The Effect of Background Music on Learners' Intrinsic Motivation and Performance

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Abstract

Numerous scholars have found that listening to background music has the potential to enhance learners' cognitive performance. Nevertheless, the empirical evidence remains equivocal regarding this phenomenon. One possible explanation is the potential role of emotions involved in the process. This present study aims to address these shortcomings by providing a comprehensive analysis that integrates a carefully chosen research design, considering the potential mediating role of emotional states based on the arousal-and-mood hypothesis. Moreover, given the importance of enhancing intrinsic motivation in educational settings and the strong relationship between emotions and intrinsic motivation, this study seeks to determine whether emotion plays a mediating role in fostering intrinsic motivation. The participants in this study were the University of Twente students (N = 44). These participants were randomly assigned into two groups, each experiencing a different sequence of the experiment: whether no music followed by music or music followed by no music. All participants completed two study topics created using an internet-based platform called Genially. Emotional states, cognitive performance, and intrinsic motivation were measured using Affect Grid, open-ended questions related to the topic, and Intrinsic Motivation Inventory, respectively. The findings of this study suggest that utilising Mozart's music as background music did not have a statistically significant impact on learners' performance and motivation. Moreover, no significant effect of background music on emotional states was found. Consequently, mediation analysis could not be conducted. Despite the absence of statistically significant results, the study revealed subtle differences in emotional states, intrinsic motivation, and cognitive performance among both groups, indicating a more complex relationship in the context of learning with background music.

Keywords: background music, emotional states, cognitive performance, intrinsic motivation, arousal-and-mood hypothesis, mediating effect

The Effect of Background Music on Learners' Intrinsic Motivation and Performance

Music has consistently played a significant role in human life throughout history, serving as another means of communication and self-expression that surpasses cultural barriers (Blacking, 1995). Moreover, with the significant advancements in technology, the accessibility of music has greatly increased, resulting in its widespread utilisation among individuals of different ages and backgrounds as part of their daily routine. Various digital streaming services can be acquired through smartphones, granting people immediate access to a comprehensive music library from different countries (Bauer, 2020; Hu et al., 2021). Individuals commonly utilise music for the purpose of entertainment, aesthetic, or spiritual purposes (de la Mora Velasco & Hirumi, 2020). In addition to its function as a source of entertainment, music has the capacity to enhance the quality of life of individuals through its strong connection to emotions, thereby resulting in broader implications for individuals' well-being and engagement (Croom, 2015; Hesmondhalgh, 2013). One of the mechanisms that may result from music listening to emotions is the activation of brain stem reflexes, which are physiological reactions in this context related to music, such as the changes in heart rate (Juslin & Västfjäll, 2008). This emotional impact of music has led to ongoing research about the potential influence of music on numerous aspects of human behaviour, some with particular focus on the role of music as a background in various settings.

Background music refers to music that is played unobtrusively in the background of the main activity without being the focus of attention. Background music is usually utilised in various settings, such as retail shops, restaurants, films, and video games, with the purpose of inducing a particular atmosphere or eliciting an intended emotion (Hwang & Oh, 2020; Klimmt et al., 2019; Wen et al., 2020). The study conducted by Västfjäll (2001) shed light on the ability

of background music to elicit both positive and negative emotions. However, the effectiveness is dependent on various aspects, including the specific context in which the music is being utilised, as well as the valence and affective content of the music itself (Västfjäll, 2001). The capacity of music to elicit a diverse range of emotions has the potential to influence the behaviour of individuals (Kiss & Linnell, 2023), for example to enhance customer behaviour in retail settings (Andersson et al., 2012). Furthermore, music has frequently been used as a background for cognitive-related activities such as studying. Consequently, many researchers have conducted multiple studies to explore the potential beneficial effect of music on learning, such as increased attention (Hu et al., 2021), cognitive performance (Angel et al., 2010; Thompson et al., 2012), and intrinsic motivation of the students (Loizou et al., 2014).

The Mozart Effect

One of the most popular theories that explores the impact of music in educational settings is called *the Mozart effect.* The theory suggests that engaging with Mozart's sonata music has the potential to enhance cognitive performance in the domain of spatial reasoning abilities (Jenkins, 2001; Rauscher & Shaw, 1998). The initial study conducted by Rauscher et al. (1993) involved college students who participated in three different listening conditions: music, relaxation, and silence in order to identify the essential elements of the Mozart effect and explain its underlying mechanisms. The study found that the participants showed enhanced performance on a spatial task, which is a cognitive task involving mental manipulation, after listening to Mozart's Sonata compared to listening to the relaxation tape or silence condition. The findings of the theory, then labelled as the Mozart effect, thus left a lasting impact on educational research.

Subsequent studies have attempted to replicate the Mozart effect, either as a prerequisite before a specific task or when utilised as background music during a particular activity, but

yielded inconsistent outcomes. Rideout & Taylor (1997) found that the participants who were exposed to Mozart's music had a small but significant improvement in spatial performance. The Mozart effect in measures of performance accuracy on special tasks was also found in a study conducted by Wilson & Brown (1997). Ivanov & Geake (2003) have found evidence of the Mozart Effect as background music on spatial reasoning abilities among upper-primary school-aged children. Another study that explored the Mozart effect on students' outcome mathematical assessment found that students who listened to Mozart as background music during assessment performed significantly better (Taylor & Rowe, 2012).

Nevertheless, there have been occasions where attempts to replicate the Mozart effect have shown inconclusive results. A study conducted by Newman et al. (1995) aimed at replicating the Mozart effect by dividing college students into three treatment conditions randomly, namely music, relaxation, or silence. This study failed to provide significant positive results on participants' spatial reasoning abilities after listening to Mozart's music. Steele et al. (1999) conducted a similar study by comparing the effects of Mozart's music to silence and highly repetitive music in a mixed-group design and did not find evidence supporting the existence of the Mozart effect. Furthermore, some similar studies exploring background music found that background music did not have an impact on verbal learning (Jäncke et al., 2014) and had an inconsistent effect on cognitive task performance (Cheah et al., 2022). The varied result of studies that have tried to replicate the Mozart effect has resulted in an ongoing debate regarding the validity and significance of the Mozart effect. One possible explanation for the varied results of these studies might stem from a lack of consideration for individual differences in emotional responses to Mozart's music.

The Arousal-and-Mood Hypothesis

The arousal-and-mood hypothesis can shed light on the varying impact of background music on cognitive performance and the lack of consistency in the Mozart Effect across studies by providing a way to understand those discrepancies (He et al., 2017; Nguyen & Grahn, 2017). This theory is based on the circumplex model of affect, which states that emotion consists of two independent dimensions of emotions: valence (mood) and arousal (Posner et al., 2005). Valence or mood can be defined as the degree of pleasant or unpleasantness of an emotional state or how positive or negative a person feels at the time (Pates et al., 2003; Thompson et al., 2012). Meanwhile, arousal defines the degree of physiological and psychological activation of an emotional state or the amount of energy a person has at the time (Pates et al., 2003; Thompson et al., 2012). According to this hypothesis, background music does not directly affect learners' performance; instead, the emotional reaction it elicits determines whether or not background music affects learners' performance (He et al., 2017). Similarly, Husain et al. (2002) suggested that changes in arousal and mood mediate the influence of music listening on cognitive performance. Specifically, this hypothesis suggests that music which induces moderate arousal levels and positive mood is essential for improving cognitive performance (He et al., 2017).

Furthermore, it is worth mentioning that the Yerkes-Dodson Law, which describes the inverted U-shaped relationship between arousal and performance, emphasises that moderate levels of arousal are optimal for cognitive performance, and both low and high levels of arousal can lead to decreased performance (Kiss & Linnell, 2023; Teigen, 1994). He et al. (2017) conducted a study to explore the potential mediating role of emotional states in enhancing cognitive functioning. The result found direct evidence that emotional states (i.e., arousal and valence) mediate the effect of music listening on creative thinking skills. Moreover, a study by

Perlovsky et al. (2013) found that participants who perceived Mozart's sonata as pleasant music tolerated stress for longer, resulting in better performance on cognitive tests, which adds depth to understanding the short-term value of the Mozart effect. Given the context, the arousal-and-mood hypothesis can shed light on understanding why people respond differently to the Mozart effect (He et al., 2017; Nguyen & Grahn, 2017). Its emphasis on the individual's emotional reaction as a factor in determining the beneficial effect of music listening can help explain the inconsistency in the Mozart effect findings (He et al., 2017).

Besides its potential mediating role between music and cognitive performance, emotions are closely linked to intrinsic motivation. Empirical evidence suggests that positive emotions (i.e., cheerfulness, calmness, and relaxation) have a significant impact on enhancing intrinsic motivation (Vandercammen et al., 2014). In accordance with the Self-Determination Theory, intrinsic motivation can be defined as the condition in which an individual is actively involved in a specific activity for its own sake due to their perception of it as stimulating or pleasurable rather than for external rewards or pressures (Deci et al., 1991; Deci & Ryan, 2015). A study by Loizou et al. (2014) found that music, whether played pre-task or during the task as background music, can act as a stimulant or sedative that positively affects emotional states and the psychological needs underlying intrinsic motivation (Loizou et al., 2014). Promoting intrinsic motivation is an essential aspect of learning as it is associated with a range of positive outcomes, including optimal achievement (Valerio, 2012), as well as improved creativity and psychological well-being (Deci & Ryan, 2015). Therefore, it is essential to explore whether the mediating role of emotion extends to intrinsic motivation, aside from cognitive performance.

