

Musical Training and Achievement in Chemistry – Is There a Link?

Annette Coppini

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Faculty of Education at the University of Malta
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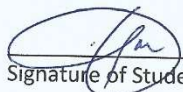
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Abstract

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Musical Training and Achievement in Chemistry – Is There a Link?

The main aim of this study was to investigate whether there is a link between musical training and academic achievement in chemistry, by using a mixed methods design. Chemistry students in Year 10 secondary and in post-secondary schools in state, church and independent sector were asked to complete a questionnaire. Undergraduates, post-graduates and alumni of the Department of Chemistry were also invited to complete a questionnaire. Additionally, four chemistry graduates with a strong background in music were interviewed. The 163 responses obtained from secondary school chemistry students in Year 10 and the 257 replies obtained from post-secondary school students studying chemistry were analysed quantitatively to investigate the research questions posed at the start of the study. The replies of chemistry undergraduates, postgraduates and alumni together with the interview data, were used to support and extend the quantitative findings. The effect of time spent studying chemistry at home, gender, parental education, motivation, instrument choice, age at which tuition commences, time spent practising music and certain character traits were examined. Overall, the results obtained indicate that there seems to be a link between music training and academic achievement in chemistry.

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Dedication

To Luca and Mia,
for all the things you make me wonder about.

To Claudio,
thank you for making me laugh, even when I did not feel like laughing.

You are my world.

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List of Abbreviations

Secondary Education Certificate	SEC
Advanced level	A-level
Faculty Research Ethics Committee	FREC
Chemistry Students who Still Study Music	CS-SSM
Chemistry Students who Used to Study Music	CS-USM
Chemistry Students who Never Studied Music	CS-NSM

CHAPTER 1

INTRODUCTION

1 Introduction

1.1 Introduction

My two children, like most other pairs of siblings, are very different from each other and yet there are two things that they are equally good at. They both excel at mathematics and music studies. This aspect caught my attention one morning, whilst they were doing their homework. I was intrigued about this and wondered whether this could be more than just a coincidence.

My musings continued and were diverted towards chemistry. I wondered whether this disposition towards mathematics would lead them to studying chemistry and whether the ease with which they carried out their work in music would translate to a similar ease in the completion of work related to other academic subjects. Did music training facilitate the uptake of knowledge of other academic subjects, or was the link between music and mathematics simply due to similarities between the subjects? I was even more intrigued by this since I myself am a musically trained chemistry graduate.

1.2 Current situation

The studies carried out in this area gained importance at the time that the Mozart effect was discovered. "The finding that listening to music composed by Mozart leads to improvements in spatial abilities generated widespread interest among the media, policy makers, and the general public" (Schellenberg & Hallam, 2005, p. 202). Research in this area has focused around measurements of specific task performance (Schellenberg & Hallam, 2005; Črnčec, Wilson & Prior, 2006; Bergman Nutley, Darki & Klingberg, 2014), comparison of past and current academic results (Cabanac, Perlovsky, Bonniot-Cabanac & Cabanac, 2013, Cox & Stephens, 2004; dos Santos-Luiz, Monico, Almeida & Coimbra, 2016; Fitzpatrick,

2006; Gouzouasis, Guhn, & Kishor, 2007; Kinney, 2008; Morrison, 1994), and behavioural and personality changes through music training (Corrigall, Schellenberg & Misura, 2013). Naturally, scepticism about the results obtained by previous authors remained (Costa Giomi, 2015).

Three areas in the published literature seemed to have been left unexplored:

- The qualitative aspect – most of the studies carried out internationally omitted the participants' voice. Consequently, mixed methods studies were also absent.
- The link between music training and chemistry – whilst most studies examined the relationship between music training and languages, and music training and mathematics, links to other academic subjects were largely ignored.
- The local perspective – data about the Maltese population with regards to this field of research were absent. There was no knowledge as to whether the links seen in other countries between music training and academic achievement were present in the Maltese population as well.

1.3 Aim of the study

The personal interest and the literature in the area led to the formulation of the research questions:

- Is there a link between music training and academic achievement in chemistry?

This research question was answered through the following three sub-questions:

- What proportion/percentage of chemistry students at SEC (Secondary Education Certificate), Advanced-level (A-level) and undergraduate/postgraduate level also study/have studied music?

- Will the percentage change on going to a higher level?
- Is there a link between music training (instrument practised, length of course, age at which tuition starts) and achievement in chemistry?

1.4 The relevance of this study

Primarily, the study set out to gather information about certain parts of the Maltese population, particularly chemistry students in Year 10 secondary education, post-secondary education, and undergraduate and postgraduate level. The aim was to understand whether the results obtained locally would concur with or differ from those obtained in other countries.

Ultimately, learning about the effect of music tuition on academic achievement might highlight possible mental processes or other factors that can be strengthened in order to make chemistry more accessible to all the students in Malta. It also serves to identify areas where further research may be necessary.

1.5 Research methodology used

The main data-gathering tool used in this study was a questionnaire. This questionnaire was available in three, almost-identical formats. The first format was written for Year 10 chemistry students in state, church, and independent schools (Appendix 1). The second, available in paper format and online, was circulated among post-secondary school students who were studying chemistry, in all three sectors (Appendix 2 and 3). The third questionnaire was sent electronically to undergraduate and postgraduate students studying chemistry at the University of Malta (Appendix 4). This questionnaire was also distributed

among alumni of the Department of Chemistry. All three versions of the questionnaire consisted of several close-ended questions, as well as some open-ended questions.

The questionnaire data were supported by the findings obtained from four interviews. The interviewees were chosen to be graduates of the Department of Chemistry with a strong background in music.

1.6 Structure of the dissertation

Following this introductory chapter, the literature review describes the work done in this field by other researchers. It includes an account of the parameters that are of interest, the mechanisms proposed for the results achieved, as well as the effect that other variables are thought to have on these same results. This chapter also tackles in more detail the areas that lend themselves to further research and the main issues present in this field.

Chapter 3 gives a detailed account of the research tools utilised, research ethics, the sampling scheme followed, and details of the method used to process and analyse the data obtained.

Chapter 4 presents the data obtained by means of the questionnaires and the interviews, whilst Chapter 5 links these results with the themes displayed in the literature review section. Chapter 6 presents the summary of results, the implications of the study, the strengths and limitations of this study, and recommendations for further work.

1.7 Conclusion

This chapter presented the origin of the questions that this study aimed to answer. It presented the research questions in detail and the relevance of the study. This chapter also

detailed the methodology that was used and the structure of the dissertation. The next chapter will discuss the international literature concerning this field of research.

CHAPTER 2

LITERATURE REVIEW

2 Literature Review

2.1 Positive effects of music

The positive effects of music are far reaching and transcultural. Music has non-academic benefits on the body and the mind. It is used to relax, or conversely, energise the body, calm the mind, alter moods amongst other things. Perlovsky, Cabanac, Bonniot-Cabanac and Cabanac (2013) even go so far as to state that music is possibly vital for the entire human evolution.

