Creating an Engaging Learning Environment for Engineers through the Mozart Effect and Problem Based Learning

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Abstract

Background music is ubiquitous in many everyday settings, and research indicates that it impacts on a wide range of activities, from driving to gambling to consumer behaviour. The 'Mozart Effect' (ME) was originally associated with the temporary enhancement of spatial-temporal reasoning abilities after listening to a piece of music by Mozart. While this premise is widely debated, studies have indicated that listening to music can impact on mood and behaviour. Music can influence a student's level of arousal and enjoyment, thus enhancing academic performance, as compared to silence.

Conscious of the need to motivate learners, engage all learning styles and develop discipline specific skills as well as 'transferable' ("softer"), team, communication and lifelong learning skills' the software module in the penultimate year of an honours engineering degree had been revised. A Problem Based Learning (PBL) approach had been adopted as a suitable pedagogical approach emphasising student centred learning. This proved positive (Donnellan; 2008: 41).

The idea for this collaborative study grew from papers presented by the authors on PBL and ME at the 2008 ICEP conference. Reflecting on what incremental steps could be made to further enhance the learning experience of the engineering learners the idea of a more effective and interesting use of the learning space was considered. Considering that 'learning styles can be affected by a student's educational experience' (Felder, 1988), the idea was mooted of introducing background music to the laboratory sessions to investigate its impact on students' engagement in the sessions. It was hoped to motivate the learners further by developing an emotionally positive learning environment, and thus progressing more than just the delivery mode. This paper outlines the process, taking into account the learning environment and setting, the educational objectives, the background music used, student feed-back, and reports on preliminary findings.

Key words: Problem Based Learning; Mozart Effect; learning environment; background music.

Introduction:

Enquiry based learning approaches are gaining recognition for their effectiveness in improving learning. One such popular approach, Problem Based Learning (PBL), had been adopted in the software module in the penultimate year of an honours engineering degree. This pedagogical approach was selected and positively applied to motivate learners and develop the range of discipline specific and 'transferable ("softer") skills required of modern professional engineers (Donnellan; 2008: 41).

At the 2008 ICEP conference the authors had presented papers on PBL and ME and this collaborative study grew from reflections on how ME could possibly motivate and enhance the learning experience for the above cohort of learners. The possible effects of introducing background music to the 'lab' sessions was considered, to investigate its impact on students' engagement in the sessions. It was believed a more effective and interesting learning space could be created. Conscious that 'learning styles are affected by a student's educational experience' (Felder, 1988) it was hoped to motivate the learners by advancing beyond purely deliver mode, to an emotionally positive learning environment.

Background music (BM) has been defined as 'music intended to be heard but not actively or purposely listened to' (Musselman 1974, in Griffin, 2006). Background music's impact on mood and behaviour has been widely researched in the context of consumer behaviour. . The fact that music effects mood and behaviour is well documented (Clynes, 1983: Hallam, 2006: Hargreaves, 1997) and specific elements of music (tempo, dynamics, mode) contribute to a greater or lesser extent to this behaviour. Lehmann et al state that 'music can express, or better, listeners can identify certain emotions in music … fast music with a strong high spectral component evokes different emotions than does music with different acoustical cues.' (2007: 217).

Griffin states that 'educators should be constantly searching and evaluating the correlation between environmental conditions, classroom facilities and student outcomes' (2006: 5). Citing Leung and Fung 2005, he states that 'lighting, temperature, ventilation noise, decoration and space management should all be considered as arousal stimuli' (ibid).

Studies of music on educational attainment can be divided into two broad categories: the impact of passive listening to music on academic performance and the impact of music instruction on academic achievement (Schellenberg, 2001). This study is concerned with the former, namely the effect of background music on academic performance.

Music, arousal and mood.

A study by Rauscher in 1993, which found temporary enhancement of spatial-temporal reasoning abilities immediately after listening to a piece of music by Mozart, sparked wide-spread interest in the area of musical enhancement of academic performance. While Rauscher's original theory, which became known as the Mozart Effect (ME), was widely challenged, other studies have found that listening to music can effect arousal, mood and preference, which in turn can impact on learning. A study by Hallam (2000) involving over 8,000 children aged 10-11 across 150 primary schools, concluded that positive results in academic tests can be explained by differences in pre-test arousal as a consequence of being exposed to background music.