This Study

This study focuses on exploring the relationship between background music and the cognitive performance of learners. The Mozart effect will be utilised as a framework in this study. This study serves as an attempt to recreate the Mozart effect, taking into account the potential mediating effects of emotional states. In addition to performance, this study also aims to explore the potential impact of the Mozart effect on intrinsic motivation by examining the mediating role of emotional states.

Within this particular context, emotional states can be understood as comprising two main components: valance or mood and arousal. Valence or mood refers to the subjective experience of positive or negative affective states that are elicited by specific stimuli. On the other hand, arousal refers to the level of activation or deactivation that is experienced in response to certain stimuli (Reisenzein, 1994), which in this case is background music. According to the previously mentioned arousal-and-mood hypothesis, cognitive function can be influenced by a moderate level of arousal and a positive valence of emotional states elicited by background music (He et al., 2017). While the influence of background music on learning outcomes may not be direct, it could have an indirect effect through increased emotional states. The impact of music on emotional states can lead to differences in learning outcomes among individuals. Moreover, the potential positive impact of background music on emotional states may lead to increased motivation during informal learning (Linek et al., 2011).

Different individuals are likely to have varying musical preferences that can potentially elicit emotional responses during the learning process. Que et al. (2020) conducted a study which investigated the impact of personalised background music on academic reading. The study suggests that listening to individually chosen music has the capacity to facilitate self-regulated

learning. The influence of individual differences in musical preferences may also influence the outcomes of emotional induction through music (Ribeiro et al., 2019). Therefore, this study incorporates musical preferences as an additional factor to improve the understanding of the effect of background music on learners' emotional states.

The need for careful consideration of the application of background music in educational settings, especially the Mozart effect, arises from the mixed findings observed in previous research about its influence. In order to address those discrepancies, this study tries to replicate the Mozart effect while also considering the potential mediating impact of emotional states, as explained by the arousal-and-mood hypothesis. Furthermore, this study explores the potential relationship between musical preferences and their emotional states. The objective is to propose a feasible resolution that can be implemented by educators and instructional designers.

Research Questions

The design of the study displayed in Figure 1 was established based on previous explanations. Consequently, the research questions are presented in this study:

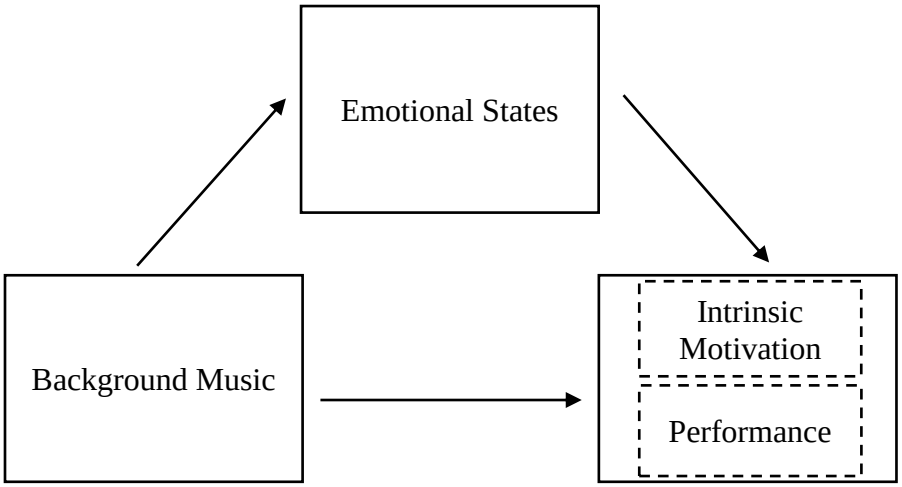
RQ1: To what extent does utilising Mozart's music as background music impact learners' intrinsic motivation and cognitive performance?

RQ2: To what extent do emotional states (i.e., arousal and valence) mediate the effect of background music on learners' intrinsic motivation and cognitive performance?

RQ3: To what extent do musical preferences correlate with individuals' emotional states when exposed to background music?

Figure 1

Current Study Design



Methods

Design

This study is an experimental study with a mix of within-subject and between-subject designs. In the present study, participants were instructed to partake in two consecutive sessions. One session was conducted without background music, while the other involved the presence of background music, specifically Mozart's classical music. This comparative approach was used to measure the specific influence of background music on each participant. In order to prevent the potential bias arising from participants being exposed to the same topic twice, two distinct topics were developed. Furthermore, a random assignment was employed to minimise the impact of the order in which participants completed the two conditions. Participants were randomly assigned to one of these sequences: one group learned the first topic without background music, followed by the second with background music. On the other hand, the second group followed the reverse sequence.

Participants

The participants for this study were students currently enrolled at the University of Twente, as this study requires participants who can come to the university to complete the experiment. The participants were recruited through the University of Twente SONA platform. Additionally, social media was also used to send digital posters and information about the experiment **(Appendix A)**. Participants who registered via SONA were rewarded with 1.5 SONA credits upon participation, which bachelor students from psychology and communication sciences need. Eligible participants were undergraduate and graduate students fluent in English, as the learning environment was presented in English.

A total of 45 participants agreed to participate and completed the entire experiment process. However, one participant was excluded from the analysis because of missing data, so the remaining data from 44 participants were analysed, with 23 participants in the first group and 21 participants in the second group. Participants were between 18 and 33 (M = 23.27, SD = 3.55). The gender of the participants consisted of 25 females (*56.8%*) and 19 males (*43.2%*) with these distributions: 12 males (52.2%) and 11 females (47.8%) were assigned to the first group and seven males (33.3%) and 14 females (66.7%) were in the second group. Two participants were Ph.D. candidates (*4.5%*), 23 participants were master's degree students (*52.3%*), and 19 participants were bachelor's degree students (*43.2%*). The top three nationalities with the most participants are Indonesian (*25.0%*), German (*18.2%*), and Dutch (*18.2%*).

Furthermore, information regarding the participants' music listening habits was also recorded. Participants' frequency of music listening habits daily between two groups was displayed in Figure 2. In addition, participants' habit of listening to music while doing cognitively demanding tasks (e.g., studying) between two groups was shown in Figure 3.

Figure 2

Frequency of Music Listening Habit between Two Groups

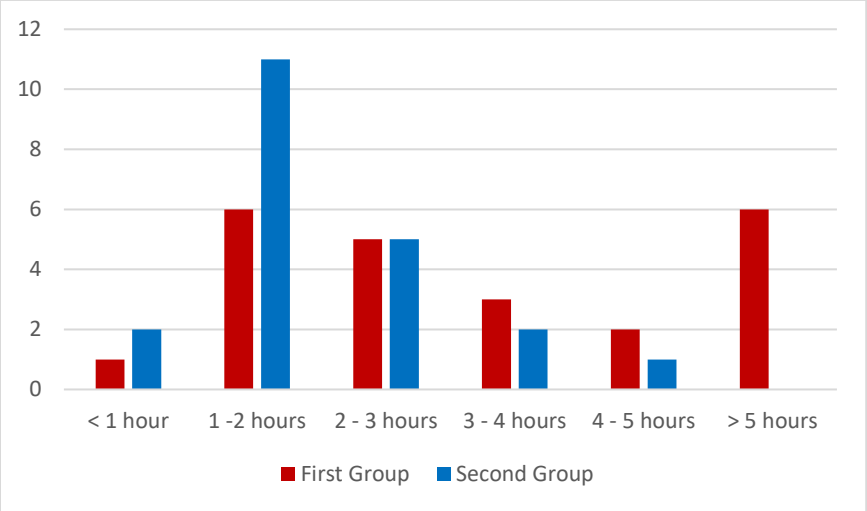
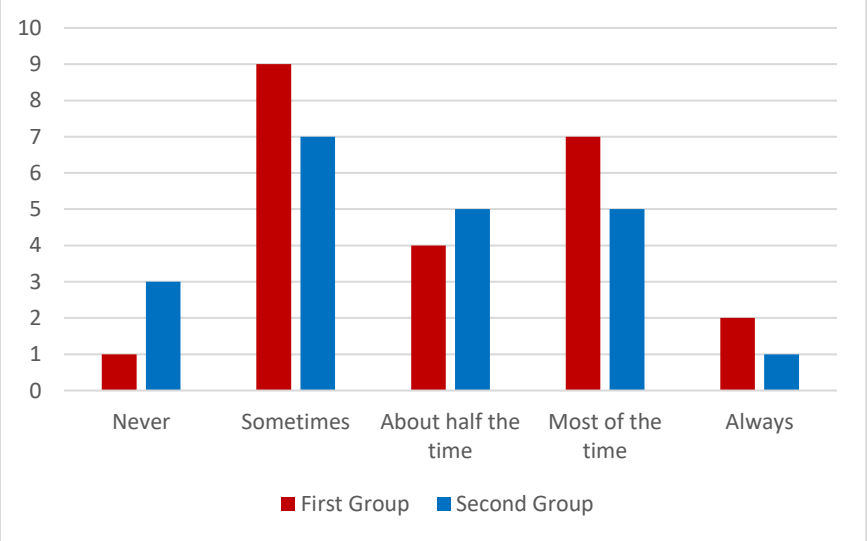


Figure 3

Frequency of Music Listening Habit while Doing Cognitively Demanding Tasks between Two Groups



Materials

The materials used in this study were Technology-Based Learning Environments (TBLEs) and a piece of background music. In addition, learners' emotional states consisting of valence and arousal, intrinsic motivation, and cognitive performance were also recorded in this study.