From a physiological perspective, Ayoub, Rizk, Yaacoub, Gaal and Kain (2005) claim that the pain medication required during minor urological surgery with spinal anaesthesia was less for patients listening to music during the procedure as compared to patients listening either to operating room noise or white noise.

Of course, music is not the only stimulus to have positive effects on a person's emotional or physiological state, however it is much less invasive and obtrusive than other options, such as medication. In general, supporters of music education proclaim that through musical training, students will experience systematic and reliable improvements in other, unrelated non-musical areas of their education.

The cognitive and behavioural benefits obtained after *listening* to music, and those achieved after *practising* (or learning) music must be differentiated. Whilst the former gives rise to short-term benefits, it is thought that the latter might impart long-term cognitive benefits.

2.1.1 *Listening to music*

The Mozart effect – the discovery that listening to Mozart's sonata for two pianos in D major, K488 led to improvements in spatial abilities – was reported by Rauscher, Shaw and

Ky in 1993. The article generated widespread interest in the media, after the authors claimed that participants that had listened to Mozart's K488 for ten minutes demonstrated higher scores in standard IQ spatial reasoning tasks than two other groups, who were either listening to relaxing music or were sitting in silence, respectively.

The finding left the scientific community uninterested since the mechanism said to be driving this effect verged on the miraculous. It is not surprising therefore that replication of the Mozart effect in other laboratories or settings was erratic. The interpretation given by the original researchers (Rauscher et al., 1993) might have been incorrect, but the effect itself was real – some researchers did manage to reproduce the findings.

In 1993, Schellenberg and his colleagues (Thompson, Schellenberg, & Hussain, 2001) took up one of the areas for further work suggested by Rauscher et al., 1993, and refined the original 'miraculous' mechanism by proposing a separate hypothesis, called the "arousal-and-mood hypothesis". Here, the authors argue that enhancement of a variety of cognitive abilities can occur by listening to music other than Mozart's K488 sonata – if the listener's mood and arousal levels are improved, the performance in cognitive tasks will be enhanced. Participants listened to an up-beat piece by Mozart in a major key, or to a more sombre piece by Albinoni in a minor key. Arousal and mood were higher after listening to Mozart than after listening to Albinoni, leading to proportionate variances in the spatial tests administered to the two groups.

During the following years, more work was carried out on the arousal-and-mood hypothesis. Schellenberg and Hallam (2005) revisited data gathered by Hallam for a previous study carried out in 1996. A group of 8,120 children aged between 10 and 11 years were split into three groups, listening to either popular music, classical music (Mozart's String Quintet in D

major, K593) or an interview, on three separate radio stations. They were subsequently given two sets of spatial ability tests. The results showed that those listening to popular music performed better in one of the tasks, whilst the results for all three groups were the same for the second task. The authors therefore concluded that it is the mood, not music itself, which enhances a subject's performance.

A different mechanism was proposed by Perlovsky et al., 2013. The authors hypothesized that listening to music helps the listener overcome cognitive dissonance in stressful conditions. This in turn enables the listener to sit in a test with unfavourable conditions for longer and even perform better during the test. In a related article (Cabanac et al., 2013), the authors extend this work to encompass the concept of music being necessary for accumulating knowledge and therefore being essential for the evolution of humans.

Neurologically, MRI procedures confirm that a very interesting phenomenon is taking place - images of the brains of subjects who listen to music whilst undergoing such a procedure light up vividly (Winter, 2016).

Alas the effects of simply listening to music, although fascinating, are brief - Rauscher et al., 1993, give a time span of 10-15 minutes. They propose that listening to music for longer or listening to other composers might extend this effect to a certain extent, however the Mozart effect remains fleeting and thus quite inconsequential.

2.1.2 Learning music

If listening to music grants limited and restricted benefits, then the opposite can be said about the reported benefits of *studying* music.

Researchers have sought evidence of transfer of skills learned through music to seemingly unrelated tasks and previously untrained skills in the academic domain. Music skills develop

listening skills, which in turn have a profound effect on the perception of language. This then bears on reading, possibly mediated by different abilities in rhythmic performance. Unsurprisingly therefore, transfer effects have been claimed in literacy (Douglas & Willatts, 1994), reading ability (Moreno, Marques, Santos, Castro & Besson, 2009) listening skills (Hirt-Mannheimer, 1995), remembering lists of prose (Jakobson, Lewycky, Kilgour, & Stoesz, 2008) and words (Brandler & Rammsayer, 2003), vocabulary and sequencing of verbal information (Piro & Ortiz, 2009; Hirt-Mannheimer, 1995), short-term memory (Tierney, Bergeson, & Pisoni, 2008), spatial reasoning (Sluming, Brooks, Howard, Downes, & Roberts, 2007), working memory (Franklin, Sledge Moore, Yip, Jonides, Rattray & Moher, 2008), mathematics (Bahr & Christensen, 2000), general intelligence, academic achievement and neurological development (Costa-Giomi, 2015) and non-verbal abilities (Forgeard, Winner, Norton, & Schlaug, 2008). Incidentally, the improvements in these cognitive domains seem to be more apparent when music instruction starts before the age of seven years and can be seen to operate via near- and far-transfer effects (Rauscher & Hinton, 2011).

2.1.2.1 What was measured

Hurwitz, Wolff, Bortnick and Kokas (1975) carried out one of the first studies to investigate the role of music in shaping children's intellectual development. In this quasi-experimental study, children in first grade were placed in two groups – the first group was given Kodaly lessons every day for seven months, whilst the second group received no instruction. The Kodaly method uses techniques that are aimed at very young children and teaches musical skills and concepts. At the end of the study, the students in the music group scored significantly higher in four out of five spatial tasks and three out of five sequencing tasks.

The music group had also higher reading measures (differences which were still discernible after two years), although no differences were recorded in verbal measures.

In 1997, Rauscher, Shaw, Levine, Wright, Dennis and Newcomb carried out another study to study changes in spatial reasoning abilities. Preschool children were studied, pre- and post-training in piano keyboard lessons, computer lessons or other controls. The piano keyboard group showed significant improvement in the spatial-temporal test, but no group showed a significant improvement in spatial recognition tests. This led the authors to conclude that this change might enhance the students' learning of academic subjects such as science and mathematics, since these subjects require extensive use of spatial-temporal reasoning.

By 1999, researchers were subjecting the participants to standard intelligence tests, in part or wholly (Bilhartz, Bruhn, & Olsen, 1999). In this work, the authors introduce the possible influence of confounding factors, such as gender, economic background, maternal and paternal education and ethnicity.

Schellenberg (2004) presents one of the most interesting pieces of research in this regard.

