Enhancing the perception of achieving learning objectives

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Abstract

Academic achievement is heavily influenced by motivation to learn. Teachers in many courses strive to motivate students by emphasizing, for example, the relevance of the learning topic for intrinsic motivation, and encouraging students to produce on time with, for example, extra points for extrinsic incentive. As a result, we wanted to experiment with different types of motivating nudges in this project by adding other aspects of perceptions to the learning process.

Therefore, this paper researches the impact of different kinds of feedback during learning as well as the impact of listening to background music while studying. An experiment with 15 participants was conducted. The majority of the participants preferred visual or a combination of visual and audio feedback. Regarding the usability, a tendency, that the usability of the visual and the combination of visual and audio feedback is higher was shown. Additionally, the results indicated a tendency that participants listening to no background music were more focused and motivated.

1 Introduction

During the past year, the pandemic greatly affected education and challenged both teachers and students to adapt to an unusual learning environment. Switching to online school had an impact on both extrinsic and intrinsic motivation, which may affect academic performance. As we were all affected by these changes and struggled to motivate ourselves to learn, we were interested in seeing if visual and audio stimuli can be used to improve the learning process and motivation in particular.

E-learning systems have become popular over the last decades, especially now during the Covid-19 pandemic. However, users often lose their learning motivation and therefore, the use of the system decreases [24]. This might be changed by motivating the user. During learning a variety of emotions can be experienced, which intertwine with key components of students' self-regulated learning, like motivation and interest [22]. A variety of studies have investigated the influence of emotions on the learning process: negative emotions can, for example, impact the learning performance [6], whereas positive emotions improve recall [14] and increased motivation and perception [26]. Efkildes et al. [10] showed that positive and negative affects, for example through feedback, are important for the learning process.

In order to improve the students' experience of academic learning, different methods such as visual or audio feedback have been used and proven to be an effective tool for providing these results.

2 Background

When it comes to visual feedback, text, images or even animations can be used. A study conducted by Shimada et. al [25] showed that using images for praising or scolding users in an e-learning environment improved motivation during the learning process. Apart from using images for giving feedback, multiple studies showed that including explanatory feedback, which explains why the answer is correct or incorrect [20], along with corrective feedback, which only tells the user if the answer is correct or not, was beneficial for retaining information [23]. In what concerns text, an important aspect of it is its colour. A study on the impact of colours in learning explained how different colours can increase the learner's attention which leads to better learning outcomes [9]. For example, it was seen that cold colours, such as blue or purple induce calmness, whereas warm colours, such as red or orange increase attention to detail [9].

Audio feedback was described as a digital sound file containing formative or summative verbal feedback given by the tutor [12]. For that reason, audio feedback could also be considered and used as a set of instructions for the correction of students' work. According to a study [13], students found the usage of audio feedback time consuming, yet it was still the preferred option among students because of its ability to receive a direct but more importantly personal response to their work. Regardless of the content of the feedback, students could project teachers' opinions through the tone of their voices as well as audio feedback provides a more detailed response in comparison to text-based feedback. As a result of the study [15], audio feedback turned out to improve students' listening and writing skills and fostered a better interpersonal relationship between the lecturers and students.

Even though the above-mentioned researchers are focusing mostly on audio feedback from a tutor to a student, in our experiment we would like to focus on the usage of short audio clips that would make the learning objectives more enjoyable for students. Nevertheless, the reason for conducting this study shares a similar goal and we would like to investigate whether using audio feedback could enhance the student experience and result in a more effective learning process.

Low-Fidelity music is an internet-born genre that gained popularity among the young generation as background music to facilitate undivided focus to study, read or relax. The influence of background music has been academically explored to a small extent with varied results and goals [8]. To begin with, in support of the notion, the Mozart effect and the arousal-mood hypothesis indicated that background music had a positive impact on achieving learning objectives [18]. The music that was used in the experiment was Mozart sonata and instrumental music, but these results varied in both the studies due to changes in musical notes, tempo and other characteristics. Lo-fi consists of repetitive hip-hop beats with a touch of nostalgia with rarely any vocals or lyrics if so present, only at the beginning or the ending of the track. In most studies, the learning outcomes were behavioural and physiological measures, such as recall and comprehension as dependent variables and cognitive memory load, heart rate, temperature as independent variables to estimate if the music playing simultaneously with learning the material hinders the learning process [17]. Several previous studies demonstrated that background music can promote, demote or have no learning experience depending upon the student's mood that the music elicits [18].