Technology-Based Learning Environments (TBLEs)

TBLEs refer to an innovative approach to learning environments influenced by technology. TBLEs aim to provide learners with an interactive learning experience tailored to their needs (Bond & Bedenlier, 2019). TBLEs were used because they could have several positive outcomes, including providing learners with the autonomy to study at their own pace, an immersive learning experience, and fostering lifelong learning (Haleem et al., 2022). Moreover, it has been suggested that TBLEs have the potential to foster academic achievement when students are engaged with the technology and are motivated to use it (Dunn & Kennedy, 2019).

The TBLEs were created using an internet-based platform named Genially (*https://genial.ly*). The selection of the platform was based on its capacity to incorporate interactive features that facilitate participant engagement throughout the learning experience. In addition, the platform also includes navigation buttons that allow participants to study at their own pace. The learning platform consisted of three main parts: an introduction, learning sessions, and a closure session. The introduction consisted of multiple-choice questions, serving as a pre-test for the participants. Subsequently, a brief explanation of the topic was presented, as shown in Figure 4. The primary component of the learning platform presented in Figure 5 was the learning sessions, where the participants gained knowledge about the topic. Various forms of quizzes were displayed throughout the learning sessions, and instant feedback was provided for the participants to evaluate their progress, as presented in Figure 6. The last component of the learning platform is a closure section, presented in Figure 7. This section consisted of a comprehensive review of the topic addressed throughout the learning sessions.

Figure 4

Introduction examples

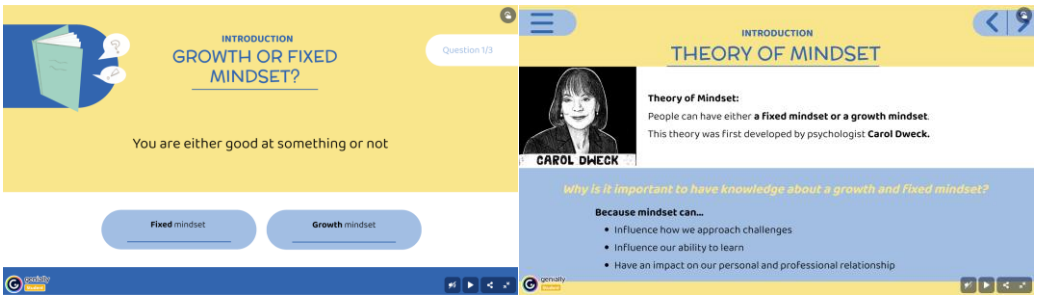


Figure 5

Learning session examples

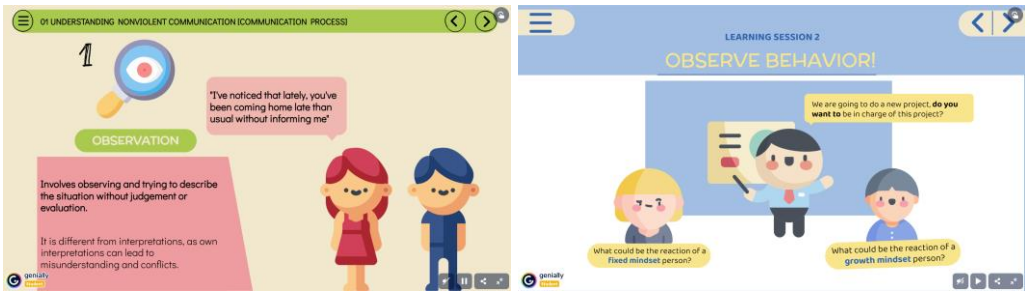


Figure 6

Quizzes examples

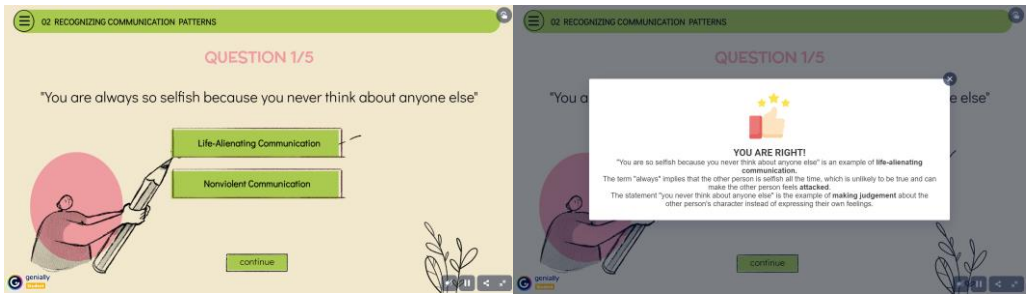
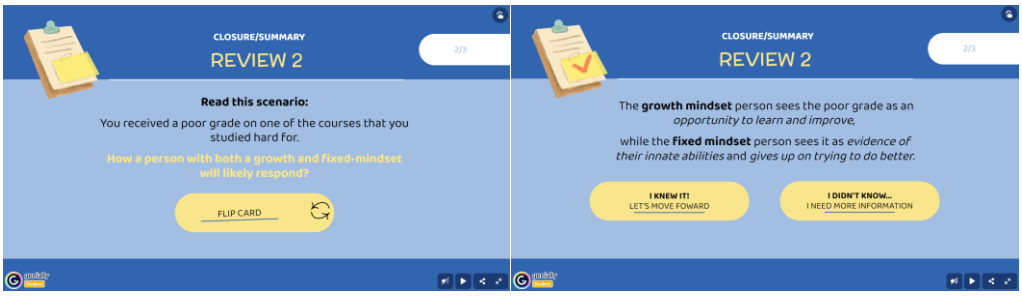


Figure 7

Closure examples



During the experiment, participants were exposed to two different topics, which are *Cultivating a Growth Mindset* and *Nonviolent Communication*. The Cultivating a Growth Mindset topic mainly discussed the differences between growth and fixed mindset and highlighted the importance of developing a growth mindset. This topic was created based on Carol Dweck's *'Theory of Mindset'* (Dweck, 2006). Meanwhile, the Nonviolent Communication topic covers the nonviolent communication concept and process, the importance of implementing nonviolent communication in real-life settings and how it differs from life-alienating communication. This learning topic was developed based on a communication theory developed by psychologist Marshall Rosenberg (Rosenberg & Chopra, 2015).

The topics were chosen because both topics are general topics that can be learned by individuals across various disciplines. In addition, learning both topics could be beneficial for personal development and improving personal or professional relationships (Dweck, 2006; Rosenberg & Chopra, 2015). Both topics can also be structured similarly on the TBLEs, so there were no significant changes in structure between both learning sessions.

Background Music

Background music was the only stimulus used in this study to induce emotional states. Mozart's Sonata for Two Pianos in D Major was utilised as it has been demonstrated to be effective in inducing positive emotional responses in previous studies (He et al., 2017). The music was played on a loop throughout the learning process on one of the topics depending on the participants' assigned group.

Measuring Emotional States

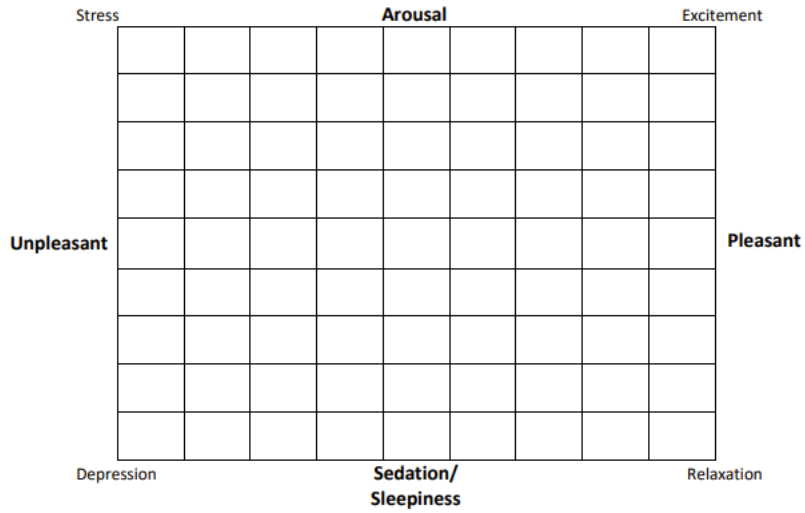
Emotional states were measured using the Affect Grid. The Affect Grid (J. A. Russell et al., 1989) is a single-item scale developed to measure two dimensions of emotional state:

pleasure-displeasure (i.e., valence) and arousal-sleepiness (i.e., arousal). This scale is a self-report measurement based on the circumplex model of effect (J. A. Russell, 1980). This scale is suitable to use for a study that involves judgements about affect (e.g., background music) to assess individuals' emotional state at a given time.

