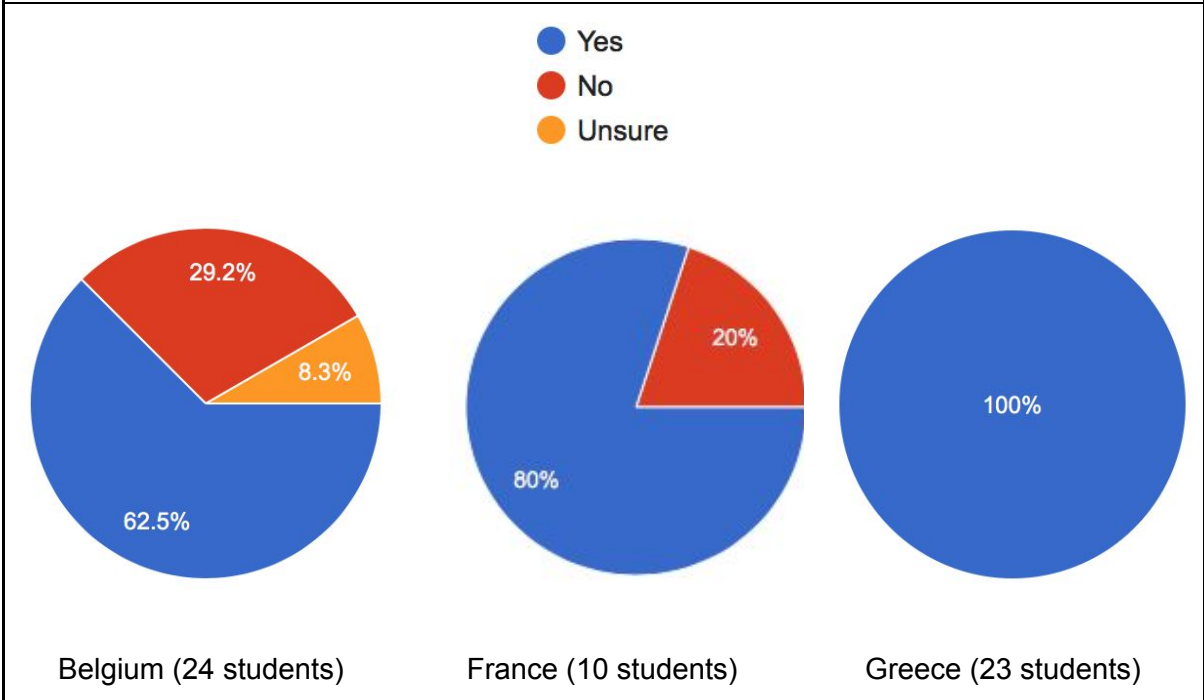
Q.3.4 Was it clear for you, that the pen erase button (or mouse right click otherwise) can be used to delete strokes?

Legend:
- Yes (blue)
- No (red)
- Unsure (orange)

Belgium (24 students): Yes 20.8%, No 62.5%, Unsure 16.7%
France (10 students): Yes 50%, No 20%, Unsure 30%
Greece (23 students): Yes 17.4%, No 82.6%

Belgium (24 students)	France (10 students)	Greece (23 students)
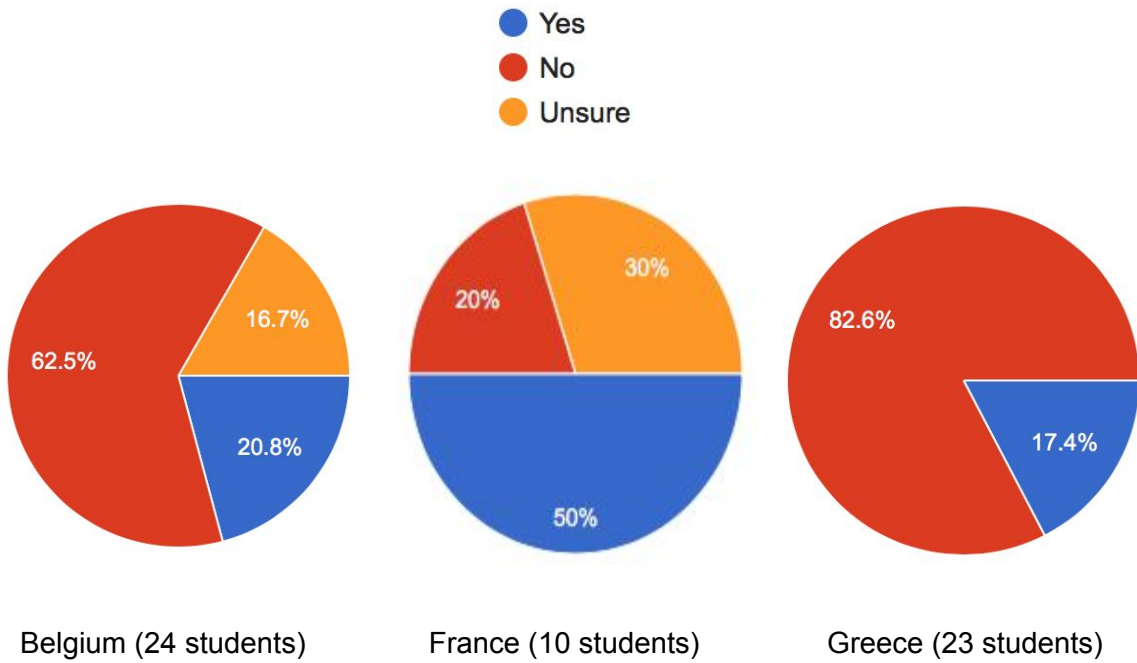
Q.3.5 Was it clear for you, that you can play the whole drawing by clicking on the "play" button?

Legend:
- Yes (blue)
- No (red)
- Unsure (orange)

Belgium (24 students): Yes 95.8%
France (10 students): Yes 100%
Greece (23 students): Yes 95.7%

Belgium (24 students)	France (10 students)	Greece (23 students)
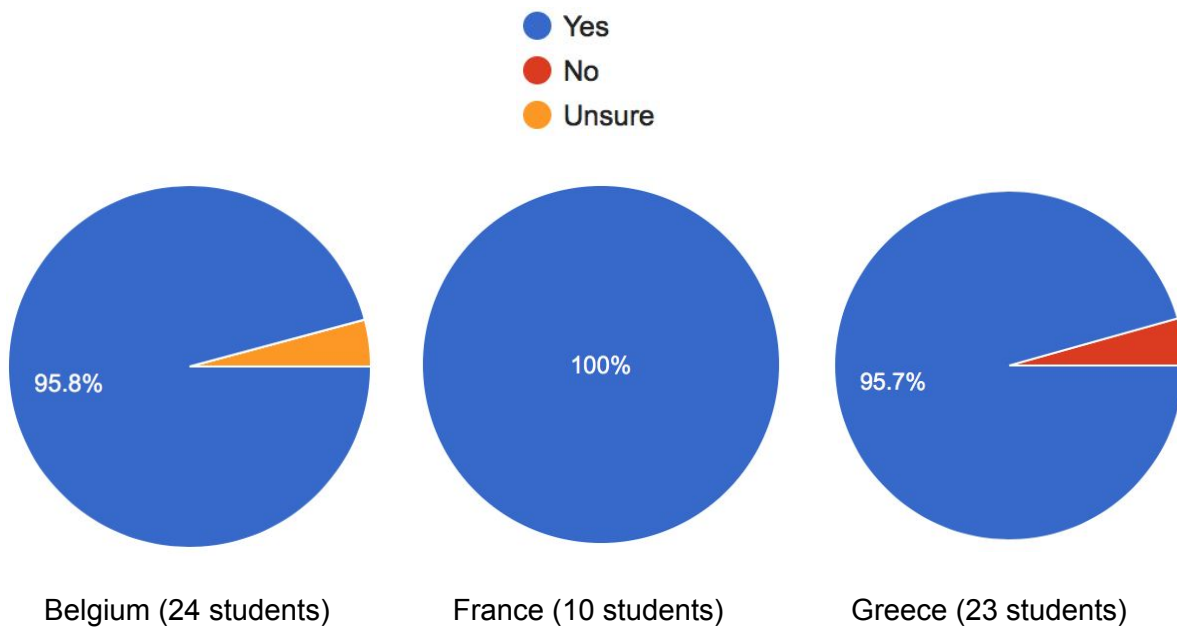
Q.3.6 Was it clear for you, that you can activate the stick to line option, to force drawing on the note/frequency lines?

- Yes
- No
- Unsure

Belgium (24 students) — 66.7%, 12.5%, 20.8%

France (10 students) — 60%, 10%, 30%

Greece (23 students) — 82.6%, 13%

Q.3.7 Was it clear for you, that anytime sound is produced, it can be visualized in the visualization panel on the right?