3 Method

3.1 Participants

In total, 15 user testers participated in the experiment of whom 7 were males and 8 were females. Since the materials for the experiment are based on the "One learns" course from the

online learning platform Open Learning Initiative (OLI), we anticipated having mainly students involved in this experiment. In terms of age and occupation, 13 participants were between the age of 20-30 and 2 were between the age of 30-40, while 14 of them were students and one participant was a recent graduate. Participants were from five different countries including Germany, Iceland, India, Slovakia, and Romania. Age, gender, and the demographics of our participants were not variables for results. The last thing that should be noted is that none of the participants was familiar with the subject of this course since no participant was or is currently taking the "One learns" course.

3.2   Test design

For the experiment, a website was created based on the content from the One Learns QA21.1 course taught by our supervisor, Olle Bälter.

Firstly, the website was designed using Figma, a prototyping tool and was later developed using HTML, SASS, Bootstrap and Vue.js. In order to give remote access, the website was hosted on GitLab.

The website consisted of three sections with each one presenting different content and providing a particular type of feedback: audio, visual or visual and audio.

Each section was divided into two parts, with the former one consisting of the reading material and the latter one being represented by a simple-choice quiz consisting of four questions that provided instant feedback. The reading material of all three sections was based on the third module of the online course, "Introduction to digital health literacy". While the first section was created based on the first chapter of the module, "Definition and Conceptualization of health literacy", the next one presented content from the next two chapters, "Determinant factors of health literacy" and "How is health literacy linked to health outcomes?". The last section was also based on two chapters, "Components of digital health literacy" and "Barriers to achieving digital health literacy".

Regarding the visual feedback, in order to signal a correct answer, green was used for the tick, text and for the border around the answer. In addition to this, a Royalty-Free GIF [1] displaying confetti was also added when the correct answer was selected. In contrast, red was used for the incorrect answers, by displaying an "X" and a red border around the answer. Apart from this, the page for the reading material incorporated a progress bar that activated on scroll. When the visual feedback was not included in the section, the text and border of the answers did not change colours and the tick or the "X" indicators had a neutral colour, light purple.

The audio feedback was implemented through the addition of two short sounds that activated when clicking either the correct or the wrong answer. To avoid copyright issues, Royalty-Free stock sound effects from Dreamstime were used [2, 4].

3.3   Procedure

For safety reasons, the experiment was conducted mainly remotely, with a few interviews being conducted in person and each participant received a PDF document with instructions they had to follow. Because the website created was not optimised for mobile devices, the participants were instructed to use a computer with internet connection. They were prompted to record their screens with a software or the screen recorder option from Windows (Windows key + "G" key). Since the website was not counting the score for the quiz part, recordings provided us with the quiz results of each participant. To make sure the audio feedback and the background music will be perceived, they were also asked to turn on the audio. Part of the instruction document was also a consent form confirming that participants agreed to take part in this experiment voluntarily and that they understood the purpose of this experiment. They were informed that multimedia resources could be potentially used for research purposes and academic publications. Each participant was
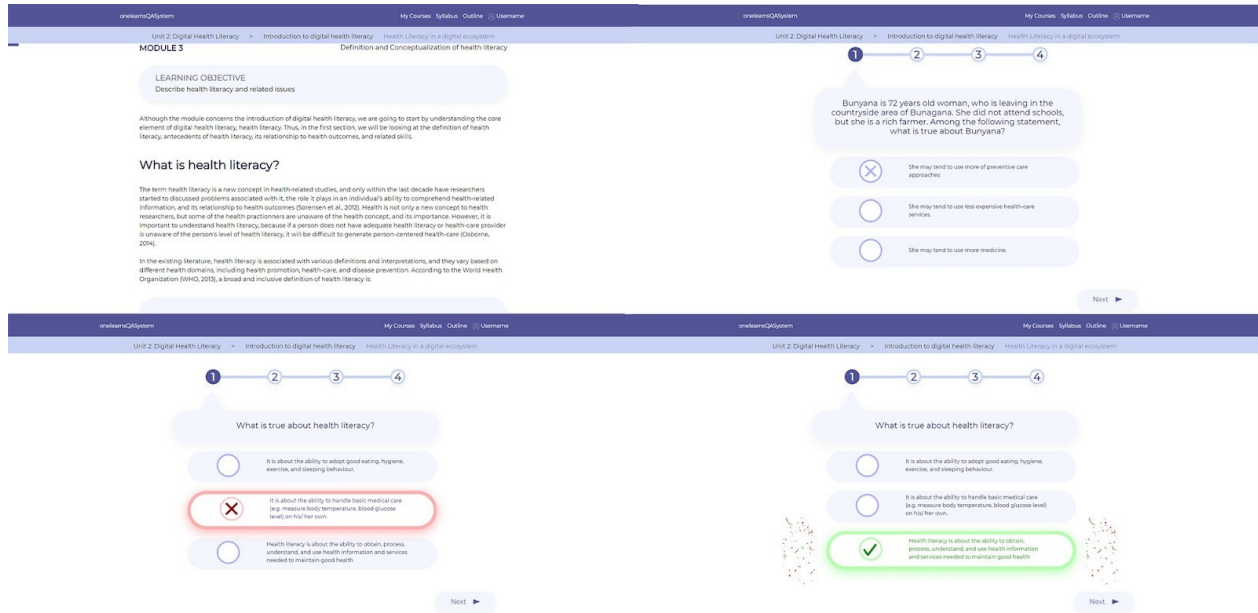
Figure 1. Top-left: Page displaying the reading material; top-right: quiz without visual feedback; bottom-left: visual feedback for incorrect answer; bottom-right: visual feedback for correct answer.