Hussain *et al* (2001) point out that in studies where a significant ME was found, the comparative conditions of the control group were less stimulating than the music condition. Their study found that test performance was significantly better after listening to Mozart's K448 (a lively allegro), than either listening Abinoni's Adagio (a slow adagio in a minor key) or silence. They cite a number of studies which have shown that arousal can affect performance in cognitive and problem solving tasks; extreme high or low levels of arousal can inhibit performance, whereas moderate levels can enhance performance (Berlyne, 1997; Sarason, 1980), with boredom and negative moods having a detrimental effect on performance (Keoster & Farley, 1982).

Nantais and Schellenberg (1999) set out to examine *preference* as a factor in increasing arousal, therefore having a positive or negative effect on results. The auditory stimuli used were music by Schubert and Mozart, and silence. Their results indicated that students scored significantly better after the music stimulus, but there was no significant difference between the Mozart and the Schubert stimulus. The authors therefore concluded that the ME had nothing to do with the music of Mozart *per se* but could generalize to any enjoyable music of the Classical period or *even to any positive stimulus.* When a story was substituted instead of music there was no significant difference in test scores, however, when the preference of the student was taken into account, scores were significantly higher in the preferred condition that the non-preferred condition. They propose therefore that task performance may be improved by hearing any pleasant auditory stimulus. Conversely, performance may be negatively affected by boring or unpleasant stimuli.

Lehmann et al pose the following question 'what does the music do to entice us to listen to it?' Citing Blood & Zatorre (2001), they offer the response that listening to music elicits a reaction similar to the one we have when eating chocolate or making love. The

scientific explanation offered by the authors is that 'the brain circuitry related to our gratification system is stimulated, causing endogenic substances, such as the neurotransmitter dopamine, to be released. Those systems are vital because they constitute an automatic reward system that reinforces behaviours essential to survival' (2007: 221). Hallam (2001) states that music can be experienced physiologically (e.g. through changes in heart rate); through movement, through mood and emotion; and cognitively, through knowledge and memories (www.thepowerofmusic.co.uk).

Background music:

In most of these studies, the subjects were exposed to music immediately *before* taking a test, and therefore it would not be termed background music. Fewer studies have focused on background music in the academic setting *during* task performance, but there have been some.

Ivanov and Geake (2003) examined for a ME among primary school students in a natural school setting (as opposed to the laboratory conditions of Rauscher's studies). This study differed in a number of ways from previous studies: instead of silence, the control group heard natural background noises and the study took place in a natural setting rather than in a controlled laboratory environment; the music was played before *and during* the administration of the test. The results found that the mean scores in a Paper Folding and Cutting (PFT) test from the Stanford-Binet tests were significantly greater for the music groups than for the control group. Savan (1998) (cited in Griffin, 2006) carried out experiments using mainly the music of Mozart with children with special needs. She found the response to music was marked with the students reporting feeling physically better and showing improved altruistic behaviours in class, and that the physical change resulted in calmer and more positive behaviour. Griffin cites a number of authors who have studied the benefits of music in reducing stress (Fagerlonn, 2005; Knight and Riccard, 2001; Savan, 1998), and concludes 'the results showed drops in systolic and diastolic blood pressure, pulse rate and temperature' (Griffin, 2006, 21).

While the study under discussion for this paper is taking place in an educational setting, it is emulating a work environment through PBL where students take responsibility for their own work-rate and learning and must relate to their peers.

For the purposes of comparison therefore, a study of particular interest in this context is that of Lesiuk (2005) which examines background music in the work-place. The subjects were software systems developers from four software companies, and the study

took place over four months. The authors report that time on task was highest when music was played and that quality of work was lowest with no music. The positive responses from the subjects in this study included:

- BM cuts out distraction
- Immersed in my own work , more productive
- Put me in a positive frame of mind, better mood
- General feeling of well-being
- Energising, especially after lunch
- Calming before a large task, stay focused for longer
- Made time go by faster
- Made me work quicker
- Good for repetitive programming tasks
- Helped my creativity

(Griffin, 2006; 26)

The negative responses related mainly to technical matters that could be rectified such as the same music being played over and over, vocals are distracting, complex music not good for difficult tasks.