- Yes
- No
- Unsure

Belgium (24 students) — 79.2%, 12.5%

France (10 students) — 90%, 10%

Greece (23 students) — 100%
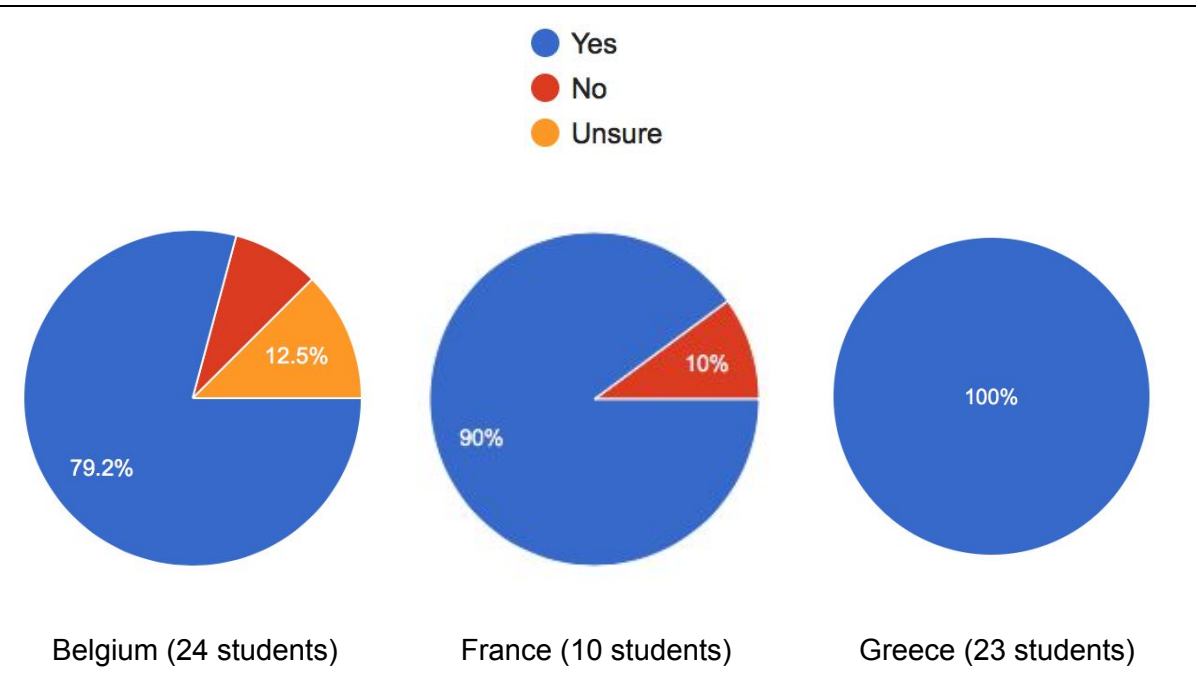
Q.3.8 Was it clear for you, that the visualization panel includes three views: 1) Waveform view 2) Fourier transform view 3) Spectrogram view

Belgium (24 students) — France (10 students) — Greece (23 students)
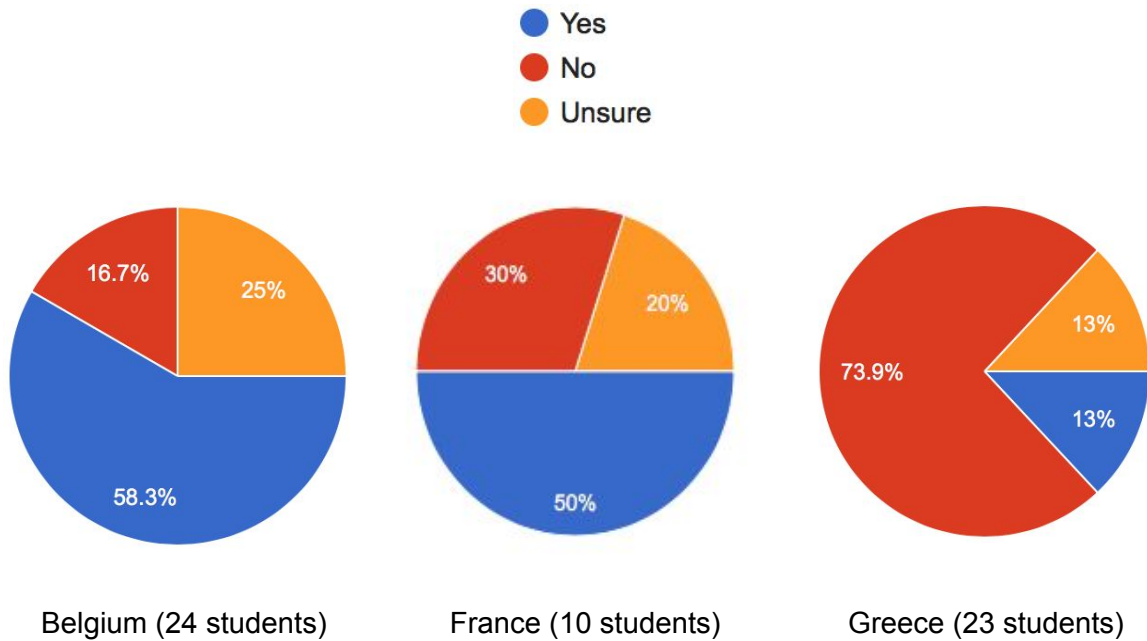
A.4 Answers to the Geometry and Algebra Tools Questionnaires

Q.4.1 Have you ever used any Dynamic Geometry or Dynamic Maths environment?

Belgium (22 students) — France (10 students) — Greece (22 students)
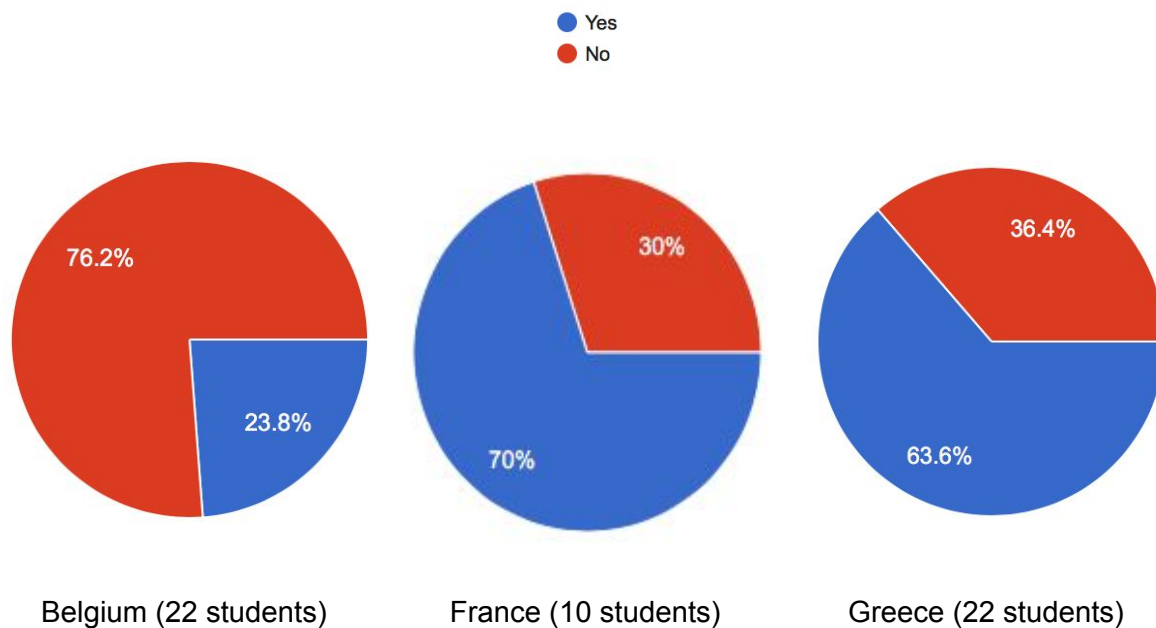
Q.4.2 How handy was the use of the various tools?
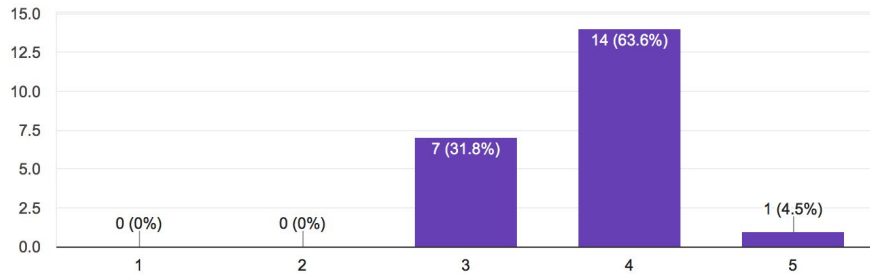
Belgium (22 students)
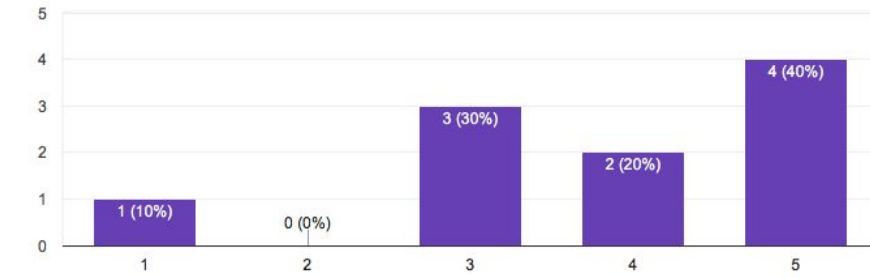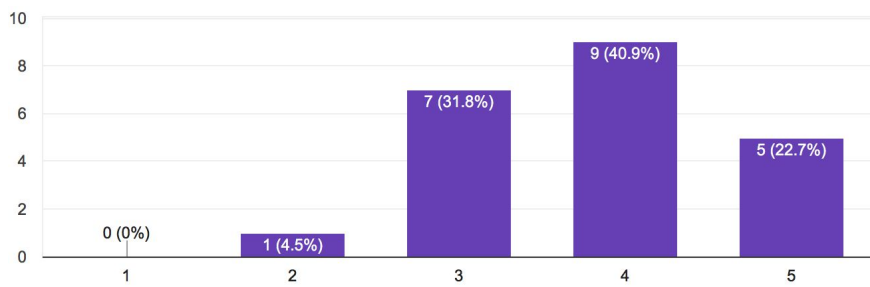
France (10 students)