assigned a unique id that was requested in all the questionnaires for identification purposes during the results analysis. In order to make the participants feel more comfortable, they were assured that they can contact us any time if they encounter any issues or if the instructions are not clear enough.

If the participants were testing the background music condition, they were instructed to open a YouTube link that redirected them to a lo-fi music compilation "3 A.M Study Session - [lofi hip hop/chill beats]" [19]. They were prompted to listen to it only while reading the materials and pause it during the quizzes.

There were four steps of the experiment. Firstly, the participants started the screen recording and made sure they opened the YouTube video for the background music, if they were instructed to do so. After that, they had to open the link for the created website "https://lariwa.gitlab.io/ob1/". The website consisted of three sections, all related to Health Literacy. Each section was followed by a quiz. Every quiz had a different feedback category, either visual, audio, or combination of both. The type of feedback was randomized to see which version leaves the

maximum impact. Each quiz offered three or four answers where only one was always correct. Participants could keep changing their answers until they got the correct one. When they finished with the quiz section, participants were asked to fill out the user experience (UX) questionnaire and subsequently return to the website to continue with the experiment.

The UX questionnaire was based on the UEQ-Questionnaire [3], by using 9 out of the 26 attributes regarding their experience with the feedback type. These attributes were measured by using 7-points Likert-type scales. Apart from this, Zijlstra's mental effort scale [11] was also included in order to determine the (perceived) level of mental effort required to complete the task. The scale was represented by a 9-points Likert-type scale, ranging from 'very, very low mental effort' to 'very, very high mental effort'. There were three UX questionnaires in total and each one of them followed up the quiz after the reading material. Since the feedback type for each section was randomized, we asked them to choose the type of feedback they received for each quiz.

When participants finished with all the sections of this experiment, they were asked to fill up the last final questionnaire regarding their demographics and perception of the background music and feedback. For this, 5-points Likert-type scales were used in order to determine how motivated, focused and distracted participants felt listening to background music while reading the material.

The last step was to send the screen recording and a picture of their workspace to a specified email address. The duration of the experiment varied depending on the participants' language skills, with the average being 30 minutes.

4 Results

4.1 Comparison of different feedback types

As an adapted UEQ-Questionnaire got used, the UEQ scales couldn't get calculated, instead a general scale got used, summing up all the different factors. A boxplot of this reported usability can be found in Figure 2. The mean for all three categories is similar (audio= 4.7, visual = 4.9, combined audio and visual = 4,8). The values for the 1. and 3. quartiles are higher for the visual and combined audio and visual feedback, indicating that the users found the usability of the visual and the combined audio and visual feedback better. The individual factors (e.g good, motivating, clear) were not significantly different. The mental effort for the different feedback categories is also not significantly different (audio: 4.73, combined audio and visual: 5.07, visual: 5.13)