The author investigates whether receiving lessons in music confers non-musical benefits.

One hundred and forty-four 6-year olds were administered the complete Wechsler

Intelligence Scale for Children-III (WISC-III) IQ test at the age of 6, before entering first

grade. They were then divided into four groups – two of these groups received 36 weeks of keyboard or voice instruction. The other two groups received drama lessons or no lessons.

The same WISC-III test was then repeated when the participants were seven years old,

between first and second grade. The results showed that all four groups showed increases in

IQ, an effect that the author claims is known as being a consequence of attending school.

The increases in IQ, however, were higher for the two music groups, and occurred across all four of the main areas measured by the WISC-III.

In another study looking at IQ, Schellenberg (2006) uses a group of 147 children and 150 undergraduates to test whether the amount of time spent practising music was proportional to the cognitive benefits accrued. The author found a modest but positive association between the number of months of music lessons and the results of the WISC-III test results, even when parents' education, family income and involvement in non-musical activities were kept constant. A similar positive correlation was seen in undergraduates, between the number of years spent practising music and the increases in IQ, this time administered via the Wechsler Adult Intelligence Scale-III (WAIS-III). The correlation was more modest than for the children's group, but still statistically significant, even when accounting for parents' education and family income. By means of these data, the author comes to four conclusions about how intellectual abilities are affected by musical training: he says that these are "(a) larger with longer periods of training, (b) long lasting, (c) not attributable to obvious confounding variables, and (d) distinct from those of non-musical out-of-school activities" (p. 319).

Success in the academic context is not solely dependent on IQ however and around 2006, attention turned from IQ testing to other areas which are thought to be central to academic success. Schellenberg (2006) finds that music lessons are still correlated to high academic achievement, even when IQ is kept constant. This means that the differences between musically-trained and non-musically trained students might exist in non-cognitive areas, or in cognitive areas not related to IQ (Corrigall, Schellenberg, & Misura, 2013). This implies that other determining factors are at play, hence the studies on executive function (Moreno

et al., 2009), motivation (dos Santos-Luiz, Monico, Almeida, & Coimbra, 2016), and the “Big Five” personality dimensions (Corrigan, Schellenberg, & Misura, 2013).

Corrigan et al., (2013) carried out a study to determine whether the main differences in personality between individuals is affected by the study of music. The authors acknowledge the large body of research which studies the link between music and cognitive skills. Such associations are reflected in listening abilities, speech, motor skills and others. The aim of this research, however, was to look at associations with what they call the “far – rather than near - transfer effects” (p. 1), defined as those non-musical cognitive abilities that do not depend on speech perception or analytical listening skills. In particular, the work looks at the effects of conscientiousness and openness-to-experience as facilitators to learning a musical instrument which is in turn linked to cognitive abilities. The authors carried out two studies: one was on undergraduates and the other was on 10- to 12-year-old children, both groups having varying amount of music training. The authors conclude that those students who are open to learning and experiencing new things will choose to take up a musical instrument. They achieve high grades at school because they also tend to have high IQ's, work hard and are self-disciplined. The authors conclude with a stark word of warning against overestimating the role of music training and underestimating the effect of personality differences on the beneficial effects on cognitive functions.

Fitzpatrick (2006) as well studied academic achievement, this time accounting for students' different socio-economic backgrounds. The author compared the Ohio Proficiency Test results for students who studied music and those who did not, in fourth-, sixth- and ninth-grade. Keeping socio-economic status constant, students who practised a musical instrument

outperformed students who did not practice a musical instrument in reading, citizenship, science and maths, at every grade level.

Student motivation became the interest of other research teams. In the work by dos Santos-Luiz, Monico, Almeida and Coimbra (2016), the authors acknowledge that there is a relationship between academic performance and socio-economic status, prior academic achievement, intelligence, and motivation. They also acknowledge however that proof of the influence of musical training on academic achievement is less strong. They studied a cohort of 207 students cross-sectionally (seventh and ninth grades) and longitudinally (from seventh to ninth grades). The cross-sectional results for the seventh- and the ninth-grade students indicate that music students perform better academically than their non-music peers. Music training was statistically positively associated with academic achievement in both grade years, even after controlling for intelligence, motivation and socio-economic status. The results of the longitudinal study show that music students retain their academic achievement on going to ninth grade, when motivation, socio-economic status and intelligence were controlled. On the other hand, academic achievement for non-music students dropped significantly on going from seventh- to ninth grade.

There is very little mention in literature of the effect of studying music on academic achievement in chemistry. Whilst changes in achievement in English and mathematics are often mentioned in literature, Cabanac et al., (2013) documented what is possibly the only piece of research that specifically discusses changes in chemistry grades as influenced by musical training. Students enrolled in the third, fourth and fifth years in the *International Baccalaureate* program were followed in this cross-sectional study. For each year group, the academic results of the musically trained students were higher than that of the non-

musically trained students, with the greatest difference being registered in mathematics. Chemistry only makes an appearance in the fifth year – the third and fourth year have an entry for science. By means of these results, the authors once again confirm a link between music training and an improvement in academic results. They suggest, possibly too hastily, that this is due to the students' ability to overcome (at least in part) cognitive dissonance caused by the contradictory knowledge presented to them at school.

Chemistry consists of several abstract concepts and mathematical computations. As such, prowess in either or both elements will strengthen a student's performance in chemistry. The assumption that there is a strong link between mathematics and music has existed for a long time (Hallam, 2010), however some researchers believe that transfer effects are seen only when the skills are 'near' rather than 'far'. Results in this area are contradictory, however there is a very strong indication that mathematical performance is improved by means of musical training, although the various factors affecting this relationship are still unknown. Consequently, an improved performance in chemistry might be observed.

If music helps students academically, how long is it after the commencement of music tuition that these differences start becoming clear? Perhaps unsurprisingly (although it would be wrong to assume this), another study shows that the greatest difference in grades between musically trained and non-musically trained students is seen in participants with longer recorded time spans of music study (Corrigall, Schellenberg, & Misura, 2013). This was refuted by Costa-Giomi (2015) who claimed that benefits level off and become inconsequential after some time learning music. What seems clear however is that the large number of different areas that music training is positively associated with implies that many cognitive domains are being tapped into (Corrigall et al., 2013).

Interestingly, Rauscher and Hinton (2011) claim that the type of instrument played has different types of effects on a subject's perceptual discrimination. Hence, string players and percussion players will both gain a perceptual advantage over non-musicians, albeit in different areas. This might explain the large variation in findings by other researchers, some of which report great differences in academic achievement occurring in language and science (dos Santos-Luiz et al., 2016), and verbal tests (Moreno et al., 2009) whilst others (Bergman Nutley, Darki & Klingberg, 2014) report a positive association with mathematics and visuo-spatial working memory, verbal working memory, processing speed and reasoning ability but not with reading comprehension.