Greece (22 students)

1: Very hard to use (some tools) - 5: Very easy and intuitive

Q.4.3 Was it difficult to open the piles containing the tools?
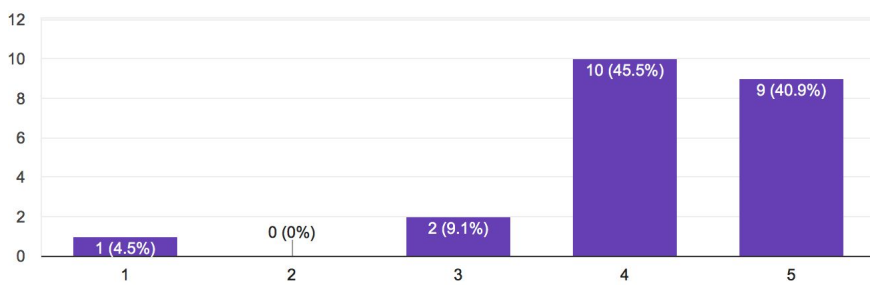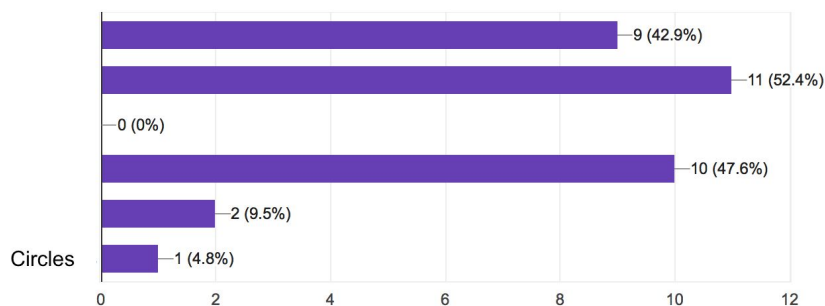

Belgium (22 students)
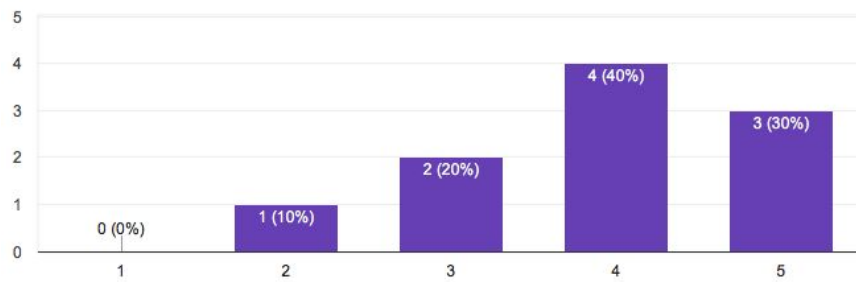
France (10 students)
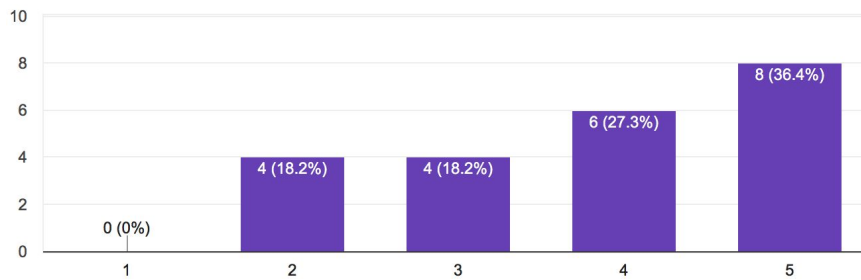
Greece (22 students)
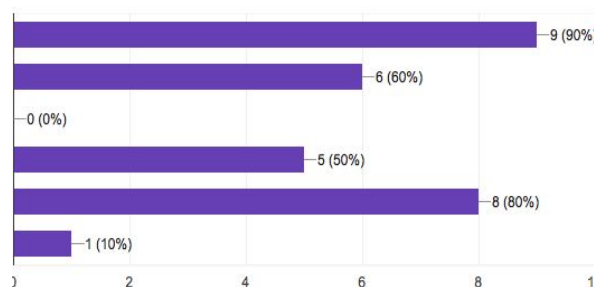
1: I could not figure out what piles are and how they work - 5: It was very easy to use them
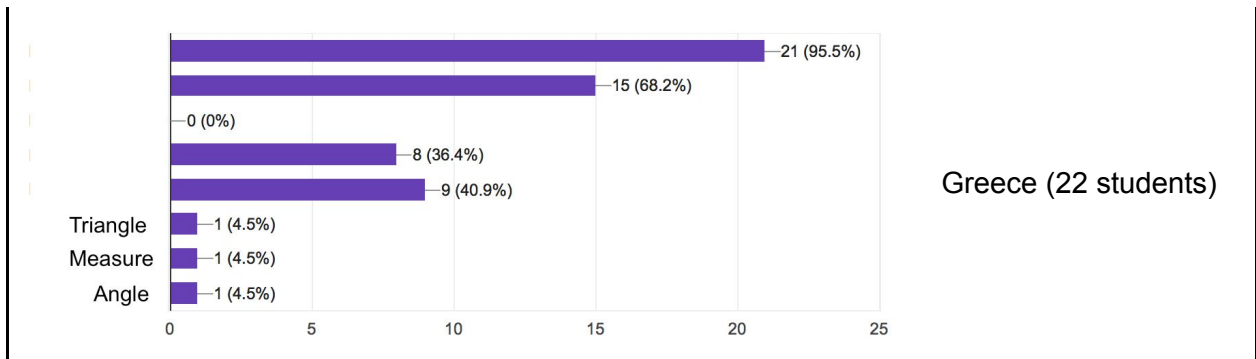
Q.4.4 What other tool have you tried ?