To determine statistical significance, we used a Robust Paired Samples T-test, since the conditions necessary for other t-tests, such as a normal distribution or homoscedasticity, did not apply to the data. No significant differences between the categories could be shown, the results of the t-test can be found in the Appendix. On the other hand, the responses to the question "Which feedback did you prefer" asked at the end of the experiment show significant
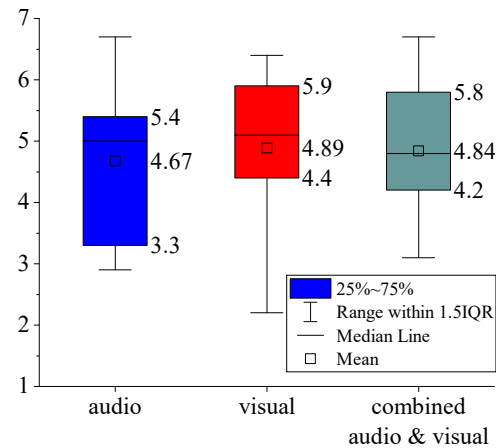

Figure 2. Distribution of the reported usability for the different feedback types (1=horribly bad, 7= extremely good)
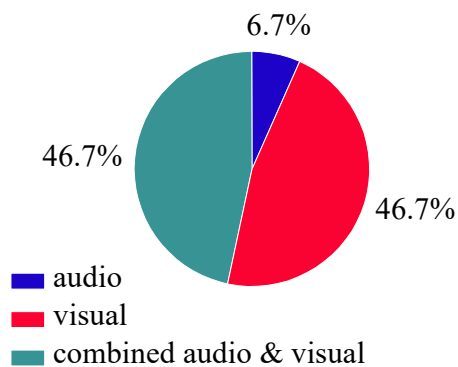

Figure 3. Distribution of the preferred feedback

results. The responses are visualized in Figure 3. The majority (46,7%) of the participants preferred visual deedback or the combined visual and audio feedback (46,7%) and only 6.7% chose audio feedback. Regarding the combined visual and audio feedback, participants stated: "It was the most motivating feedback in my opinion" and "It made me less likely to get distracted" as well as "makes me happy". Participants, who chose the visual feedback said the feedback is less disruptive and music distracted them. The participant preferring audio feedback said that the sound was more motivating.

4.2 Background music

When it comes to studying with background music, 5 of the 15 participants preferred listening to music, whereas 9 completed the study with music playing in the background. We carefully selected both participants who enjoyed and did not favour music for the experiment to better understand how differently they perceived background music while studying and to assess their performance. We discovered that, based on individual preferences for how effectively background music helped people stay motivated and concentrated without interruption, there was little evidence that background music was counterproductive. Participants who enjoyed the music while studying stayed focused and appreciated the music playing during the test but who did not, felt it was quite distracting as they seemed to read slower or louder to understand the content. This can be also seen in Figure 4, participants who normally don't listen to music while studying preformed were more focused and motivated without music. Figure 5 visualized the collected data for all participants. The mean for both the study groups is quite similar (without background music = 3.61, with background music= 3.26). The quartiles are slightly higher for the preference without background music indicating that they were motivated and focused to read the
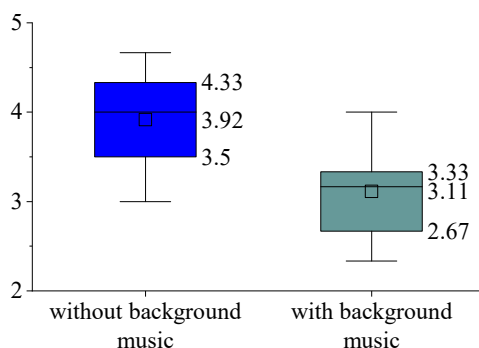

Figure 4. Distribution of the reported background music preference while studying over motivation and focus for participants who normally don't listen to music.
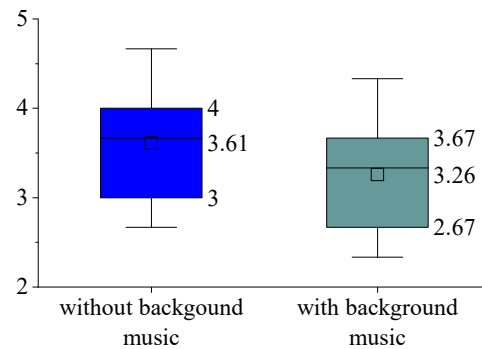

Figure 5. Distribution of the reported background music preference while studying over motivation and focus for all participants. (1=horribly bad, 5= extremely good)

material and attend quizzes without the hindrance of any kind of music. By analysing the performance of the quizzes attended by both groups, no much differences were noticed except users most of the time forgot that there is music playing in the background while they were attending the quiz.