It is unclear how long the effect of learning music lasts. Some researchers (Rauscher et al., 1997) found spatial-temporal benefits – but not spatial recognition - to last for at least one day, which is considered long-term. Hurwitz et al., (1975), and Rauscher & Hinton (2011) recorded benefits lasting two years after discontinuation of music lessons.

2.2 Possible reasons affecting outcome

In order to arrive at a decision as to whether the benefits in academic achievement stem from music, researchers have studied various variables that have been associated with academic achievement, such as intelligence (Babo, 2004), socio-economic status (Babo, 2004; Fitzpatrick, 2006; Hille & Schupp, 2015; Kinney 2008; Schellenberg, 2006), cognitive stimulation within the family (Hille & Schupp, 2015), home environment or family structure (Hille & Schupp, 2015; Kinney 2008), type of musical instruction (Kinney, 2008), quality of musical instruction (Johnson & Memmott, 2006), gender (Babo, 2004; Hille & Schupp, 2015; Schellenberg, 2006), prior academic achievement (Fitzpatrick, 2006; Kinney, 2008), parents' personality (Hille & Schupp, 2015) and children's personality (Corrigall et al., 2013), and

participation in additional non-musical extracurricular activities (Schellenberg, 2006). A few of the more prominent factors are reviewed in Section 2.2.1 to 2.2.5.

2.2.1 Prior academic achievement

A number of studies have concluded that music instruction seems to attract students with higher academic orientation (Fitzpatrick, 2006; Corrigan et al., 2013; Kinney 2008). In Fitzpatrick's study, students from fourth-grade just about to start their musical training, already had higher grades than their non-enrolled counterparts. Kinney (2008) also concluded that playing in a band (as opposed to choir or none) attracted higher-achieving students from the start. If this is the case, then it can possibly be said that intelligence is a predictor of participation in music programs, rather than the other way round.

2.2.2 Brain changes

Performing and learning music is a notable exercise for the brain because this activity strengthens the synapses between brain cells. Through music, a variety of functional brain systems are engaged, such as planning movements, learning memory, the perceptual, sensory and the cognitive systems, and feedback and evaluation of actions. In short, playing music is an excellent exercise for the brain (Weinberger, 1998).

Learning an instrument is a multisensory motor experience, involving the decoding of a musical score, relating this to a motor activity and adjusting according to multisensory feedback. It is probably not surprising then that professional keyboard players are seen to have significantly more grey matter in their brains than amateur players (Schlaug, Norton, Overy, & Winner, 2005). The authors carried out cross-sectional testing of a group of nine-

to eleven-year olds who had an average of four years of music training against a group of students who had no musical training. The authors found that the children who studied music had significantly more grey matter volume. Additionally, the music group performed significantly better on a battery of tests and the authors noted that transfer effects had started to emerge in addition to stronger evidence of motor and auditory gains.

The creation of music activates the neurons in the corpus callosum – the connection between the two hemispheres of the brain – thus optimising communication between the two hemispheres (Winter, 2016). Groussard, La Joie, Rauchs, Landeau, Chetelat, Viader, Desgranges, Eustache and Platel (2010) examined the effect of musical training on brain function by means of functional magnetic resonance imaging during long-term memory retrieval. The density of grey matter in the hippocampus was higher for musicians than for non-musicians. Additionally, the authors conclude that musical training changes long-term memory processes and causes functional and structural plasticity in the hippocampus.

The study of the effect of music on the brain is admittedly fascinating. It is however, considered to be beyond the scope of this study and hence further knowledge will not be pursued here.

2.2.3 Executive function, personality and motivation

Winter (2016) quotes Schellenberg's work on executive function as being an important factor in academic achievement. A link between music and higher-level performance was being sought and it was thought that the missing link could be executive function. This is understandable since music training requires high levels of control, attention and memorization (Moreno et al., 2009). The results however showed that, although higher IQs

were linked to better performance on the executive function tests, executive function was not the link between musical training and IQ.

Winter (2016) mentions Angela Duckworth's work on grit and believes that this character feature is as important to success in life as IQ or talent, if not more. She states that she feels "confident hypothesizing that there would be a strong positive correlation between musical study and grit and likely causation as well" (p. 17).

Corrigall et al., (2013) state that the best way to tell whether a child will study music is to look at his/her openness to experiences, whilst conscientiousness can be used to predict how long the student will study music for, and whether they will do well academically. This plausible conclusion moves away from the restrictive dialogue of IQ testing and implies other personality characteristics in the relationship between music and academic achievement.

In his work entitled 'Music and Cognitive Abilities' (2005), Schellenberg postulates that music bolsters academic achievement for the simple reason that music lessons are structured similarly to school lessons which students find enjoyable. Whilst this might be one of the reasons, it would be wrong to assume that all music lessons – especially those used in different levels and in the different countries reported in literature - are structured like a regular class lesson.

Other mechanisms are suggested by the same author, such as the similarity between learning music and acquiring a second language or an improvement in abstract reasoning. A more plausible mechanism links music lessons to a variety of synergetic skills, like an increased level of focus and concentration, fine-motor skills, memorization and others.

Certain factors, such as the teaching method and the instrument played, might be significant.

One other factor influencing academic achievement in students is motivation. Motivation is an aid to the two other predictors of academic success, such as prior grades and standardized achievement (Casillas, Robbins, Allen, Kuo, Hanson & Schmeiser, 2012). For this reason, motivation was included as a covariate in the study by dos Santos-Luiz et al., (2016). These researchers found a correlation between motivation and academic performance. Hallam (2005) also mentions motivation as the crucial factor that determines how well children do at school. Motivation, being linked to aspirations, self-efficacy and ability, might be intensified if involvement in music increases positive perceptions of self. This variable might explain why there is conflicting evidence regarding general attainment for music students.

2.2.4 Socio-economic background

Perhaps unsurprisingly, students who were enrolled in music lessons had better-educated parents (Schellenberg as in Winter, 2016; Corrigan et al, 2013). Nonetheless, as per Schellenberg referenced in Winter (2016), there was a positive correlation between the number of months spent studying music and results of the IQ tests carried out, even when family income and education were accounted for.

A family's socio-economic status has a strong influence on academic performance in mathematics and reading, stronger than the influence observed when enrolling in an instrumental music program (Babo, 2004; dos-Santos Luiz et al., 2016). However, the cognitive benefits to children coming from impoverished backgrounds are even more substantial (Rauscher & Hinton, 2011).

2.2.5 Lack of difference in achievement

Other pieces of research have yielded results in which the link between music and increased academic achievement and cognitive abilities is not reliably detectable.

Schlaug et al., 2005 tested two groups of children: a group of five- to seven-year old children and a group of nine- to eleven- year olds. Whilst promising results were seen in the latter group (who had undergone four years of musical training), no significant effects were seen in the former group, who had been given one year of piano or string instrument training.