- Tool from the "Point" pile
- Tool from "Line" pile
- Tool from the "Curve" pile
- Tool from the "Polygon" pile
- Tool from "Polyhedron" pile
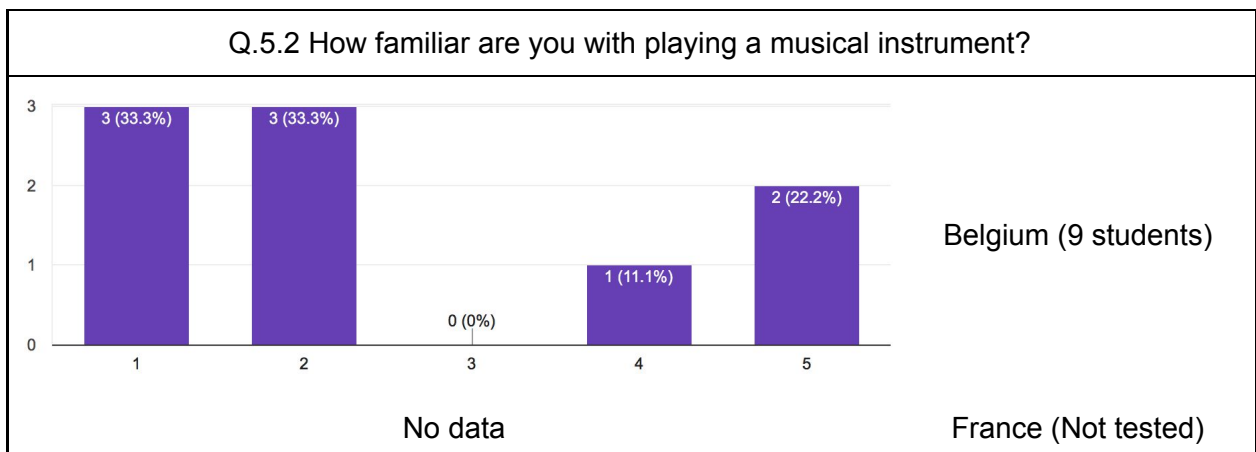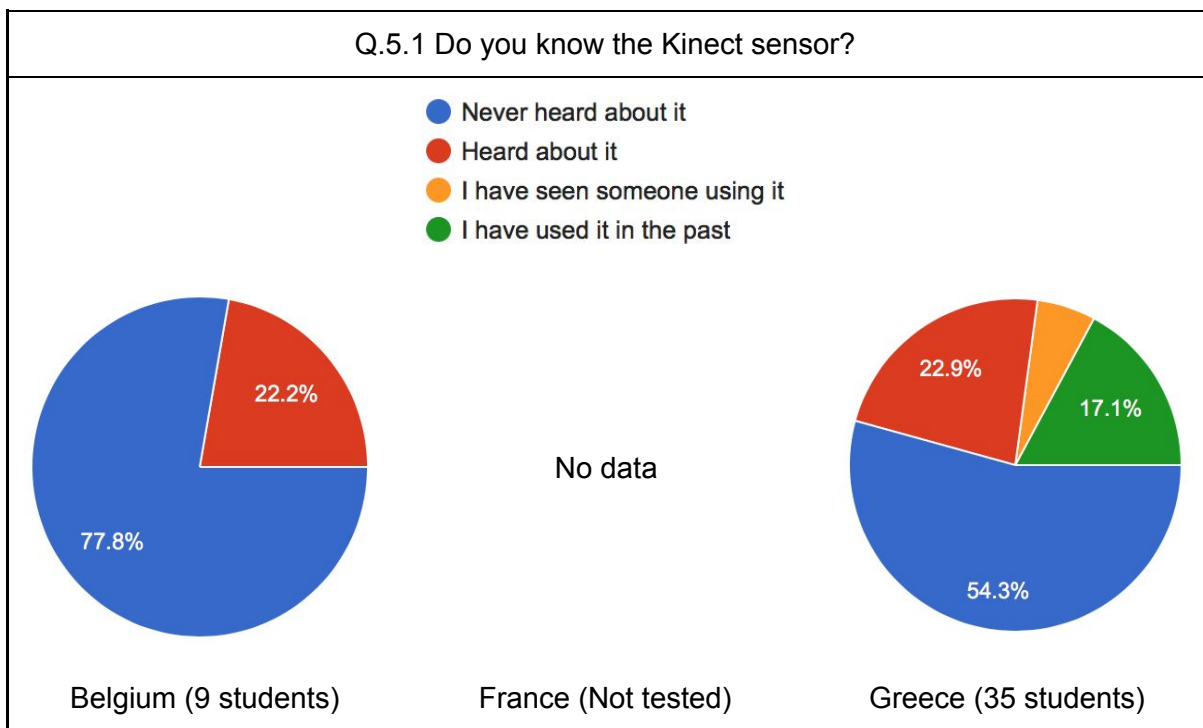- Other (added at the end of each list)
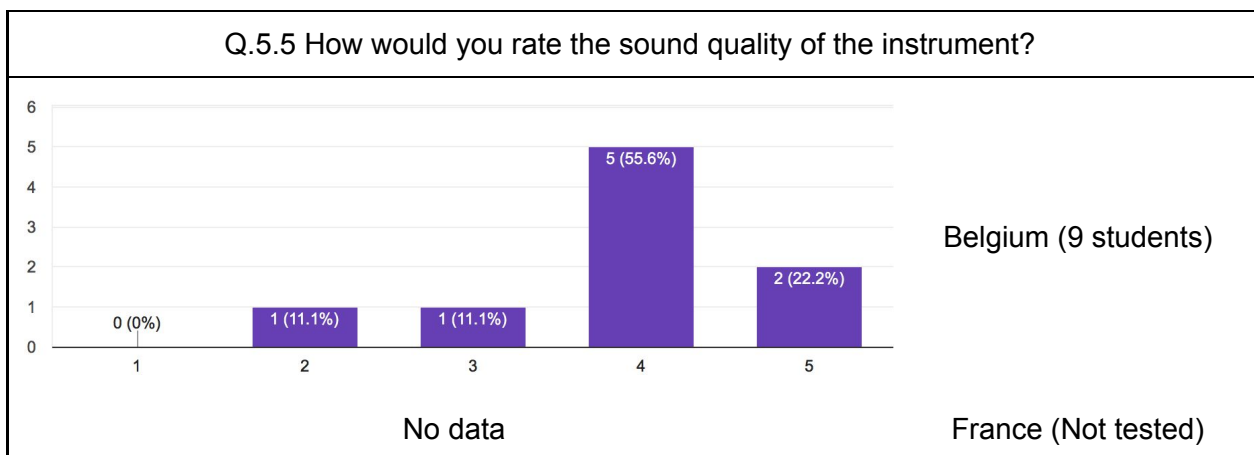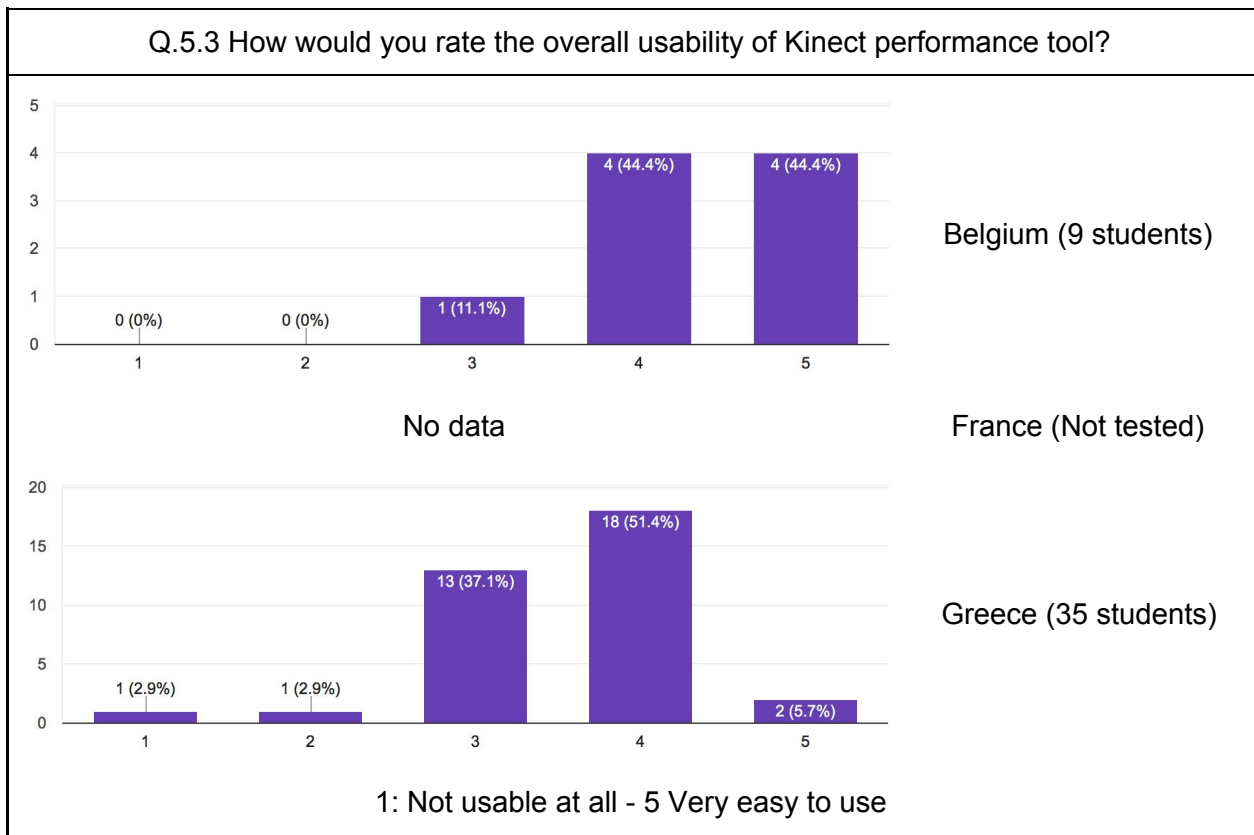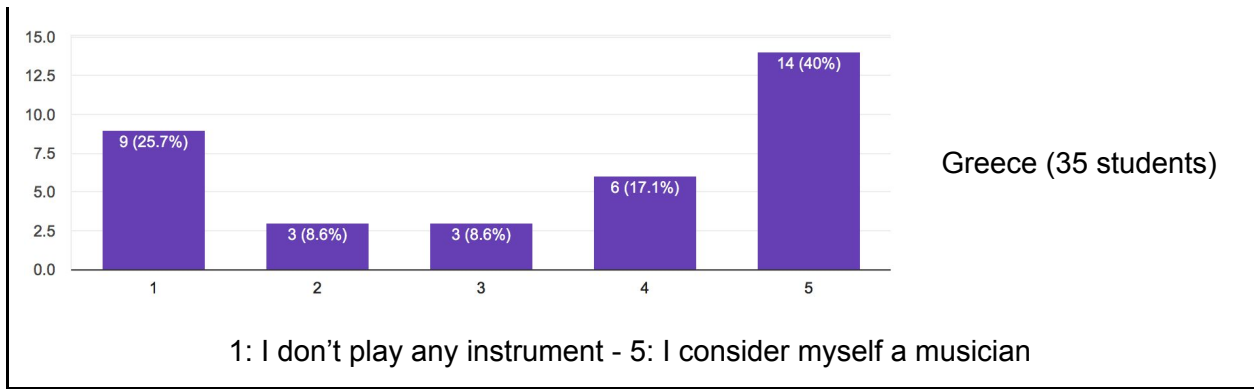

Belgium (22 students)

France (10 students)

Greece (22 students)

A.5 Answers to the Kinect Guitar Questionnaires

Q.5.1 Do you know the Kinect sensor?

- Never heard about it
- Heard about it
- I have seen someone using it
- I have used it in the past

22.2%

77.8%

No data

22.9%

17.1%

54.3%

Belgium (9 students)   France (Not tested)   Greece (35 students)

Q.5.2 How familiar are you with playing a musical instrument?