A sample of the Affect Grid is presented in Figure 8. The horizontal boxes represent the degree of valence or the pleasure-displeasure emotion. The left half of the grid represents unpleasant feelings, while the right half of the grid represents pleasant feelings. The farther to the left, the more unpleasant and the farther to the right, the more pleasant. The vertical boxes represent the degree of arousal, with the lowest box representing minimum arousal and the highest box representing maximum arousal. Filling in the centre of the grid indicates an entirely neutral feeling. In this study, the participants were instructed to fill the affect grid both prior to the experiment to measure their baseline condition as well as after each session of the experiment. The participants were instructed to mark the grid with a single 'x' to indicate how they were feeling at that time. The valence score ranges from 1 to 9, counting from the left, and the arousal score ranges from 1 to 9, counting from the bottom of the grid.

Figure 8

The Affect Grid (adapted from Russell et al., 1989)



Measuring Learner's Performance

The learners' cognitive performance was assessed using open-ended questions **(Appendix C)**. After completing each topic, participants were asked to answer four open-ended questions about the topic presented in the TBLEs beforehand. A comprehensive scoring rubric was created to quantify the participants' answers, ranging from one to four points, based on the depth and accuracy of participants' answers **(Appendix D)**. The cumulative score was used to analyse the learners' cognitive performance.

Measuring Intrinsic Motivation

The Intrinsic Motivation Inventory (IMI) was used to measure participants' intrinsic motivation. The IMI is a multidimensional self-report measurement that aims to assess participants' subjective experiences regarding how they perceive certain situations. The complete version of IMI consists of 45 items that assess seven dimensions: Interest/Enjoyment, Perceived Competence, Effort/Importance, Pressure/Tension, Perceived Choice, Value/Usefulness, and Relatedness.

The present did not use the entire IMI, which consists of 45 items. Instead, this study used one out of four specific versions of the IMI that have been previously used in prior studies.

This study used a specific version known as the ‘Task Evaluation Questionnaire’. In this version, a total of 22 items are distinguished by four distinct subscales: interest/enjoyment, perceived choice, perceived competence, and pressure/tension **(Appendix E)**.

Procedure

This study was conducted after obtaining ethical clearance from the University of Twente, as indicated by request number 230887. The study was conducted at the University of Twente, utilising one of the *flexperiment* rooms for data collection during the months of June and July 2023. The room was equipped with a computer and a set of headphones. The computer was utilised to display the TBLEs and all questions for the data collection through the Qualtrics platform. This platform is used to collect informed consent, demographic questions, assessments, and self-report measurements. The headphones were utilised for playing the background music. In addition, an iPad was utilised to collect the emotional state data, thereby substituting the conventional method of paper and pencil.

Each participant was informed about the study and its purpose and was asked to complete a consent form on Qualtrics before starting the experiment **(Appendix B)**. After providing their consent, each participant was assigned a number for their code and asked to complete the demographic questions and the Affect Grid scale to measure their emotional state baseline condition. The participants were then provided with a tutorial on how to use the learning platform to familiarise themselves with it. After ensuring that the participants understood how to use the platform, they were introduced to the first topic, “Cultivating a Growth Mindset,” and instructed to complete the learning platform. Participants who were assigned to complete the first topic with background music wore headphones that played background music.

After completing the first topic, participants were directed to complete the Affect Grid scale again, followed by an assessment of the first topic and the IMI scale. Participants who completed the first session with background music were also asked with a series of additional questions regarding their preference for the background music played. Participants were then given roughly five minutes to rest before starting the next session. The second session with the topic “Nonviolent Communication” was presented, and the participants were asked to complete it either with or without background music according to their assigned group. After completing the learning session, they filled out the same measurement as before and completed an assessment about the second topic. The participants were then given a debriefing **(Appendix F)** that revealed the true purpose of the study.

Data Analysis

SPSS version 28 for Windows was used to conduct the statistical data analyses. Most of the data, including participants' demographic data, music listening behaviour, open-ended performance tests, and IMI scale, were exported directly from Qualtrics to SPSS. In addition, the Affect Grid data collected via iPad during each experimental condition were scored according to the scoring scheme for both valence and arousal. The scoring scheme ranges from 1 to 9, with higher values indicating greater arousal or valence level. The scores were calculated to find the difference between each experimental condition and the baseline, with the scores being subtracted to represent the change in emotional states. These raw scores and differences were imported into the SPSS dataset for analysis purposes.

In the performance test, a structured rubric was made to ensure consistent evaluation. The rubric displayed critical criteria and descriptions for each score level to quantify participants' open-ended performance test responses. Each question was evaluated on a scale ranging from 1

to 4, with 1 indicating the lowest level of understanding and 4 representing the highest level of understanding. To increase scoring reliability, an additional scorer joined to score the responses of the participants. The additional scorer evaluated 10 participants' responses using the same rubric. Inter-rater reliability analyses were conducted to assess the degree of agreement between the primary scorer and the additional scorer. Cohen's Kappa was used to determine the inter-rater reliability score. The Cohen Kappa (κ) ranged from .531 to .750, indicating that there is various level of agreement between the raters for each question. According to the guidelines from (Altman, 1990) and adapted from Landis & Koch (1977), a kappa (κ) ranged from 0.41-0.60 indicates moderate agreement, which in this case is for growth mindset Q1 and nonviolent communication Q1. Meanwhile, the remaining questions were categorised as a good agreement with a kappa (κ), ranging from 0.61-0.80. Furthermore, the *p*-value for all the questions is <.05, and the kappa (κ) coefficient is statistically significantly different from zero. The inter-rater reliability analysis showed a reasonable level of agreement between the raters, indicating that the rubric created is a reliable tool.

Regarding the IMI scales, certain items needed to be scored in reverse. Therefore, a recoding procedure was required for these items to ensure that each item received the same score. After recoding the required items, the subscale scores were calculated by averaging the item scores within each subscale. These subscale scores provided a comprehensive overview of participants' perceived levels of intrinsic motivation in each subscale. In the end, the sum of all subscale scores was not calculated as one of the subscales indicates negative aspects of intrinsic motivation.

To answer the first research question, 'To what extent does utilising Mozart's music as background music impact learners' intrinsic motivation and cognitive performance?' linear

mixed models (LMM) were used. In accordance with the design of the study, in which each participant completed two sessions with different orders (one with background music and one without), two separate LMM analyses were conducted to analyse the influence of condition on intrinsic motivation and performance. In addition, LMM was used to analyse the influence of conditions on intrinsic motivation before conducting a mediation analysis. A mediation analysis was supposed to be conducted to answer the second research question, 'To what extent do emotional states (i.e., arousal and valence) mediate the effect of background music on learners' intrinsic motivation and cognitive performance?'. It is essential to note, however, that the mediation analysis could not be conducted due to the results of the LMM analysis. The outcome of the LMM analysis will be presented in the following sections.

To answer the third research question, 'To what extent do musical preferences correlate with individuals' emotional states when exposed to background music?' Pearson's Correlation analysis was conducted. This analysis was conducted to determine the relationship between participants' self-reported musical preference and their emotional state, including valence and arousal levels. Participants were asked whether the background music played accurately reflected their personal musical preferences. They must then select an option using a 5-point Likert scale, ranging from "Not accurately at all" (1) and "Extremely accurately" (5). The correlation between this preference score and their respective valence and arousal levels was then used to determine to what extent participants' musical preferences affected emotional responses.

Results

Effect of Background Music on Learners' Performance

Table 1 presents the descriptive statistics regarding learners' cognitive performance between two conditions for each topic. Based on the study model, specific comparisons were made between participants who performed with and without background music for each topic. In the first topic ‘Cultivating a Growth Mindset’, participants who studied this topic without background music achieved a slightly higher performance score in comparison to participants who studied the same topic with background music. Similarly, participants who studied the second topic, ‘Nonviolent Communication’ without background music, achieved a slightly higher performance score than participants who studied the same topic with background music. The comparison of the mean performance scores is displayed in Figure 9.