Similarly, Costa-Giomi's work (1999) throws doubt on the claims of increased cognitive and musical abilities, motor proficiency, self-esteem and academic achievement for those learning to play an instrument. Sixty-three children were given piano lessons from fourth to sixth grade, whilst fifty-four were not. Although the children's general and spatial cognitive development was affected, the size of such effects was small, even after three years of music lessons. Additionally, no advantages at all could be detected seven years after the lessons were stopped.

The seemingly contradictory results seen across the literature could be explained if the large number of variables that are at play are considered. Costa-Giomi (2015) tries to explain these differences by viewing the reported results through the angle of mediating variables. Starting from the students' background, their own personal interest in music lessons, the time they have at their disposal to attend lessons and practice, as well as the family's structure and interests, amongst others, will have an effect on the outcome of research looking at changes that occur as mediated by music. Length of music training and the age at which such training started (Schellenberg, 2006) and the instrument played might also be mediating factors.

2.3 Areas for further research/Issues

2.3.1 *Lack of causation*

The main caveat in a large majority of the papers listed in this review is the lack of identification of causation of any of the transfer effects reported. This is understandable, considering how intricately intertwined many variables are. Most studies are by necessity correlational in nature and causality might be difficult to prove. In fact, only a few of the works reviewed have claimed to have shown causation (Hurwitz et al., 1975; Bilhartz et al., 1999; Rauscher et al., 1997; Schellenberg 2004).

A quasi-experimental design necessitates that the children participating in the study are sent to music lessons and given music instruments for practising at home, at no extra cost to the family. This obviously requires a sizeable fund (Corrigall et al., 2013) and even then, the participants would be influenced by several of the pre-existing variables, such as demographic and pre-existing cognitive differences.

2.3.2 *Lack of long-term longitudinal studies*

A number of longitudinal studies have been made, but the time period of such studies is typically less than one year (Costa-Giomi, 2015). Although they have consistently shown the positive effects of music instruction over several months on specific as well as general cognitive abilities in children, little is known about the effects of music training due to longer periods of music instruction. Interestingly, such longer longitudinal studies could shed some light on whether the cognitive improvements gained in the short-term remain present after stopping music lessons.

2.3.3 Lack of mixed methods research

Another interesting possible area of research is the field of mixed methods. Most papers deal with IQ testing and other psychological tests, as well as assessing the improvement in school grades from one scholastic year to the next. No papers have been reviewed whereby a mixed methods approach has been taken. Cabanac et al., 2013 come closest to this when, as part of a survey, students are asked why they left music. This is however far from a proper interview that can uncover specific themes that can help to shed light on the subject.

2.3.4 Others

There is stark lack of uniformity across the literature regarding the format and quality of the music lessons that the participants undertook. At times, lessons were done at school and in a group, whilst in other articles the lessons were individual, after-school sessions. In one study, participation in choir practice also made the student eligible for the 'music' group (Cox & Stephens, 2006). This variation is especially troubling considering the findings in Bergman et al., 2014, indicating that the number of hours spent practising per week had a significant effect on the outcomes measured for visuo-spatial working memory, verbal working memory and a trend for reasoning ability.

Even in a quasi-experimental study, an important part of the students' lives remains outside the control of the researchers. In the review of Schellenberg's work by Corrigan et al., 2013, whereby young students were assigned to receive either one year of music lessons, drama lessons or no lessons, the authors comment that, even though the greatest IQ changes were seen in students who were following the music group, the amount of practice time at home for this group was much less than if the parents had to pay for the music lessons.

2.4 Conclusion

This literature review has presented the origin of the interest in the possible link between music and academic achievement. The tools used to measure cognitive and personality changes in participants before and after music training were described. It is not possible to separate the results obtained from the effects of other variables that the participants are in contact with, therefore the main variables have been identified and described. This chapter also presented areas which have not yet been well researched.

The next chapter, Methodology, describes the research tools and procedures used to investigate any possible links between music training and academic achievement in chemistry, in Malta.

CHAPTER 3

METHODOLOGY

3 Methodology

3.1 Introduction

The aims of this study were to obtain data about the percentage of chemistry students at SEC, A-level, and undergraduate and postgraduate level who study or have studied music. Through these data, the changes in percentages of chemistry students who are studying or have studied music on going to a higher level can be examined. Finally, the possible existence of a link between music training and achievement in chemistry can be explored.

3.2 Strategy employed

Qualitative and quantitative methodologies are at times viewed as opposites, with fixed delineations. It is more productive to think of them as sitting on the opposite ends of a methodology continuum; hence a study will lean towards a qualitative or a quantitative methodology. A mixed methods study will reside somewhere along the middle of such a continuum. Applying this methodology to the research questions of this study, both quantitative and qualitative data were collected and then integrated, to yield an understanding which is deeper than either method can provide.

The lack of local data on this topic necessitated the collection of many responses, to be able to obtain a picture of the population. This study used an explanatory sequential design due to the strong quantitative element required to address the research questions. This study therefore made use primarily of data collection by means of a questionnaire containing 18 questions. This was followed by qualitative data collection: a small number of interviews were carried out with chemistry graduates who had extensive musical training. The

interview questions (Appendix 5) explored areas that were not best done by means of a questionnaire.

3.2.1 *The questionnaire*

3.2.1.1 *Strengths and limitations*

The questionnaire's main advantage is that it can reach a large number of respondents in the target population. The data is rapidly collected because the researcher does not need to be present when the questionnaire is being administered.

Another powerful feature of a questionnaire is the anonymity it provides; hence, the participant may feel more comfortable giving truthful replies (Bell, 2006). The anonymity of the participants was safeguarded throughout the process. The questionnaires, once completed, could not be traced back to the participant. This was true even of the questionnaires completed online, since no details about the participants was collected.

Questionnaires are subject to low response rates and this was a problem experienced in this study as well, except for post-secondary schools where more than the targeted number of responses were received. In order to obtain sufficient replies, additional schools were asked to participate in the study until the number of completed responses was close to the targeted value.

The number of responses from undergraduates, postgraduates and alumni was also very low. The link to the online questionnaire is sent by the Registrar's office and therefore, no reminders could be sent to this group of participants. In an attempt to increase the number of responses obtained from undergraduates, lecturers were asked to remind students about the questionnaire.

Even when responses are received, the researcher has no control over how the questions had been understood, how many questions had been answered hurriedly or had been left unanswered (Dawson, 2009). The pilot study (Section 3.3.1.1.1) carried out before the questionnaire was distributed to the schools, gave a good degree of confidence that the questions were not ambiguous. The questionnaire was kept as short as possible, whilst still collecting all the information required for the study. Additionally, many of the questions were close-ended questions, to encourage students to complete the questionnaire in its entirety. In fact, of all the responses received, only two questionnaires had been left completely empty, which indicated that students probably did not experience problems with the actual questions or with the length of the questionnaire.