3 (33.3%)   3 (33.3%)   2 (22.2%)

0 (0%)   1 (11.1%)

Belgium (9 students)

No data

France (Not tested)

Greece (35 students)

1: I don't play any instrument - 5: I consider myself a musician

Q.5.3 How would you rate the overall usability of Kinect performance tool?

Belgium (9 students)

No data

France (Not tested)

Greece (35 students)

1: Not usable at all - 5 Very easy to use

Q.5.5 How would you rate the sound quality of the instrument?

Belgium (9 students)

No data

France (Not tested)

Greece (35 students)

0 (0%)   1 (2.9%)   9 (25.7%)   19 (54.3%)   6 (17.1%)

1: Very poor - 5: Excellent

Q.5.6 How would you rate the responsiveness of the instrument?

Belgium (9 students)

0 (0%)   2 (22.2%)   3 (33.3%)   2 (22.2%)   2 (22.2%)

No data

France (Not tested)

Greece (35 students)

0 (0%)   6 (17.1%)   14 (40%)   13 (37.1%)   2 (5.7%)

1: Not at all - 5: Very much

Q.5.7 Was it easy to identify the notes produced from the instrument using the tuner?

Yes
No
Sometimes

33.3%
22.2%
44.4%

No data

25.7%
74.3%

Belgium (9 students)   France (Not tested)   Greece (35 students)
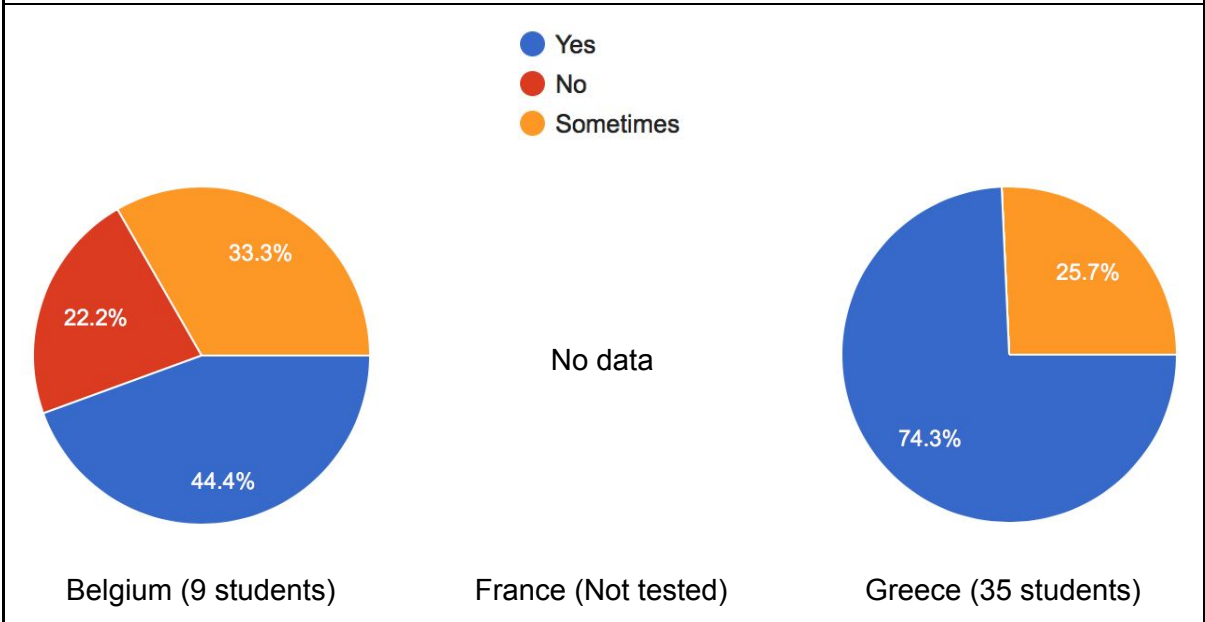
Q.5.8 Were you able to control which notes the instrument produces?

Yes
No
Sometimes

33.3%
11.1%
11.1%
44.4%

No data

20%
54.3%
20%

Belgium (9 students)   France (Not tested)   Greece (35 students)
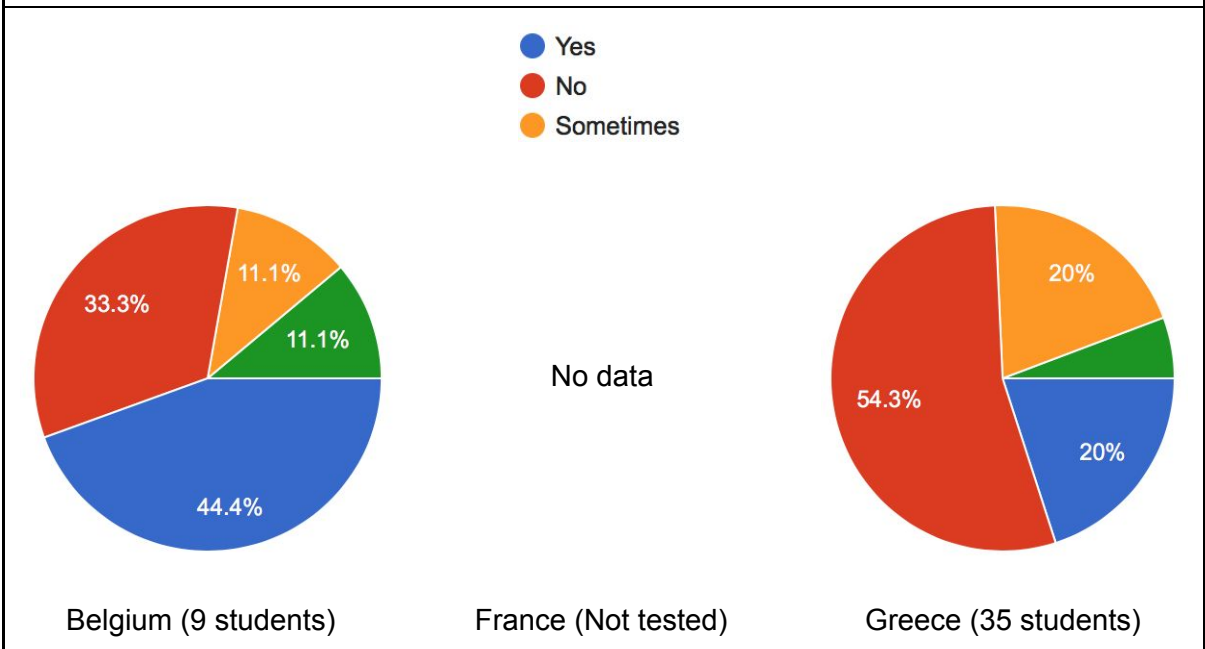
Q.5.9 Were you able to control the volume of the note that the instrument produces?

Yes
No
Sometimes

50%
12.5%
37.5%
Belgium (9 students)

No data
France (Not tested)

51.4%
11.4%
34.3%
Greece (35 students)
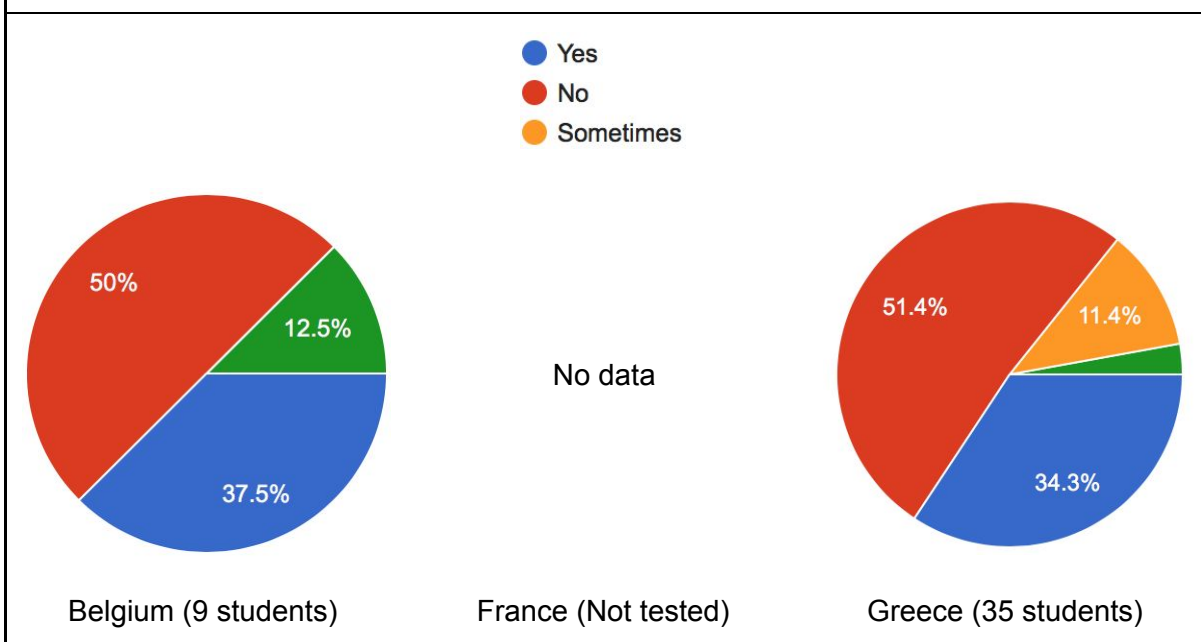
A.6 Answers to the Sonification Usability Questionnaire

Q.6.1 Overall, rate how difficult or easy it was to complete the tasks.