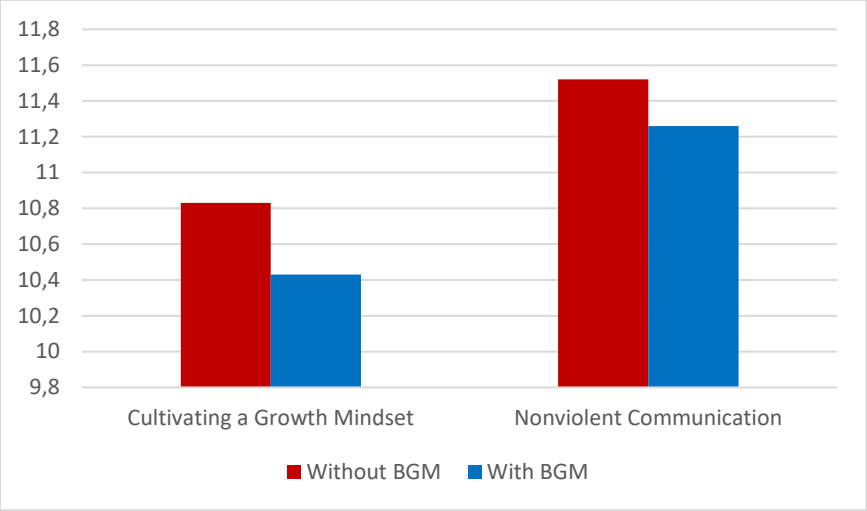
Table 1

Means and Standard Deviations of the Learners’ Performance Test between Two Conditions for Each Topic

Condition	Topic	*M*	*SD*
Without BGM	Cultivating a Growth Mindset	10.83	2.35
	Nonviolent Communication	11.52	1.94
	Total	11.16	2.17
With BGM	Cultivating a Growth Mindset	10.43	2.54
	Nonviolent Communication	11.26	1.98
	Total	10.86	2.28

Figure 9

Means of the Learners’ Performance Test Comparison between Two Conditions for Each Topic



Linear Mixed Models (LMM) were conducted to explore the effect of background music on learners' cognitive performance. The LMM included condition as the fixed effect representing the various experimental conditions (i.e., with and without BGM). In this analysis, SPSS used Condition=2, which is the condition with background music as an intercept or baseline condition. The intercept was estimated at 10.953 (*SE = 0.326, t = 33.558, p < 0.001*). Meanwhile, the effect of Condition=1 compared to the intercept was 0.283 (*SE = 0.463, t = 0.610, p = 0.543*). This means that the no background music condition did not have a significant difference in learners' cognitive performance compared to the background music condition, as displayed by the p-value for Condition=1. Therefore, the analyses did not reveal a significant relationship between background music and learners' cognitive performance.

Effect of Background Music on Learners' Intrinsic Motivation

For learners' intrinsic motivation, specific comparisons were made between sessions with and without music based on the study model. The average scores for each subscale were presented in detail in Table 2 for each group. First, a comparison was made between participants who completed the first topic without background music and participants who completed it with background music. Participants who completed the first topic without background music

achieved slightly lower scores on subscale interest/enjoyment, perceived competence, and perceived score compared to participants who completed the first topic with background music. In addition, on the pressure/tension subscale, participants who completed the first topic without background music achieved slightly higher scores than those who completed the first topic with background music. Figure 10 compares the mean scores of each IMI subscale for the first topic.

On the contrary, when looking at the results in the second topic, participants who completed the second topic without background music achieved slightly higher scores on subscale interest/enjoyment, perceived competence, and perceived score than participants who completed the second topic with background music. Meanwhile, on the pressure/tension subscale, participants who completed the second topic without background music achieved slightly lower scores compared to those who completed the second topic with background music. The comparison between the mean scores of each IMI subscale on the first topic is displayed in Figure 11.

Table 2

Means and Standard Deviations of the Learners' IMI Score between Two Conditions and Order

Condition	Topic	Interest/ Enjoyment		Perceived Competence		Perceived Choice		Pressure/ Tension	
		M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Without	1	5.33	.81	5.09	.75	5.74	1.08	2.43	1.01
BGM	2	5.37	1.12	5.36	.87	5.92	1.01	2.40	.91
	Total	5.35	.96	5.22	.81	5.83	1.04	2.42	.95
With BGM	1	5.63	.76	5.16	.87	5.81	.91	2.00	.67
	2	5.33	.85	5.02	1.09	5.56	1.13	2.56	1.38
	Total	5.47	.81	5.09	.98	5.68	1.03	2.29	1.12

Figure 10

Means of the Learners' IMI Score Comparison between Two Conditions for 'Cultivating a Growth Mindset' Topic

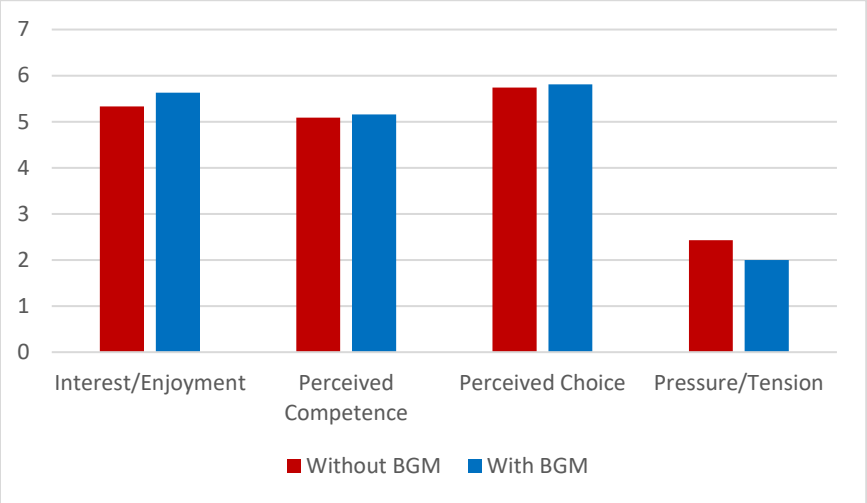
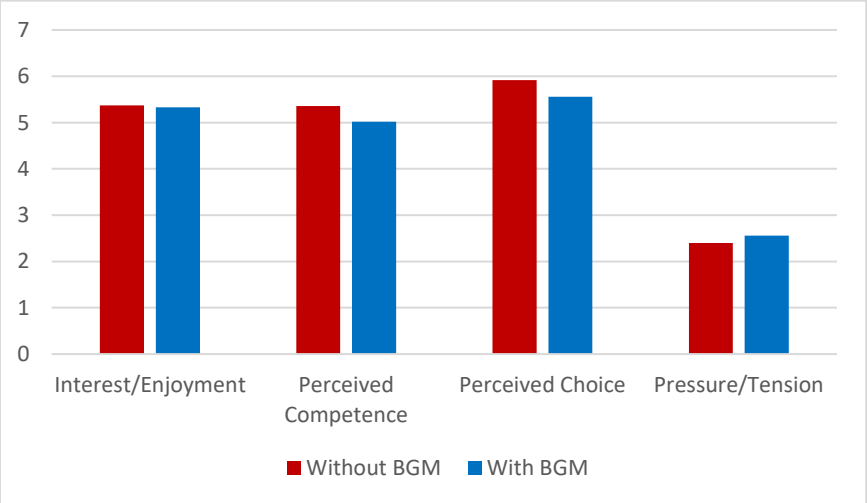


Figure 11

Means of the Learners' IMI Score Comparison between Two Conditions for 'Nonviolent Communication' Topic



In order to explore the effect of background music on learners' intrinsic motivation in a technology-based learning environment, Linear Mixed Models (LMM) were conducted.

However, the Linear Mixed Models (LMM) were conducted separately on each subscale rather than the total score, as one of the subscales acted as a negative predictor for intrinsic motivation.

In this analysis, SPSS used Condition=2, which is the condition with background music as an intercept or baseline condition. On the first subscale (Interest/Enjoyment), the intercept was estimated at 5.474 (*SE = 0.134, t = 40.857, p < 0.001*). Meanwhile, the effect of Condition=1, when compared to the intercept, was estimated at -0.123 (*SE = 0.143, t = -0.866, p = 0.391*). On the second subscale (Perceived competence), the intercept was estimated at 5.086 (*SE = 0.154, t = 37.545, p < 0.001*) and the effect of Condition=1 when compared to the intercept was estimated at 0.132 (*SE = 0.122, t = 1.081, p = 0.286*). On the third subscale (Perceived choice), the intercept was estimated at 5.677 (*SE = 0.156, t = 36.445, p < 0.001*) and the effect of Condition=1 when compared to the intercept was estimated at 0.150 (*SE = 0.094, t = 1.588, p = 0.120*). For the last subscale (Pressure/tension), the intercept was estimated at 2.286 (*SE = 0.157, t = 14.549, p < 0.001*) and the effect of Condition=1 when compared to the intercept was estimated at 0.132 (*SE = 0.161, t = 0.817, p = 0.418*). These results indicated that each subscale of intrinsic motivation measured on the without background music condition did not have a significant difference compared to the background music condition, as displayed by each of the p-values for Condition=1. Therefore, the analyses did not reveal a statistically significant relationship between background music and learners' intrinsic motivation.

Effects of Background Music on Emotional States

Another LMM analysis was conducted to explore the effect of background music in eliciting emotional states among learners. This analysis was performed to make sure that while background music does not directly have an impact on learners' intrinsic motivation and cognitive performance, it might still be capable of inducing participants' emotional states.

Firstly, the result of the descriptive analysis is presented in Table 3. The valence and arousal scores presented were previously calculated as the difference between either the first or second condition and the baseline condition. Participants who did the first session without background music and the second session with background music were compared for each topic.

In terms of valence, participants who performed the first topic without background music condition received a slightly lower average valence score compared to participants who performed the first topic with background music. In contrast, participants who conducted the second topic without background music received a slightly higher average valence score compared to those who completed the second topic with background music. The comparison between the mean average valence scores for both topics is presented in Figure 12. Regarding the arousal score, it was observed that participants who completed the first topic without background music condition obtained a slightly lower average arousal score compared to participants who performed the first topic with background music condition. On the contrary, participants who conducted the second topic without background music had a slightly lower average arousal score when compared to participants who conducted the second topic with background music. Figure 13 illustrates the comparison between the mean average valence scores for both topics.