3.2.1.2 *Participants*

The cross-sectional questionnaire was used to study any trends, attitudes, and opinions within multi-level, stratified samples of chemistry student cohorts. Figure 3.1 shows an overview of the educational levels and specific groups of students who were targeted for participation in the study by means of the questionnaire.

The study follows a cluster sampling design; hence the levels were identified first, followed by the school sector.

The number of responses targeted from all three levels were:

- a) 200 responses from Year 10 students
- b) 150 responses from post-secondary students
- c) 50 responses from undergraduate students

In order to obtain a representative sample of the population, all three school sectors were included in the study at secondary and post-secondary level: state, church and independent schools.

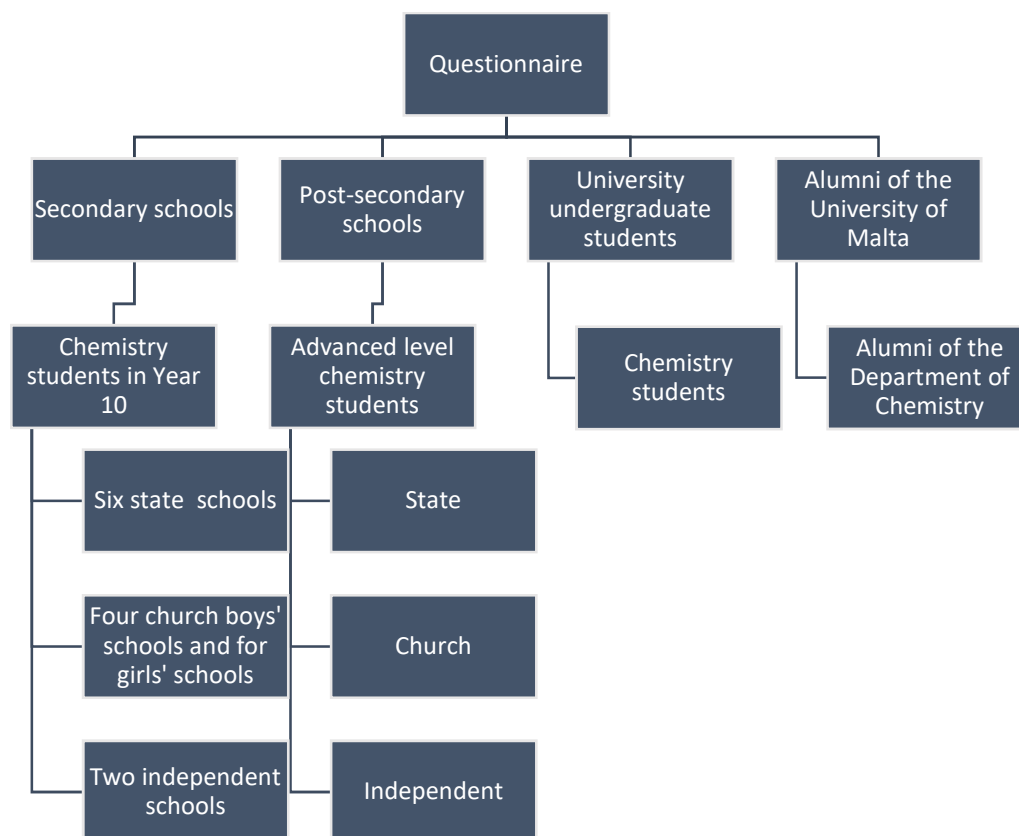


FIGURE 3.1 - OVERVIEW OF THE QUESTIONNAIRE PARTICIPANTS

3.2.1.2.1 SECONDARY SCHOOLS

Secondary schools were contacted and asked whether they were willing to distribute the questionnaire to the Year 10 chemistry students attending the school.

Assuming that:

- a) 40% of completed questionnaires were expected and
- b) two classes of chemistry students (with 15 students per class) were present in each school,

it was decided to recruit students from approximately eight state and eight church schools, as well as two independent schools. Since there are 10 state colleges, each college was approached to maintain fair representation of all localities.

Two independent schools were chosen at random out of seven. International schools were omitted from the selection in order to try and maintain a common cultural background between respondents.

All state schools, as well as the independent schools chosen, welcome a mixed-gender cohort. Conversely, most church schools are single-sex schools. In view of this, four out of the eight schools needed for the study were boys' schools and the other four were girls' schools. This attention to gender balance was the only restriction that was imposed upon the choice of church schools.

Not all schools agreed to participate in the study. To ensure that enough responses were returned, additional church schools were approached and invited to participate in the study. A second request for approval for research in church schools was sent to the Secretariat for Catholic Education. The new schools were again chosen at random, making sure that gender balance was maintained.

After initial contact with the Heads of School, it transpired that the number of chemistry students in Year 10 was about half the number predicted. Originally, the plan was to request participation from one class per college/school however, with new information regarding the number of students in Year 10, schools were asked to distribute the forms to all chemistry students in Year 10.

3.2.1.2.2 POST-SECONDARY SCHOOLS

All the post-secondary institutions were contacted and asked whether they would be willing to distribute the questionnaire amongst the students studying chemistry at Advanced level.

There are nine higher education institutions in Malta, from all three sectors. Of these, two offer vocational training and education and were therefore omitted from the study: the other seven were contacted for participation.

Completion of online questionnaires, albeit simple and environmentally friendly, often results in fewer responses. This meant that all students studying chemistry in the institutions targeted were asked to complete the questionnaire, so that the targeted number of completed responses could be met.

3.2.1.2.3 UNIVERSITY OF MALTA

The University of Malta is the only tertiary education institution in Malta which offers undergraduate courses in chemistry, therefore no selection process was necessary.

Undergraduate participants were recruited from courses where chemistry is taught. Using the University of Malta's website, a search was carried out for all the courses which had the word 'chemistry' in the title; this returned seven courses. One of the courses had not been subscribed, leaving six courses where chemistry was being taught, which are:

- a) Bachelor of Science (Honours) in Chemistry
- b) Bachelor of Science (Honours) in Biology and Chemistry
- c) Bachelor of Science (Honours) in Chemistry with Materials
- d) Bachelor of Science (Honours) in Chemistry and Physics

- e) Bachelor of Science (Honours) in Chemistry and Mathematics
- f) Bachelor of Science (Honours) in Chemistry and Statistics and Operations
Research

In view of the small number of students in each course, all students in the six courses were asked to participate in the study. Alumni who were registered with the University of Malta and who had studied chemistry were also asked to participate.

3.2.1.3 *Design of the questionnaire*

The secondary school (Year 10) questionnaire was created first (Appendix 1). This was designed purposely for this research, following review of the international literature, with the aim of addressing the research questions.