0 (0%) 0 (0%) 0 (0%) 14 (66.7%) 7 (33.3%)

Belgium (21 students)

0 (0%) 0 (0%) 1 (10%) 4 (40%) 5 (50%)

France (10 students)

Greece (24 students)

1: Very difficult - 5: Very easy

Q.6.2 Overall, rate how easy or difficult was it to figure out the correct icons and sequence of actions.
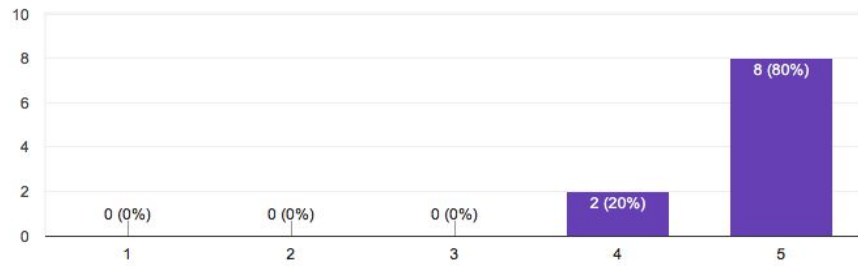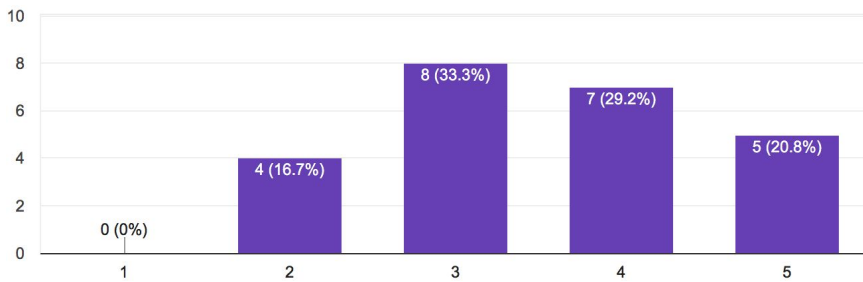

Belgium (21 students)

France (10 students)

Greece (24 students)

1: Very difficult - 5: Very easy
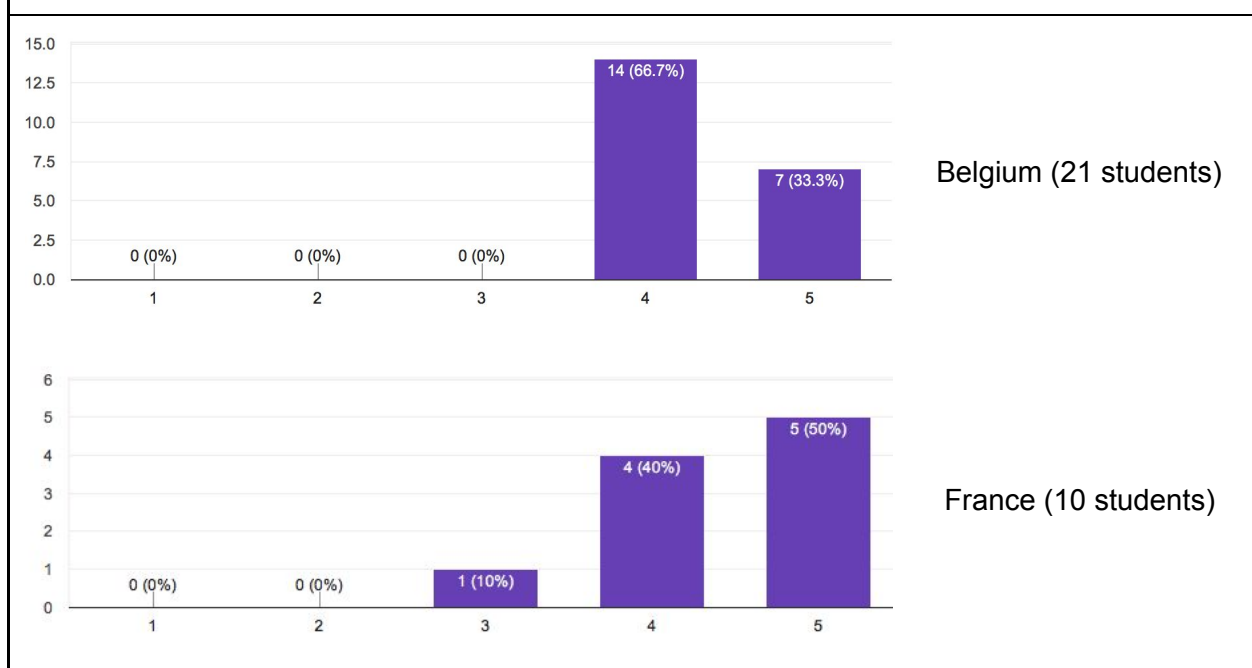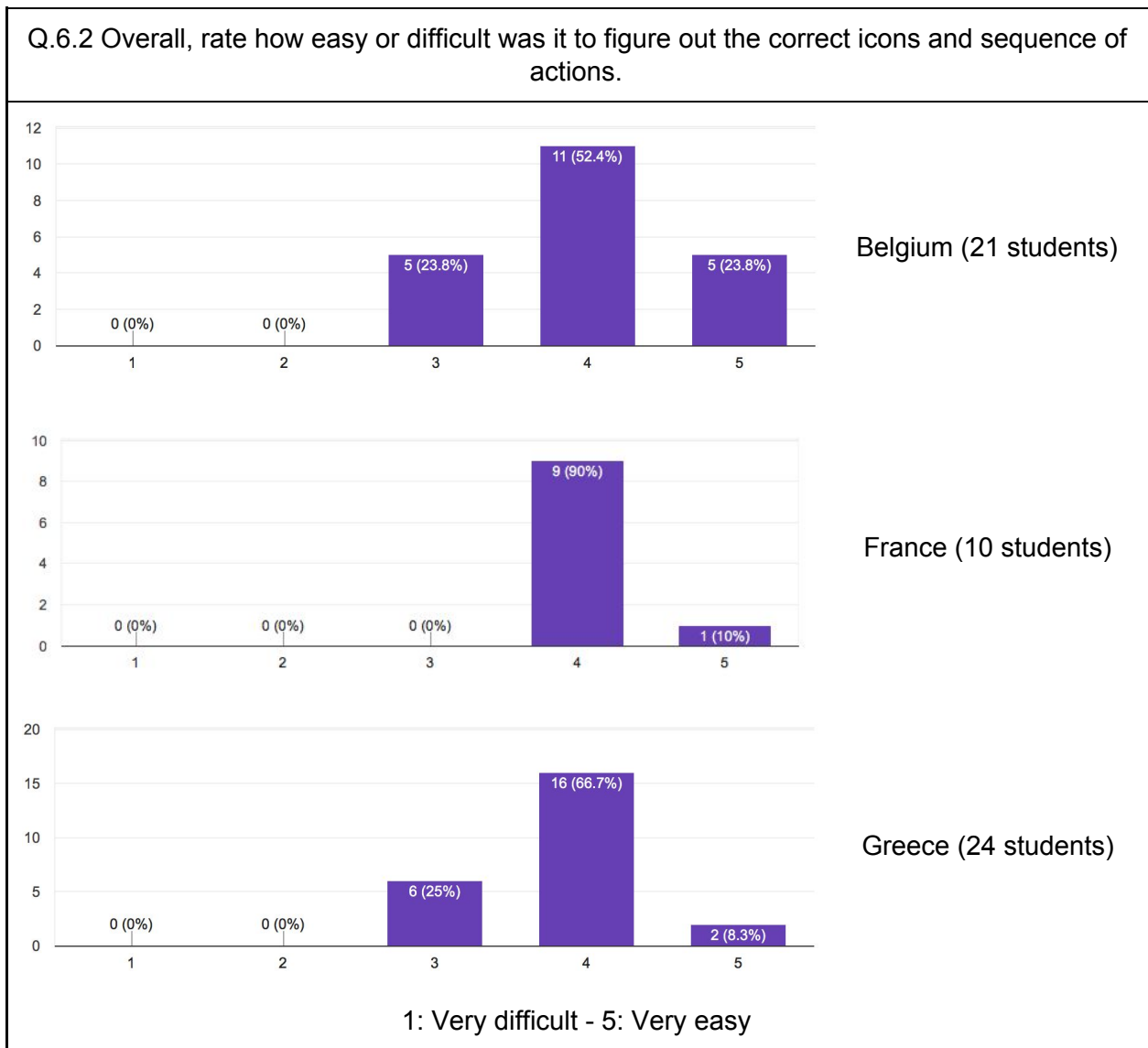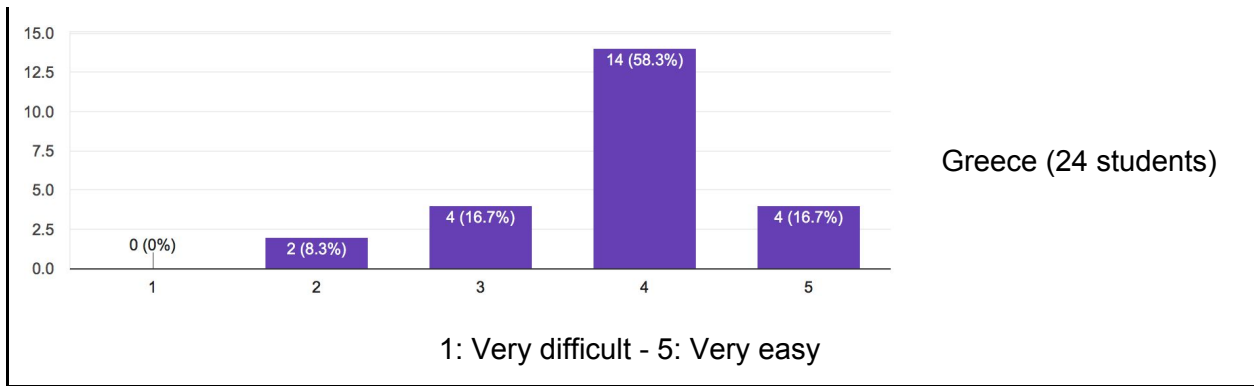
Q.6.3 Overall, I am satisfied with the amount of time it took me to complete the tasks in this study.
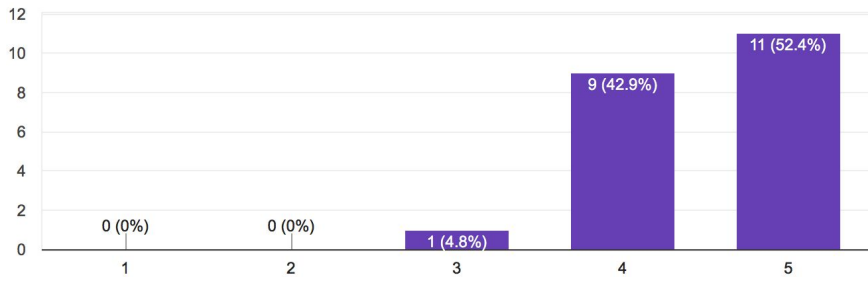
1: Very difficult - 5: Very easy