Table 3

Means and Standard Deviations of the Difference in Learners' Emotional States between Baseline Measurements for Each Topic

Condition	Topic	Valence		Arousal	
		M	*SD*	*M*	*SD*
Without BGM	1	.30	1.15	.78	1.83
	2	.29	1.45	.05	1.40
	Total	.30	1.29	.43	1.66

With BGM	1	1.05	1.16	.00	1.84
	2	-.04	1.33	.65	2.40
	Total	.48	1.36	.34	2.16

Figure 12

Means of the Learners' Average Valence Scores Comparison between Two Conditions for Each Topic

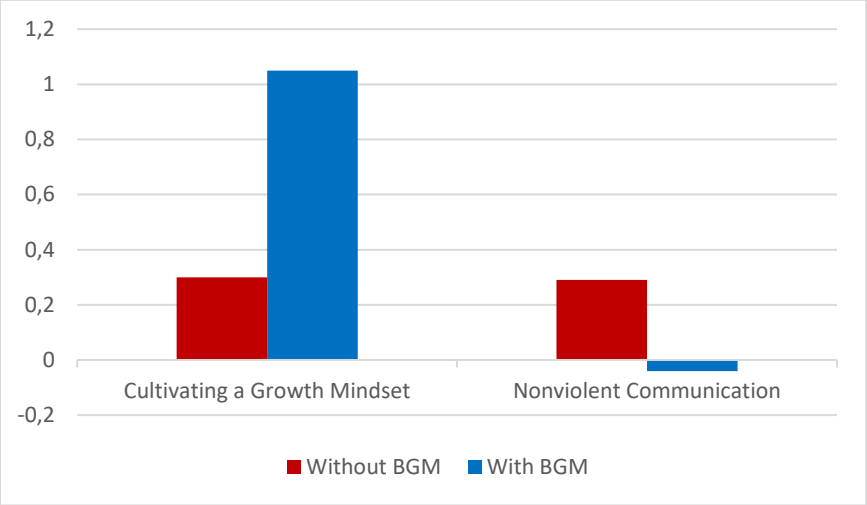
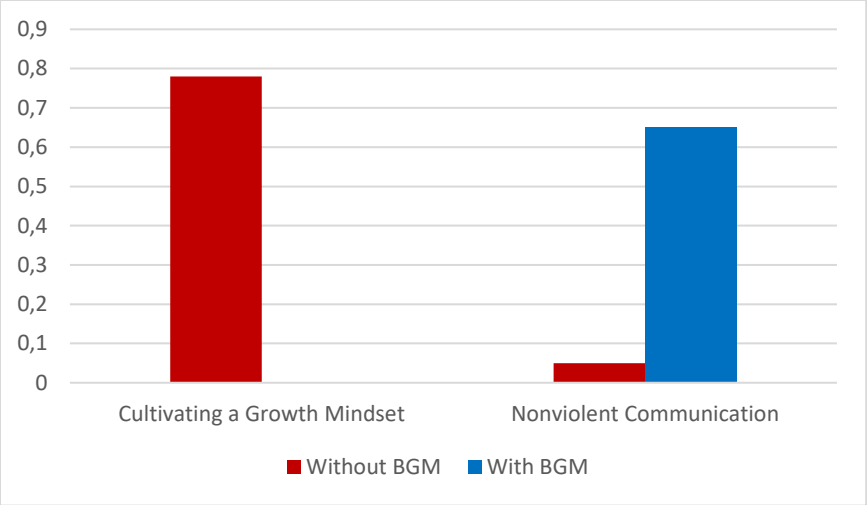


Figure 13

Means of the Learners' Average Arousal Scores Comparison between Two Conditions for Each Topic

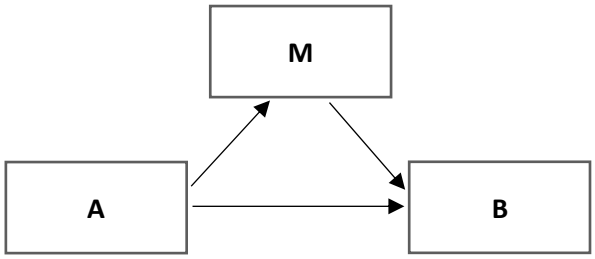


Furthermore, Linear Mixed Models (LMM) were conducted to explore the effect of background music on learners' emotional states. The LMM included condition as the fixed effect that represented the various experimental conditions (i.e., with and without BGM). In this analysis, SPSS used Condition=2, which is the condition with background music as an intercept or baseline condition. In terms of valence score, the intercept was estimated at 0.477 (*SE = 0.199, t = 2.396, p = 0.019*). Meanwhile, the effect of Condition=1 when compared to the intercept was -0.182 (*SE = 0.219, t = -0.831, p = 0.411*). This means that the no background music condition did not have a significant difference in learners' valence score compared to the background music condition, as displayed by the p-value for Condition=1. Meanwhile, for the arousal score, the intercept was estimated at 0.341 (*SE = 0.290, t = 1.175, p = 0.244*). Meanwhile, the effect of 'Condition=1' was estimated at 0.091 (*SE = 0.268, t = 0.340, p = 0.736*). This means that in terms of learners' arousal scores, there were no significant differences between the no background music and background music conditions. Therefore, the analyses did not reveal a statistically significant relationship between background music and learners' emotional states.

According to the second research question, 'To what extent do emotional states (i.e., arousal and valence) mediate the effect of background music on learners' intrinsic motivation and cognitive performance?', mediation analysis should be conducted to test the mediating effect. However, no significant results were found based on the LMM analyses conducted to test the relationship between background music and learners' motivation and performance. Furthermore, no significant results were found between background music and emotional states. From Figure 14 and based on the definition of a mediator provided by Baron and Kenny (1986), variable *M* is considered a mediator if (1) *A* significantly predicts *B*, (2) *A* significantly predicts *M* and (3) *M* significantly predicts *B* controlling for *A* (Preacher & Hayes, 2004). In this study, the first and second condition was not met, so mediation analysis could not be performed.

Figure 14

Illustration of a Mediation Design.



Musical Preference and Emotional States Correlation

Pearson's Correlation analysis was conducted, and the results are displayed in Table 4. Regarding valence, the result displayed a weak negative correlation between participants' musical preference and valence level. This suggests that there is a slight tendency that as the participants' preference for the background music played increases, their reported valence level tends to decrease slightly. However, the result showed that the correlation is not statistically significant.

Similarly, the findings revealed a weak negative correlation between the music preference of participants and their level of arousal. This finding indicates that as participants' preference for music intensifies, there is a tendency for their arousal levels to decrease slightly. It is essential to acknowledge that the observed correlation is not statistically significant, as indicated by the p-value of 0.704. When the lack of statistical significance in the correlation between learners' musical preference and their emotional states is observed, there is barely any relationship between these variables.

Table 4

Preference of Music and Emotional States Correlation

	Valence Level		Arousal Level	
	r	*P*	*r*	*P*
Preference of Music	-.068	.663	-.059	.704

Note. r= Pearson's Correlation, P= P-value

Discussion

This study aimed to explore the effect of background music on learners' intrinsic motivation and cognitive performance. In relation to the first and second research questions (RQ1: To what extent does utilising Mozart's music as background music impact learners' intrinsic motivation and cognitive performance? RQ2: To what extent do emotional states (i.e., arousal and valence) mediate the effect of background music on learners' intrinsic motivation and cognitive performance?) no significant results were found between utilising Mozart's music as background music and both learners' intrinsic motivation and cognitive performance. Furthermore, no significant results were found between background music and emotional states. Based on that finding, it was not possible to conduct a mediation analysis. Consequently, the results indicated

that emotional states did not mediate the effect of background music on learners' intrinsic motivation and cognitive performance.

According to the arousal-and-mood hypothesis, the presence of background music has the potential to induce emotional states (Nguyen & Grahn, 2017; Schellenberg, 2005). These emotional states may have the capacity to influence learners' motivation and cognitive performance. The success of this hypothesis has been supported by previous research in the field of music and education (e.g., He et al., 2017). However, the result of this present study does not align with the arousal-and-mood hypothesis, suggesting that additional factors besides background music may contribute to eliciting emotional states. One potential explanation for this finding is that the capacity of background music to elicit emotional states can vary based on the specific context in which it is utilised (Västfjäll, 2001). In addition to musical parameters (Kämpfe et al., 2010; Kelley et al., 2014; Kiss & Linnell, 2023; Shih et al., 2012) and individuals' personal music preferences (Ribeiro et al., 2019), additional factors such as individuals' prior musical experience, traits, current emotional states, and the location and event which the music is being played can also play a role (Västfjäll, 2001). The fact that this study is an experimental study in which participants do not have the autonomy to choose their study conditions, including the option to listen to background music or not, may have influenced their emotional responses.

The utilisation of the affect grid scale to measure emotional states could have influenced the results. It is possible that the utilisation of the affect grid as a repeated measure, where participants had to complete it multiple times, may have led some participants to exaggerate their emotional state fluctuations due to social desirability bias towards the researcher (Y. I. Russell & Gobet, 2012). Furthermore, the participants were instructed to complete the second and third

assessments of the affect grid after studying each topic, which raises the possibility of inconsistency in interpretation across the measurements. Those reasons may have an impact on the interpretation of the data.