The questions that would help gather the information required to meet the objectives were written down and then ordered later. Every effort was made to avoid leading questions, complex questions, negatives and double negatives, and biasing by association. Particular attention was taken to avoid complex language and jargon, thus ensuring that the meaning of the questions was clear (Denscombe, 2012).

The items were ordered to keep basic, unthreatening factual questions about the participant first: the more delicate and personal open-ended questions were grouped at the end of the questionnaire.

The questionnaire consisted of close-ended questions with a few open ended-questions.

The number of open-ended questions were kept low due to the relatively large sample size that was being targeted and so as not to discourage students from replying. At this level, questionnaires were presented solely as a paper copy, due to ethical reasons.

Four different types of questions were employed, namely:

- a) dichotomous questions
- b) multiple-choice questions
- c) Likert scale questions
- d) open-ended questions

The aim of the questionnaire was to collect basic demographic information about the respondents and their parents/guardians, as well as behaviours and attitudes towards chemistry and towards music. The first eight questions were to be answered by all respondents, whilst the remaining ten questions were to be answered solely by those respondents who:

- a) used to take music lessons or
- b) still take music lessons or
- c) taught themselves to play a musical instrument

Two other questionnaires were created from this questionnaire, namely:

- a) Questionnaire for post-secondary school students (Appendices 2 and 3)
- b) Questionnaire for University students (Appendix 4)

In all three cases, responses were only sought from students studying chemistry.

3.2.1.3.1 POST-SECONDARY QUESTIONNAIRE

The questionnaire employed in post-secondary educational institutions was almost identical to the one presented to secondary school students, bar one question: whereas the latter were asked for the grades they had obtained (in a number of subjects) during their last

annual examinations, post-secondary students were asked for the SEC exam results obtained in the same subjects.

Of the seven post-secondary institutions that agreed to participate in this study, three were presented with hard copies of the questionnaire and four were presented with a link to the online version of this same questionnaire: the questions in the online questionnaire were identical to those in the paper questionnaire. All the questions in the online questionnaire were marked as 'required', meaning that respondents would have to answer all the questions posed before submitting. This was done by ensuring that respondents were directed to different sections, depending on whether they had ever studied music or not, and whether they were still playing a musical instrument or not.

3.2.1.3.2 UNIVERSITY QUESTIONNAIRE

Once again, the questionnaire at this level was identical to the one presented to secondary school students, except for the question regarding grades achieved in several academic subjects: here students were asked for the results obtained in their A-levels. This necessitated the creation of a separate online questionnaire, which was different to the one circulated amongst post-secondary students.

3.2.2 Interviews

The interview "can often put flesh on the bones of questionnaire responses" (Bell, 2006, p. 157). It is an opportunity for two people to exchange their views on a common subject: not only are views exchanged, but they are also constructed, between the interviewee and the

interviewer. This was attempted through the use of a small number of semi-structured interviews.

3.2.2.1 Strengths and limitations

An interview's main strength is its adaptability: replies can be probed, followed-up on, and used to investigate feelings and motives. Through body language and facial expressions, it is possible to pick up on nuances that do not come through by the sole use of the questionnaire (Dawson, 2009).

On the other hand, interviews are time-consuming: finding respondents, agreeing on a place and time, meeting face-to-face and then transcribing and coding the responses is substantially time-consuming (Bell, 2006).

There is the possibility of interviewer bias, both during the interview itself as well as during coding of the replies. It is very easy to over-emphasize certain topics whilst brushing aside others. This issue was countered by being constantly aware of this and being critical of the conclusions being drawn.

Through interviews, the researcher has the advantage of being able to gain insight into how respondents have assigned socially constructed meanings to their experiences. This gives a unique and individual interpretation to reality, a feature of human society that questionnaires alone would not give justice to.

Naturally, interviewees cannot be offered anonymity – only confidentiality. This did not seem to perturb the participants greatly, possibly because the nature of the study is not a sensitive one.

3.2.2.2 *The participants*

Interviewees were recruited via the network of alumni of the Faculty of Science. The four participants were required to have studied chemistry at undergraduate or postgraduate level and have played a musical instrument extensively at some point in their life. When selecting interviewees, preference was given to those who are currently working in different types of employment.

The study aimed to carry out interviews with four participants who had studied chemistry at the University of Malta and had received music tuition for several years. Ideally, two males and two females were to be recruited, but this proved not to be possible. The interviews were carried out with three females and one male instead. Table 3.1 presents some more information about the interviewees.

<i>Participant</i>	<i>Gender</i>	<i>Experience in music</i>	<i>Employment details</i>
P1	Female	Teaches music	Science-related employment
P2	Male	Choir member	Science-related employment
P3	Female	Professional musician	Discontinued science
P4	Female	Does not currently play	Science-related employment

TABLE 3.1 - DETAILS OF THE INTERVIEWEES

3.2.2.3 *Interview questions*

The main items used for the interviews were based on the questionnaire, hence also reflecting the literature. Following receipt and data input of the completed questionnaires, the interview questions originally drafted were adapted, to reflect the new information that was being received. The final interview protocol, which was used consistently throughout the interviews, contained 14 questions, with probes being used as required. Wherever possible, the questions were kept open-ended so as not to limit what the participants wished to say, and to promote the establishment of a rapport between the two parties.

The order of the interview questions followed that of the questionnaire. The interviewees were first asked questions about their music training in general. The questions then turned to their behaviours and attitudes towards chemistry. Finally, the interviewees were asked about the combination of music and chemistry.

The interviews were carried out at a time and place that suited both parties. After a small introduction and some light conversation, the participants were presented with the information sheet (Appendix 6) and the consent form (Appendix 7), both of which had already been made available to them prior the interview. Once the consent form was signed, the interviewee was asked whether the audio recording equipment could be switched on: upon approval, the audio equipment was switched on and the interview commenced. Although a list of questions was available, the respondents were allowed a considerable degree of freedom to reply and give their own experiences and opinions.

None of the interviews lasted longer than the 30 minutes that had been anticipated. Three of the interviews were carried out in-person, whilst the other was carried out via a web-based voice call.

3.3 Validity and Reliability

3.3.1 *Validity*

In its simplest form, the validity of a research tool indicates whether the tool is measuring or describing that which it is supposed to measure or describe. More accurately, validity can be defined as the design of research in such a way that it produces credible conclusions (Creswell & Creswell, 2018).

3.3.1.1 *Questionnaire validity*

Since the questionnaire was purposely constructed, it was not possible to refer to previously established validity of results obtained by using this instrument.

Creswell and Creswell (2018) list 10 possible types of threat to the internal validity of a study, which can originate from participants, use of an experimental treatment that is manipulated by the researcher, and from procedures that are used in the experiment. Of these 10, the following could affect this study:

- a) History: whilst the respondent was completing the questionnaire, an outside event might have influenced the response. This has been countered by keeping the questionnaire as brief as possible.
- b) Study attrition: participants may drop out of the study. To account for this, additional schools were recruited as necessary, to try and reach the targeted number of responses.