Q.6.4 Was it clear for you that the 👆 icon allows you to hand-draw geometric shapes?

Yes (blue) / **No** (red)

- Belgium (21 students): Yes 90.5%, No 9.5%
- France (10 students): Yes 80%, No 20%
- Greece (24 students): Yes 75%, No 25%

Belgium (21 students) — France (10 students) — Greece (24 students)
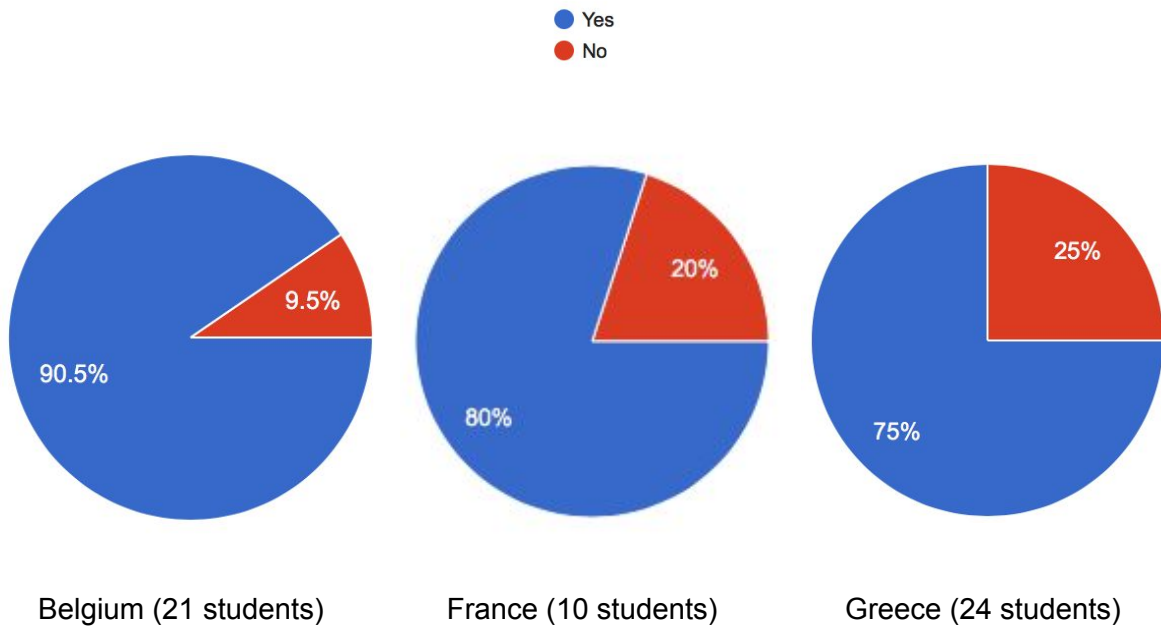
Q.6.5 Was it clear for you that the x^2 icon allows you to open the Math Editor?

Yes (blue) / **No** (red)

- Belgium (21 students): Yes 95.2%
- France (10 students): Yes 50%, No 50%
- Greece (24 students): Yes 79.2%, No 20.8%

Belgium (21 students) — France (10 students) — Greece (24 students)
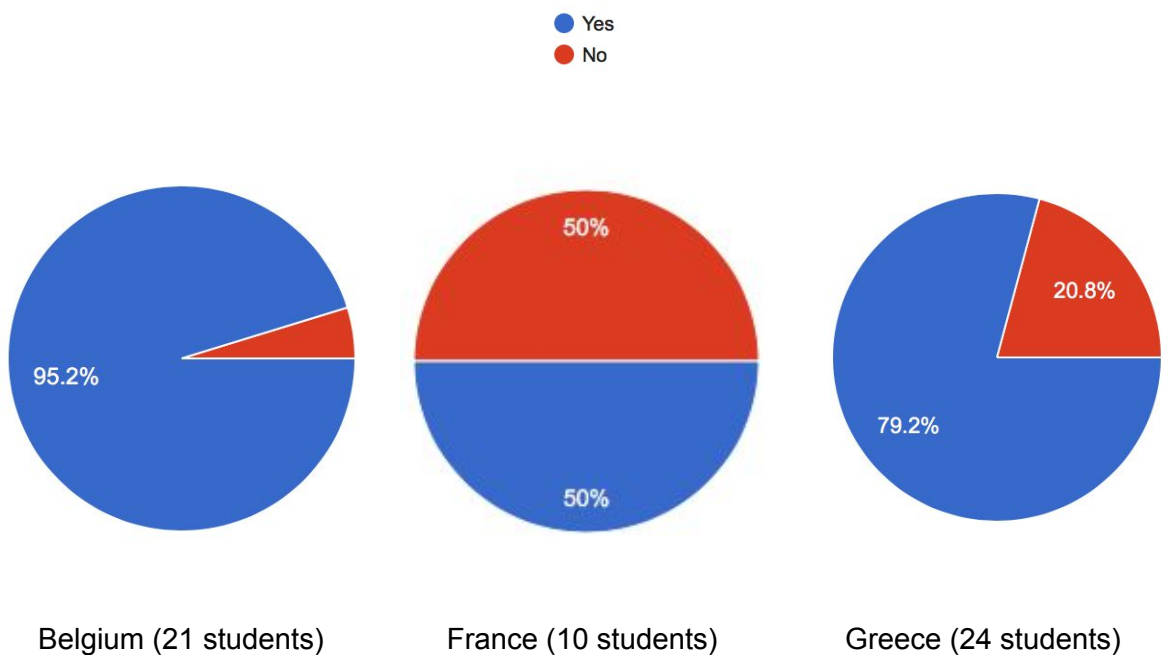
Q.6.6 Was the recognition engine able to correctly transform the strokes into geometric shapes?

Belgium (21 students) — France (10 students) — Greece (24 students)
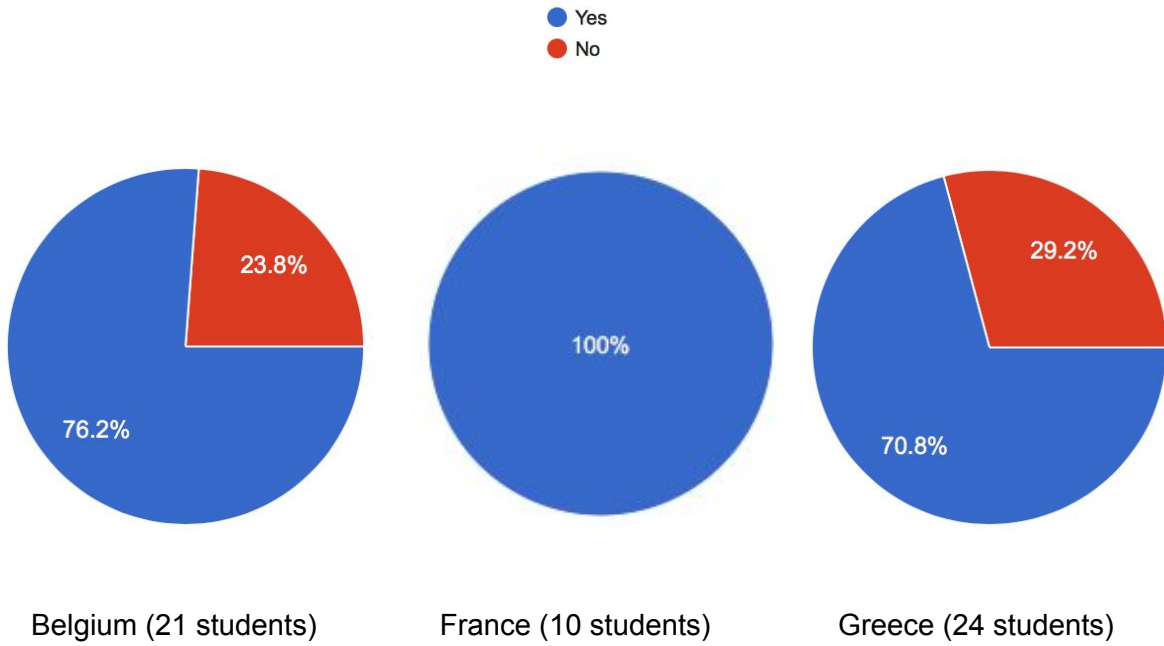
Q.6.7 Was the math recognition engine able to correctly recognize the strokes into the proper math equation?