5 Discussion

The results regarding the prefered feedback type obtained by the UEQ Questionnaire are not significantly different, only a tendency for a preference of the visual and the combined visual and audio feedback is shown. A reason for this could be that the participants only answered four questions and got feedback for this. The results might have been clearer, if the participants would have spent more time and interacted more on the webpage. When the participants were asked at the end of the experiment which feedback type they preferred, the majority preferred visual or a combination of visual and audio feedback. This could indicate that the preference of the feedback type is not connected to the usability. For example Moreno et al. found that when adding sounds the performance of the participants got worse. This could be explained by the cognitive theory of multimedia learning, the auditory working

memory auditory adjuncts can get overloaded [21].

When analysing the effect of background music, it was evident that people who preferred to listen to music while studying enjoyed and did well. They elicited their mood and helped them focus better by eliminating other distracting noises in the background [16]. Especially the music chosen for the experiment, Lo-Fi didn't have any lyrics but calm beats and rhythm that could be played without causing the participants to be distracted with lyrics or sudden change in the flow of the music. In addition, it was intriguing to notice how participants' facial expressions changed when they incorrectly answered a question when both visual and audio feedback were given. When personally interviewed, it was understood that they didn't prefer the audio when it comes to answering incorrectly as it discouraged them to even retry the question and skip to the next one. Hence, indicating that music/ audio have the power to elicit negative emotions as well [5].

As the experiment was conducted remotely, multiple factors could have potentially influenced the results, such as the type of computer used or the speed of the internet connection. It was seen that a slow internet connection can negatively influence the learning process and lead to frustration [7]. This risk could be minimized by conducting the experiment on campus and being able to offer the participants more reliable equipment. Another aspect that could lead to unconcluded results is the fact that the experiment was conducted in a structured way, with minimum flexibility regarding the pace and the content. All participants finished all the sections of the website in one session, without taking brakes. Apart from this, they had no options when it came to the content of the reading material, which might not be of interest for most of them. That is why this type of experiment set-up could lead to inaccurate results regarding the level of motivation during reading.

In addition to this, the complexity of the digital interface can impact the student's experience when using an online learning platform [7]. Even though we tried to make an intuitive and user-friendly interface that included several audio and visual elements and took into account the findings about how colour can influence learning [23], no usability testing was conducted. This might represent a problem as the participants could have the chance to point out issues regarding navigation or the layout of the pages.

6 Future Work

As we wanted to keep the experiment short (30 min) to not overwhelm the participants, the participant didn't have much time to interact with the quizzes and get feedback. In a further step this could be changed, giving the participants more time, could lead to clearer results. This could be for example done by splitting the experiment in three parts and doing a break in between. Additionally we conducted the experiment with 15 people, doing it with more participants might be useful. Different aspects regarding the perception of the feedback could be investigated further, as we found that there is no clear connection between usability and metal effort regarding the preference of the feedback.

Another aspect that could be further investigated in the research would be to conduct the experiment in a more natural setting, over a longer period of time. While it could still be conducted remotely as online learning platforms are mostly used outside of educational institutions, observing how participants interact with the website over a longer period of time could lead to more meaningful results in terms of the level of motivation and focus.

Apart from this, instead of using just corrective feedback in the forms of colours, sounds and animated GIFs, explanatory feedback could

also be included in order to improve the learners' performance. One thing that made our interviews a bit more complicated for our participants was the requirement of recording their screen. More participants mentioned that they had some difficulties with running the screen recorder but also subsequently uploading their videos and sharing them with us due to the size of the recordings. This could be solved by adding the possibility of tracking the score of participants' answers for the quiz part. Even though lo-fi background music was integrated into our prototype further research could be held to explore how effective and motivating this music genre is. Our study showed that people who often listen to music while studying appreciated the music during the test. To see how background music can enhance the learning process it could be interesting to keep working with these participants and observe the impact of this genre on achieving the learning objective. With education moving to a digital and accessible platform, a convenient alternative to traditional education is needed. The need for new ways and methods to learn is essential for helping students with the change. Taking into account deeper research on the drawbacks of how making classes online will affect the students in the long term leads to more issues that have to be considered, such as online learning making the world become more introverted, the efficiency of digital learning etc. The most important question would be "Does being away from a study environment deteriorate a student's mental health?".