Although the linear mixed-models analysis did not produce statistical significance, slight differences were observed in the participants' mean valence and arousal scores across different conditions for each topic. When compared to participants who completed the first topic without background music, those who completed the first topic with background music reported slightly higher valence scores and slightly lower arousal scores. On the other hand, the scores were found to be inverted in the second topic. These findings suggest that the topic itself may have an influence on the participants' emotional states. Participants' emotional responses can vary depending on the specific activity conducted (Hu et al., 2021), which could potentially overshadow the impact of background music on emotional states.

Apart from the lack of significant findings regarding the relationship between background music and emotional states, there are additional factors that can help to understand the absence of a significant effect between background music and learners' motivation and cognitive performance. Task complexity is an additional factor that should be taken into consideration. In this study, the TBLEs that were developed exhibited a range of complexity levels. While most of the tasks were generally straightforward and easy to understand, it is important to acknowledge that the participants' lack of familiarity with the learning platform could potentially result in higher cognitive processing demand. It is important to take into account that task complexity might also influenced by participants' familiarity with each topic. Several participants already had prior knowledge of either one or both topics, resulting in different perceptions of task complexity. Participants who have been exposed to the topic before

might perceive the task as simple, while others who have no prior knowledge might perceive the task to be more complex. As suggested by recent research (Kiss & Linnell, 2023), the impact of background music on cognitive performance may not be solely determined by the mere presence or absence of music but rather by complex factors. The findings indicated that participants were more likely to select music with higher levels of arousal for enjoyment during simple tasks, while they tended to choose less arousing music during complex tasks. The fact that this study only utilised one specific music for everyone can potentially explain why there is an absence of statistically significant findings.

Moreover, while there was no statistically significant difference in performance between learning with and without background music, there was a slight difference in the mean performance score. Participants who studied the first and second topics without background music constantly scored slightly higher than participants who studied with the presence of background music. One potential explanation may be connected to the concept of cognitive load. The presence of background music during study sessions can create an additional cognitive load, as they have to simultaneously process both the learning materials and the auditory stimuli of background music (de la Mora Velasco & Hirumi, 2020). Hence, although some studies have indicated that background music can enhance learners' performance (Thompson et al., 2001), the presence of background music that creates an additional cognitive load can potentially create hindering effects by slightly reducing the available cognitive resources.

In relation to the measure of intrinsic motivation, a slight distinction was observed in the participants' average IMI score. Upon examining the scores for each subscale, it was observed that participants who engaged in studying the first topic with background music achieved slightly higher scores on the subscale of interest/enjoyment, perceived competence, and perceived

choice. On the contrary, they obtained slightly lower scores on the subscale of pressure/tension in comparison to those who studied without any background music. This can be attributed to the theoretical understanding that the pressure/tension subscale is a negative predictor of intrinsic motivation (*Intrinsic Motivation Inventory (IMI) – Selfdeterminationtheory.Org*, n.d.). Meanwhile, on the second topic, contrasting results were observed. These results suggest that the topic being presented may have an impact on the intrinsic motivation of the participants. This aligns with the principle of self-determination theory, which proposes that individuals are more likely to show higher levels of intrinsic motivation when they find the topic enjoyable (Deci & Ryan, 2015).

Additionally, in relation to the third research question (RQ3: To what extent do musical preferences correlate with individuals' emotional states when exposed to background music?), the findings indicate a weak negative correlation between participants' musical preference and both valence and arousal. Nevertheless, no statistically significant effects were observed. Therefore, to answer the third research question, musical preference did not have a significant positive influence on participants' emotional states when exposed to background music.

There are multiple factors that can explain the difference observed in this study. It is essential to recognise that the participants were not given the opportunity to choose their own preferred music. In contrast, because this attempts to replicate the Mozart effect, the participants were presented with one of Mozart's music and were asked to rate their personal preference for this specific music. This could potentially result in participants lacking familiarity or personal connection with the background music, which may subsequently influence their emotional responses. Whereas in everyday life, individuals are given the opportunity to choose their preferred music, thereby potentially eliciting stronger emotional reactions. This is supported by

the result of a study by Kämpfe et al. (2011), which found that the impact of background music appears to be contingent upon the participants' liking and familiarity. In addition, the elicitation of positive emotions is not solely dependent on individuals' musical preferences. As previously mentioned, various musical parameters can also interact with individual preferences in order to evoke specific emotional responses, such as tempo (Kämpfe et al., 2011; Kiss & Linnell, 2023), genre (Kelley et al., 2014), and lyrical content (Shih et al., 2012). These factors have the potential to diminish the direct impact of their musical preference alone.

Limitation and Future Implementation

This study offers insights into the impact of utilising Mozart's music as background music on learners' intrinsic motivation and cognitive performance. However, it is important to acknowledge several limitations that could be addressed in future research endeavours with a similar nature. The main limitations are regarding the topic of the study. In this study, participants were instructed to engage with two different topics without collecting data pertaining to their preferences on these topics. Hence, this study is unable to analyse any potential influence of the topic chosen on participants' emotional states. Different topics may have different impacts on participants' emotional states, potentially influencing their intrinsic motivation and performance.

Another limitation relates to the background music. As the primary objective of this study is to examine the Mozart effect, it is important to acknowledge that this study solely uses a singular background music selection. This may elicit varying results for each participant and potentially limit the ability to generalise the findings. Furthermore, it should be noted that the participants in this study were not given the option to choose their preferred background music. The lack of autonomy could potentially influence participants' emotional states differently than

what might occur in real-world settings, where individuals have the autonomy to choose their preferred music.

In response to these limitations, it is important to conduct further study in order to have a more comprehensive understanding of this topic. There are two alternative study pathways that researchers could consider for future studies. One potential path is to focus on a more controlled condition, with the aim of gaining a deeper understanding of the Mozart effect. It is recommended that future studies consider aligning the study with participants' actual topics of study. This strategy could help reduce the variability in participants' familiarity with the topic, hence potentially minimising cognitive load. The other path is to focus on the general influence of background music in educational settings. For instance, one approach is to provide participants with the autonomy to choose their preferred background or to incorporate music with different genres. Those implementations have the potential to enhance a more comprehensive understanding of the role of music preferences or specific musical parameters. Furthermore, in order to minimise the social desirability and the risk of inconsistent interpretation of emotional state measurement, using physiological such as heart rate or skin conditions may be advantageous compared to relying solely on self-report measures.

Conclusion

In conclusion, the present study did not yield statistically significant findings regarding the effect of utilising Mozart's music as background music on learners' emotional states, intrinsic motivation, and cognitive performance. As a result, mediation analysis could not be conducted. Furthermore, no statistical correlation was found between participants' music preferences and their emotional states. Despite the results mentioned before, this study contributes to the understanding of the influence of background music in the educational context.

The findings of this study suggest that the choice of study topic can have an impact on learners' emotional states and intrinsic motivation, regardless of the presence or absence of background music. Furthermore, it is crucial to acknowledge that both the task complexity and the presence of background music have the ability to increase cognitive load, which potentially hinders the impact of background music on cognitive performance. Future research should explore these factors to gain a deeper understanding of the relationship between background music and its impact on educational settings.

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Appendices

Appendix A – Flyer and Description

Hi everyone!
My name is Anindita, and I am looking for UT students who would like to participate in my master's thesis.
*See the image for more information

If you are interested, you can book a timeslot via this link:
https://bit.ly/BookTimeSlot
For psychology students, you can register via SONA and get 1.5 SONA credits via this link:
https://bit.ly/TimeSlotSONA
or you can also scan the QR code on the image for both options.

If you do not wish to participate but know other students, I would appreciate it if you forwarded this message to them.
Thank you, and hopefully see you there!

Appendix B – Informed Consent

Informed Consent

Researcher: Anindita Supriyanta (M-PSY)
Supervisor: Dr. H.H. Leemkuil

Purpose of Study:

This study has the purpose of exploring the role of background music for learners in a technology-based learning environment.

Procedures:

Before starting the study, you will be asked to fill out demographic questions and a self-report question about your current condition. This study will be split into two sessions. In each session, you will be encouraged to learn one study topic that will be presented in a technology-based learning environment (TBLE). One study topic will be presented with music through headphones, while the other will be presented without music. In addition, your screen will also be recorded during the experiment. At the end of each session, there will be questions related to the study topic and self-report questions about your learning experience.

Risks and Benefits:

If you decide to participate in this study, you will face only minimal risks. You may feel exhausted as you will have to learn two new topics consecutively. However, each session will also have a rest period to reduce that risk. The potential benefit is that you will gain knowledge about new topics that can be applied to your daily life.

Confidentiality:

All data collected during the study will be kept strictly confidential. Your personal data will be anonymised and securely stored. Only authorised research personnel will have access to the data, and your identity will be kept private in any reports or publications produced as a result of the study.

Contact Information:

If you have any questions or concerns before, during, or after the study, please feel free to contact the researcher, Anindita Supriyanta, at sagefarahnuraninditasupriyanta@student.utwente.nl.