Belgium (21 students) — France (10 students) — Greece (24 students)
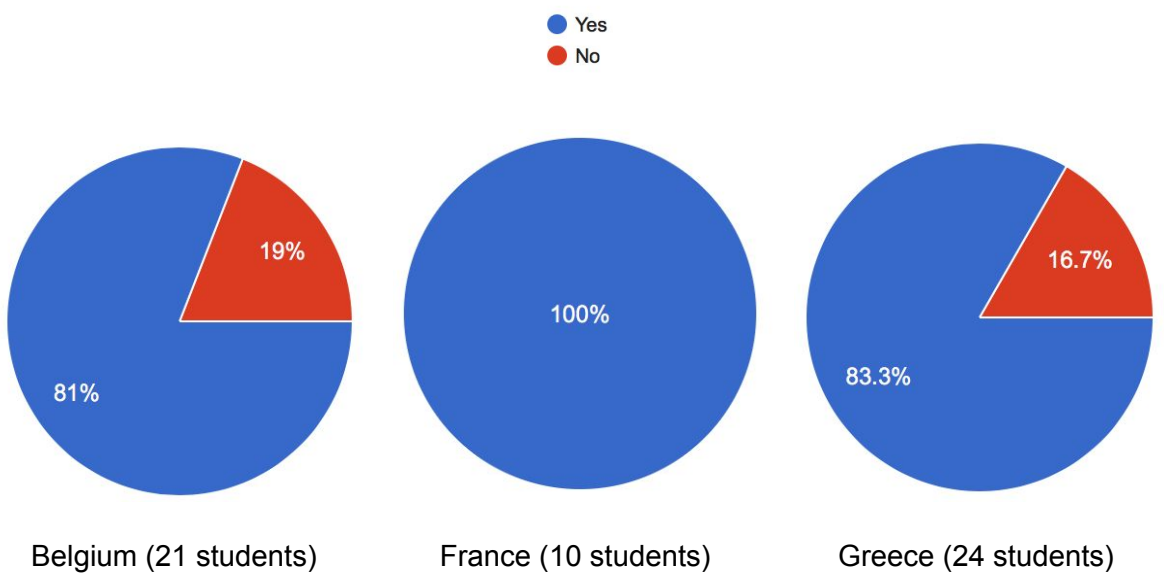
Q.6.8 Was it clear for you the relationship between the y-axis value and the frequency played?

Yes
No

33.3%
66.7%

Belgium (21 students)

90%
10%

France (10 students)

29.2%
70.8%

Greece (24 students)
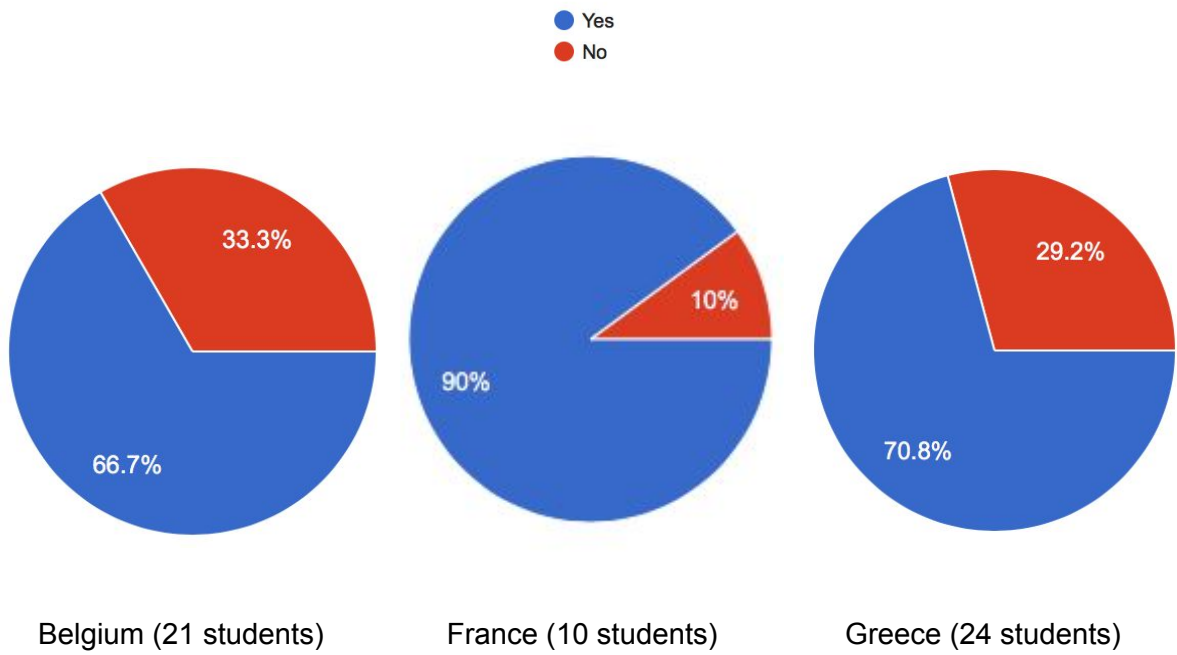
Q.6.9 Was it clear for you that the trash icon (upper-right part) allows you to delete the drawing canvas?

Yes
No

19%
81%

Belgium (21 students)

30%
70%

France (10 students)

12.5%
87.5%

Greece (24 students)
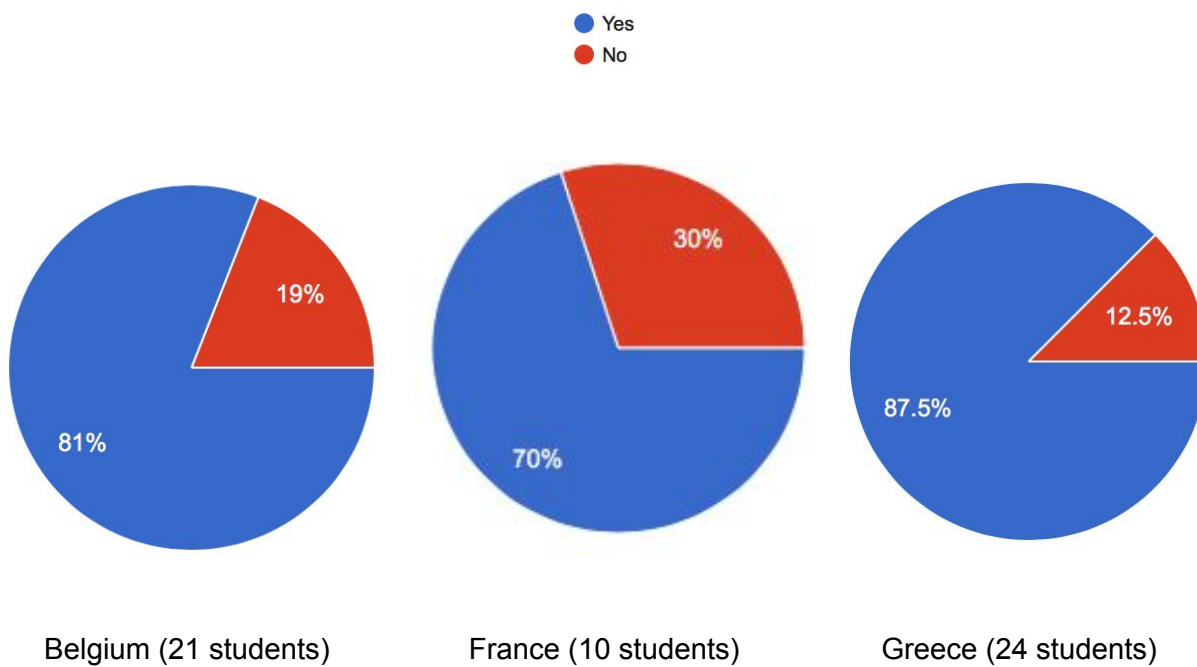
Q.6.10 Was it clear for you that you can play every geometric shape by clicking on the "play" button?

Belgium (21 students)   France (10 students)   Greece (24 students)