Selecting music for this study:

In selecting the background music for this study, consideration of the psychological effects of music were taken into account. Much of the early work done on music and mood was carried out by Hevner (1936) and this work remains very influential today. She reported associations between musical elements, such as fast tempo, loud dynamics, rhythm and register with perceptions of music as happy, merry, graceful etc. Slow, quiet, low register music were reported as sad, dreamy or sentimental (Alpert, M *et al* 2005).

Lehmann *et al* cite a study by Schubert (2003) which develops a model of adjective clusters that are schematically aligned around a circle, which has as its axes, valance (positive and negative reactions to music) and activity (high and low stimulation from music). Music that has high valance is described as 'bright, cheerful, happy, joyous' or 'humorous, light, lyrical, merry, playful' (Lehmann *et al*, 2007: 218). On the other hand music that provokes negative valance and low activity is 'dark, depressing, gloomy, melancholy, mournful, sad, solemn' or 'tragic, yearning' (*ibid*). Certain music can, according to Schubert's scheme, have high activity but low valance; this would be

described as 'agitated, angry, restless, tense' (*ibid*). On the other hand, certain types of music can have a high valance but low activity; this would be described as 'calm delicate, graceful, quiet, relaxed, serene, soothing' (*ibid*). In choosing music for the current study, these parameters were used as a guide. It was considered that music of moderately high valance and activity would be most appropriate.

In relation to preference, Lehmann *et al* state that moderate levels of arousal in music stimulate the highest levels of preference, whereas 'too little and too much arousal lead to lower levels of liking' (2007, 219). The authors also state that 'processing music requires cognitive resources, and when those are already occupied by other processes, we need to reduce arousal by decreasing the cognitive load' (*ibid*). This idea is supported by Griffin who speaks of a 'listening load'. For example, many researchers have found that vocal music is considerably more distractive than instrumental music. Furthermore, narrow dynamic range, repetitive forms and narrow pitch range all resulted in easier processing (Pelletier 2004, in Griffin 2006).

In the study discussed in this paper, the primary objective was to enhance the working/learning environment of the students who were predominately aged 21 to 23. Since musical preference and arousal are important factors, it was decided that the students should have input into the music played. While the initial tracks chosen would be subject to the preferences, experiences and taste of the writers, an effort was made to provide choice in terms of genres. The criteria for music selection were based on the findings of the research literature cited above and were as follows.

1. The music was instrumental (as vocal music produces a 'higher listening load.' (Griffin, 2006)
2. The music was of moderate to high valance and moderate to high activity. Consequently, the music was of a moderate to quick tempo and harmonically familiar (consonant not dissonant), providing a pleasing, moderately arousing auditory stimulus which has been shown to have the most positive effect.
3. The music or musical style would be familiar, but not overly so; e.g. musical associations with advertisements or well known film scores etc. were avoided.
4. A selection of genres was represented including classical (or Western Art), traditional Irish fusion and jazz. Popular music *per se* was not represented, mainly due to the vocal nature of music of this music, and also due to the fact there could be an over-familiarity with some popular pieces which could produce boredom.

5. Student preferences were taken into account. Lesiuk (2005) reports that personal preference is an important factor in mood enhancement and relaxation.

Methodology:

Having developed a plan for the learning environment it was implemented by introducing the music to the laboratory. There were 12 male students, eleven Irish and one non-EU student, aged between 21 and 23 in the sample group. The music was played from one speaker placed on a table. Academic performance was measured by the performance in the PBL assignment performed in the lab and compared to the previous groups on this programme. Attendance was also monitored, as a crude indicator of engagement with the environment. The learners were observed to gauge any effects of the music, but this is obviously subjective on the part of the observer. The students were also provided with a questionnaire for feedback on the music and their opinions about its effect on their working environment.

Initially the learners were exposed to a range of musical styles, rather than their determined preferences. To enable the students give feed-back on their preference for BM while they worked, they heard jazz, traditional Irish fusion, classical and easy listening. Consequently the first CD was an eclectic mix of tracks, ranging from calm and serene (Pachelbel's *Canon*) to dramatic (Verdi's *Dies Irae*) to jazz, contemporary Irish and world music. The second CD featured mainly contemporary music with jazz, film music and Irish traditional fusion, while the third CD was mainly classical.