Voluntary Participation:

Your participation in this study is voluntary. You have the right to decide whether or not to take part in this study. If you have agreed to participate, you are still free to withdraw at any time without a reason, and there will be no consequences. Withdrawing from this study will not affect the relationship you have, if any, with the researcher. If you withdraw from this study before data collection is completed, your data will not be used and destroyed.

Consent

By clicking the 'I agree' button, I agree to participate in the study. I have read the provided information about this study, and I acknowledge that I have understood the information provided in this consent form. I have had the opportunity to ask questions, and I have received satisfactory answers. I understand that my participation in this study is voluntary, and I have the right to decline and withdraw at any time without giving a reason and without any consequences.

- ○ I agree
- ○ I do not want to participate in this study

Appendix C – Performance Test Open-Ended Question

Questions for the topic "Cultivating a Growth Mindset."

1. How does a growth mindset differ from a fixed mindset?
2. Julian received his math exam grade and unfortunately failed that exam. Consider Julian's response to failing his math exam with a fixed versus growth mindset! (Please justify your answer)
3. Nora is a student who struggles to write an essay and feels like she will never be good at it. How can you provide feedback to help her cultivate a growth mindset as a teacher? (You can choose one (or more) of the strategies of providing feedback to cultivate a growth mindset and give an example)
4. There are several strategies to cultivate a growth mindset. Can you recall one and give an example of using that strategy?

Questions for the topic "Nonviolent Communication."

1. Can you define Nonviolent Communication and how can it foster healthy relationships?
2. Sarah is living in a shared house with a shared kitchen. One day, she noticed that Tess had been neglecting her dishes for several days in the sink. As a person who values cleanliness and organisation, she feels frustrated. How can Sarah address this situation using Nonviolent Communication? (Please give an example of how to apply each NVC process [Observation, Feeling, Need, Request] in this scenario)
3. Tom and Sofia are in the same group project. However, Sofia has been slacking off and missing group meetings. This has caused a delay in their project. How would Tom react if he is using Life-Alienating Communication and how would he also react using Nonviolent Communication? (Please provide an example of sentences in both situations)
4. Can you give me one situation from your past where you can use Nonviolent Communication to resolve a conflict positively? (Please also give an example of how you can address the conflict using Nonviolent Communication)

Appendix D – Performance Test Rubric

Questions	Score			
	1	2	3	4
Cultivating a Growth Mindset				
How does a growth mindset differ from a fixed mindset?	Fails to explain the concept of both growth and fixed mindset with significant inaccuracies or misconceptions.	Manages to explain the basic idea of growth and fixed mindset without further explanation	Successfully identifies and summarises the main concepts of growth and fixed mindset and highlights their differences.	Clearly identifies and summarises the main concept of growth and fixed mindsets and provides a thorough explanation of their differences with examples.
Julian received his math exam grade and unfortunately failed that exam. Consider Julian's response to failing his math exam with a fixed versus growth mindset! Give both examples, and please justify your answer	Fails to give an example of both growth and fixed mindset in the scenario provided with significant inaccuracies or misconceptions.	Manages to give an example of both growth and fixed mindset but lacks connection with the scenario provided.	Successfully gives an example of both growth and fixed mindset with a connection to the scenario provided but lacks explanation.	Clearly states an example of both growth and fixed mindset related to the scenario provided, followed by a thorough explanation.
Nora is a student who struggles to write an essay and feels like she will never be good at it. How can you provide feedback to help her cultivate a growth mindset as a teacher?	Fails to provide feedback to cultivate a growth mindset, or the strategies used are ineffective.	Manages to suggest a feedback strategy to cultivate a growth mindset but fails to provide an example.	Successfully gives feedback that demonstrates an effective feedback strategy to cultivate a growth mindset with a relevant example.	Clearly uses a comprehensive feedback strategy to cultivate a growth mindset with a relevant example and further guidance for improvement.
There are several strategies to cultivate a growth mindset. Can you recall one and give an example of using that strategy?	Fails to recall/limited recall of a growth mindset strategy and/or provides inaccuracies on the examples.	Identifies the right strategy to provide a growth mindset without an example.	Successfully identifies the right strategy to cultivate a growth mindset and provides a clear example without further explanation.	Clearly identify the right strategy to cultivate a growth mindset. Successfully provides a thorough example with detailed explanations.
Nonviolent Communication				
Can you define Nonviolent Communication and how can it foster healthy relationships?	Fails to explain the concept of Nonviolent Communication with significant inaccuracies or misconceptions.	Manages to explain the basic idea of Nonviolent Communication but does not explain them clearly and lacks clarity.	Successfully identifies and summarises the main idea of Nonviolent Communication.	Clearly identifies and summarises the main concept of Nonviolent Communication and provides additional explanation.
Sean is living in a shared house with a shared kitchen. One day, she noticed that Tess had been neglecting her dishes for several days in the sink. As a person who values cleanliness and organisation, she feels frustrated. How can Sarah address this situation using Nonviolent Communication?	Fails to apply the communication process of Nonviolent Communication with significant inaccuracies or misconceptions.	Manages to apply the communication process of Nonviolent Communication but does not distinguish each process clearly.	Successfully applies the communication process of Nonviolent Communication and provides a clear example by distinguishing each process clearly.	Clearly applies the communication process of Nonviolent Communication with a deep understanding and provides additional explanation of each process.
Tom and Sofia are in the same group project. However, Sofia has been slacking off and missing group meetings. This has caused a delay in their project. How would Tom react if he is using Life-Alienating Communication and how would he also react using Nonviolent Communication?	Fails to give an example of both life-alienating and nonviolent communication, with significant inaccuracies or misconceptions on both examples.	Manages to give an example of both life-alienating and nonviolent communication but contains inaccuracies or misconceptions in either one of the examples.	Successfully gives an example of both life-alienating and nonviolent communication but lacks further explanation.	Clearly states an example of both life-alienating and nonviolent communication provides a further explanation and justification of the answer.

Can you give me one situation from your past where you can use Nonviolent Communication to resolve a conflict positively?	Fails to give an example of a scenario where they can resolve the problem with nonviolent communication.	Manages to give an example of a scenario without further explanation.	Successfully gives an example of a scenario and provides an example of how nonviolent communication can be used to resolve the problem.	Clearly provides an example of a scenario and an example of how nonviolent communication can be used to resolve the problem with further explanation.

Appendix E – Intrinsic Motivation Inventory

For each of the following statements, please indicate how true it was for you when you were learning the topic. Use the following scale: [1 = not at all true, 4 = somewhat true, 7 = very true].

	1	2	3	4	5	6	7
While I was working on the task I was thinking about how much I enjoyed it.	○	○	○	○	○	○	○
I did not feel at all nervous about doing the task.	○	○	○	○	○	○	○
I felt that it was my choice to do the task.	○	○	○	○	○	○	○
I think I am pretty good at this task.	○	○	○	○	○	○	○
I found the task very interesting.	○	○	○	○	○	○	○
I felt tense while doing the task.	○	○	○	○	○	○	○
I think I did pretty well at this activity.	○	○	○	○	○	○	○
Doing the task was fun.	○	○	○	○	○	○	○
I felt relaxed while doing the task.	○	○	○	○	○	○	○
I enjoyed doing the task very much.	○	○	○	○	○	○	○
I didn't really have a choice about doing the task.	○	○	○	○	○	○	○
I am satisfied with my performance at this task.	○	○	○	○	○	○	○
I was anxious while doing the task.	○	○	○	○	○	○	○
I thought the task was very boring.	○	○	○	○	○	○	○
I felt like I was doing what I wanted to do while I was working on the task.	○	○	○	○	○	○	○
I felt pretty skilled at this task.	○	○	○	○	○	○	○
I thought the task was very interesting.	○	○	○	○	○	○	○
I felt pressured while doing the task.	○	○	○	○	○	○	○
I felt like I had to do the task.	○	○	○	○	○	○	○
I would describe the task as very enjoyable.	○	○	○	○	○	○	○
I did the task because I had no choice.	○	○	○	○	○	○	○
After working at this task for awhile, I felt pretty competent.	○	○	○	○	○	○	○

Appendix F – Debrief

Debrief

Thank you for taking part in our study titled *'The effect of emotional states induced by background music on intrinsic motivation and learner performance'*. Now that you have completed your participation in this study, we would like to provide you with a debriefing on the true nature and objectives of the study.

Purpose of the study:

This study aims to investigate how background music that induces certain emotional states can have an effect on learners' intrinsic motivation and performance in technology-based learning environments.

Study Procedures:

Throughout the study, you were asked to learn two different study topics with different conditions. The study involved measuring your emotional states before and after the learning activity to detect any differences between both conditions. In addition, the assessment and self-report are collected to measure the difference in performance and intrinsic motivation.

Confidentiality:

Please be assured that all the data collected during the study will be kept strictly confidential. Any personal information will be anonymised and securely stored. The data will only be accessible to authorised research personnel and will be used solely for this study.

We appreciate your time and dedication and want to thank you for your contribution.

If you have any further questions about the study or would like to withdraw from this study, please feel free to contact Anindita Supriyanta (sagefarahnuraninditasupriyanta@student.utwente.nl). Your data will be deleted and not be used in the analysis if you decide to withdraw after this.

Thank you and I am wishing you the best of luck for your journey! :)

Sincerely,
Anindita Supriyanta