7 Group assessment

During all the stages of the project, we scheduled Zoom meetings with our supervisor and both online and offline meetings within the team. Working hybrid benefited as with more time and energy to focus on the website and conducting user interviews to an extent. The meetings with our supervisor greatly helped us better understand the aim of the project,

shape the website and gave feedback for the questionnaires for the evaluation part.

The work was divided equally between the team members for all the steps of the project, such as writing the draft, designing the interface, developing the website, evaluating the user experience, conducting the experiment and finally, preparing the deliverables such as reports, poster and presentation. Splitting up the tasks gave us also the opportunity to work on our preferred tasks (e.g programming and designing). Overall, this approach made the process smoother and faster, but some aspects could still be improved. For example, the experiment was conducted rather late, as more time was spent deciding on the content for the website, designing it and developing it in order to be suitable for testing. Apart from this, conducting the experiment in person would have more benefits, as we would be able to explain the instructions to the participants in a more clear way and the technical risks would be minimized.

Our main learning outcome was organising and conducting the experiment along with analyzing and interpreting the results.

8 Conclusion

We tested three different kinds of feedback (visual, audio, combined visual and audio) using a self-developed website based on the "One learns" course from the online learning platform Open Learning Initiative (OLI). Additionally, we tested the impact of listening to background music while studying.

The results showed that the majority of the participants preferred visual or combined audio and visual feedback. While this wasn't clear from the results of the UEQ-questionnaire, where only a tendency towards this preference was shown, the answers regarding their favourite feedback showed a clear preference. For the background music a tendency that participants without background music were more focused and motivated was shown. For participants

who normally don't listen to music while studying the tendency was higher.

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A Appendix

A.1 T-test

Table 1. Robust Paired Samples T-Test comparing the UEQ-results of the different feedback

	t	df	p
Audi – Visual	-0.832	8.00	0.430
Audio & Visual – Audio	0.272	8.00	0.792
Visual& Audio – Visual	0.951	8.00	0.370

A.2 User Experience Questionnaire

Person ID

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Feedback type

- Audio (purple tick/cross and audio sound)
- Visual (green/red feedback and no audio sound)
- Audio and Visual (green/red feedback and audio sound)

Please answer the following questions regarding your experience with the feedback you got during the quizzes (correct/incorrect feedback).

Mental Effort during the quizzes

- 1 = very, very low mental effort; 2 = very low mental effort; 3 = low mental effort; 4 = rather low mental effort; 5 = neither low nor high mental effort; 6 = rather high mental effort; 7 = high mental effort/ 8 = very high mental effort; 9 = very, very high mental effort

Very very low mental effort 1 2 3 4 5 6 7 8 9 Very very high mental effort

Good	1 2 3 4 5 6 7	Bad
Annoying	1 2 3 4 5 6 7	Enjoyable
Not understandable	1 2 3 4 5 6 7	Understandable
Easy to learn	1 2 3 4 5 6 7	Difficult to learn
Motivating	1 2 3 4 5 6 7	Demotivating
Clear	1 2 3 4 5 6 7	Confusing
Attractive	1 2 3 4 5 6 7	Unattractive
Boring	1 2 3 4 5 6 7	Exciting
Obstructive	1 2 3 4 5 6 7	Supportive

A.3 Final Questionnaire

Person ID

....

Gender

- Female
- Male
- Non-binary
- Prefer not to disclose

- Other

Age

- Under 20
- 20-30
- 30-40
- Over 40
- Other

What are you studying?

…………………………

Where are you from?

…………………………

Do you normally listen to music while studying?

- Yes
- No

If yes, what type of music?

…………………………

Did you listen to background music in the experiment?

- Yes
- No

I was motivated reading the material

Strongly disagree   1   2   3   4   5   Strongly agree

I was focused while reading the material

Strongly disagree   1   2   3   4   5   Strongly agree

I got distracted while reading the material

Strongly disagree   1   2   3   4   5   Strongly agree

What feedback did you prefer?

- Audio
- Visual
- Visual and audio

Why did you prefer that feedback?

…………………………