At this stage the students were given a questionnaire and asked questions about their preferences. These included which condition they preferred; silence, music, or no opinion. When asked if they found BM helped them focus on their work, they predominately selected 'To a mild extent' on a range from 'Very much' to 'It was a distraction'. They were asked which of the genres played during the laboratory sessions they preferred; they could select 'Jazz', 'Traditional Irish fusion', 'Classical (easy listening)' or 'A mix of all of the above'. Preferences were also requested on the issue of loudness or softness, fast or slow, invigorating or relaxing. Requests were also made for music suggestions that could be played during the session (instrumental only).

Some students expressed a preference for jazz, but those individuals were also quite satisfied with the classical pieces. Predominately classical was the clear preferred option, with nobody expressing a dislike for it, whereas some expressed that classical was their only choice, and did not want jazz, etc. Unfortunately the students did not volunteer any

suggested music that could be played during the session, but this may change with future groups if they get more used to the practice from the start of their course. While other studies have indicated that males find music of high valance and activity to be stimulating (Huang et al 2008: 744), this group indicated such music was distracting while they worked and preferred the music of Vivaldi, Mozart and a more 'classical' or easy listening sound. Their preferred music was of moderately quick tempo, mainly for string orchestra, non-vocal and melodic, with predictable harmonic progressions and formal structures. This style of music would be moderately familiar to the group as it is used in many public places, although they may not have any cognitive experience or knowledge of it. This would support the concept of music with a 'lower listening load' being preferable in work settings, and that moderately familiar music is preferred. It is interesting to note that many previous studies use the music of Mozart which was chosen by the researchers, but in this case, the subjects voluntarily chose Mozart or music of a similar style.

Conclusion:

Although the students' feed-back on having BM was positive, the initial study showed no measurable difference in academic performance compared to the previous groups on this programme. While improved learning is the ultimate objective of this study, it is believed future revisions, discussed below, could have a positive impact and that it is worth pursuing for the benefit of future learners. The lack of an academic difference may be as a consequence of issues such as the period the learners were exposed to the full range of music, rather than their determined preferences. Through the experience and knowledge gained from the work discussed in this paper it is believed future learners should be exposed from the start to selections that were more appealing to the previous groups (which will be similar in age); but it will be vital to continually monitor this as cultural, ethnic or other differences may impact on preference. Furthermore, programme revisions, that have resulted in more group and active learning based activities, may result in learners being more exposed to experiences which are not the traditional "chalk and talk" environments, and so they may influence the experience for future students. In future it is planned to determine the learners response to the music using the Profile of Mood States (POMS) (McNair, Lorr & Droppleman, 1992) arousal scale, or some similar measure, in order to analyse more accurately the effects of the pieces on the learners.

There was also no obvious difference in attendance, which may have indicated greater engagement with the environment, but this may also have been influenced as above.

Possible improvements and other refinements, such as making the music available at each workbench rather than from one speaker (as was this case in this study) are worth examining, as any improvements that enhance engagement with the learning environment would be welcomed by all practitioners. Furthermore, while feedback was obtained during the study, no feed-back was obtained from the students on completion of the study which might have provided information on distraction levels or negative issues relating to the delivery of the music.

Lesiuk's study (2005) compares the work rates of the workers in conditions with and without music. This is done through observation, through feed-back from the workers, through questionnaires, and from a comparison of their work output during the two conditions. In developing this study further, these factors might be considered in the methodology to establish if there is a distinguishable difference in work or study behaviour in the two conditions; and to ascertain if students found it to be of any personal benefit to them in their study.

Hallam and Price (2002), in a study of 10-12 year olds listening to BM, found that while accuracy in maths was only marginally improved, BM had significantly improved work-rate and altruistic behaviour. In the study under discussion for this paper, the measurable outcomes used were results in project work and attendance which did not reveal any significant results. Future work in this area might (through observation) also examine work-rate, communication skills and team-work which are also significant objectives in the PBL setting. The initial student feed-back from the students to BM in the PBL setting was positive, although they felt that it impacted on their work only 'to a mild degree'. It has provided information on the type of music that they liked to listen to while working, and will be a useful starting point for further groups. The authors consider that the information gained and methodology explored in this study will enable a more cohesive approach for future groups. While the experiment is still at an exploratory stage, it is considered from the findings that it is worth investigating further whether music in the learning environment can contribute to an emotionally positive learning experience.

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