The authors also list three possible threats to the external validity of the study.

“External validity threats arise when experimenters draw incorrect inferences from the sample data to other persons, other settings, and past or future situations” (Creswell & Creswell, 2018, p. 171). The results that will be obtained will be used solely to discover trends in current populations of chemistry students so as not to affect external validity.

3.3.1.1.1 PILOTING

The questionnaire was expected to generate the most copious amounts of data therefore, it was imperative to pilot it. The aim of the pilot was mainly to confirm that all the questions were clear, age-appropriate and well understood by the respondents. Additionally, the pilot

was used to ensure that the questionnaire did not take longer than expected to complete, since this might have caused students to answer hurriedly or not at all.

The piloting was carried out with a group of 10 chemistry secondary school students. They completed the questionnaire and commented on a few areas where the questions or responses offered were not clear or not comprehensive. It became evident that the questionnaire did not take longer than 15 minutes to complete, even if students were musically trained and hence would have to answer all the questions presented to them.

The questionnaire was updated with the results of the pilot project – it was then ready for distribution.

3.3.1.2 *Interview validity*

“Validity is one of the strengths of qualitative research and is based on determining whether the findings are accurate from the standpoint of the researcher, the participant, or the readers of an account” (Creswell & Miller, 2000 as quoted in Creswell & Creswell (2018), p. 199).

There are multiple ways of incorporating strategies that increase validity in this study. One example is triangulation of data from different sources. Triangulation is the “[effort that] should be made to cross-check findings, and in a more extensive study, to use more than one method of data collecting” (Bell, 2006, p. 116).

In a study which employs mixed-methods such as this one, the two methods used will allow the examination of a particular topic from different perspectives. The areas of convergence and divergence obtained using both methods will help shed more light on the entire study.

3.3.2 Reliability

“Reliability is the extent to which a test or procedure produces similar results under constant conditions on all occasions” (Bell, 2006, p. 117).

3.3.2.1 Questionnaire Reliability

At the request of Heads of School at two separate institutions, two groups of students were observed whilst they were completing the questionnaire. During this period, only one question was asked and this arose due to the fact that the respondent had not read the question in its entirety. This gave a degree of assurance that the questions were clear, thus also increasing the level of reliability of this research tool.

3.3.2.2 Interview Reliability

Creswell & Creswell (2018) state that the reliability of the interview process can be increased by documenting as many of the procedures used as possible. They also suggest that transcripts should be thoroughly checked for errors. These recommendations were adhered to in this study.

Since this is not a multi-researcher study, there could be no errors in defining codes between researchers. Care was taken to ensure consistent coding throughout and across transcripts.

3.4 Research ethics

“Research ethics is about being clear about the nature of the agreement you have entered into with your research subjects or contact” (Blaxter, Hughes & Tight (2001) as quoted in Bell, p. 45-46). This simple statement defines all the documentation and procedures that need to be fulfilled prior to commencing the study with the aim of preventing any potentially harmful or illegal studies from taking place.

Before commencing this study, ethical clearance was sought from the Faculty Research Ethics Committee (FREC).

3.4.1 Questionnaires

Once the FREC clearance had been obtained, permissions were sought from the gatekeepers, namely the:

- a) Directorate for Research, Lifelong Learning and Employability (online application)
- b) Secretariat for Catholic Education (Appendix 8)
- c) Heads of Schools (Appendix 9)
- d) Registrar (for undergraduate students) (Appendix 10)
- e) Administrator of Alumni (Appendix 11)

3.4.1.1 *Secondary school students*

Parent information sheets (Appendix 12) and consent forms (Appendix 13), as well as student information sheets (Appendix 14) and the actual questionnaire were delivered to the Heads of School or members of the senior management team personally: the purpose of the study and the procedure to be followed were explained and discussed verbally, and any

queries were answered straight away. The subject teacher distributed the parent information sheets and consent forms to Year 10 students. Once the parent consent form had been signed and returned, the students were given a questionnaire to complete. The student information sheet was placed at the front of the questionnaire - completion of the anonymous questionnaire was taken as assent to participate in the study. Parent consent forms and completed questionnaires were kept as two separate documents, to ensure anonymity of the responses. Once they had been completed, these questionnaires were collected.

3.4.1.2 Post-secondary school students

Following approval from the gatekeepers, the post-secondary institutions were asked whether they would rather carry out the data-gathering exercise online or via a hard copy of the questionnaire. In cases where the schools had opted for an online questionnaire, the school administration electronically sent the text for students containing information about the study (Appendix 15) as well as the link to the online questionnaire.

In cases where the school had opted for a paper copy of the questionnaire, the student information sheet and the questionnaires were personally delivered to the school and distributed to the students by staff. Once the questionnaires had been filled in, the school would indicate a date and time when these could be collected.

Parental consent was not required in this case. Nonetheless, one institution requested parent/guardian information and consent forms to be distributed and completed, prior to distribution of student questionnaires.

3.4.1.3 *University students*

Data from undergraduate and postgraduate students, and alumni were collected electronically.

Information about the study (Appendix 16) and the link to the online questionnaire was sent to undergraduate students via the Registrar's office. Students would receive the email notification only if:

- a) they were enrolled in a specific course (refer to Section 3.2.1.2.3)
- b) they had accepted to receive such emails at the beginning of the scholastic year.

Due to recent changes in GDPR legislation, students were asked to opt in to receive these types of emails. Anyone who opted in would receive an email containing information about the study as well as a link to the online questionnaire.

Registered alumni of the University of Malta were contacted via the Administrator's office. They were given the same information and link as undergraduate students.

3.4.2 *Interviews*

The interviews were to be carried out with adults; hence no gatekeeper approval was required following clearance from the FREC.

Interviewees were duly informed about the study by means of an information letter, which included details about the expected duration of the interview, audio recording of the interview and confidentiality of the process. Naturally, anonymity could not be offered – the respondents did not seem particularly troubled by this once they had been informed about the aims of the study.

Participants were also informed that they were free to opt out of the study at any point.

After reading the information letter, the participants were asked to sign a consent form thus giving permission for the interview to commence.

3.5 Data and analysis

3.5.1 Data from questionnaires

Questionnaire responses were received in two formats – paper or electronic. In the case of post-secondary schools where responses were received in both formats, the data were initially entered in two separate spreadsheets. Prior to data analysis, the data in these two spreadsheets were used to create a single, combined spreadsheet. This combined spreadsheet was then used for data analysis.

3.5.1.1 Electronic format

Once the respondent had answered all the questions in the form and clicked on ‘submit’, the form generator program would automatically enter the data into the linked spreadsheet using a timestamp as a unique identifier (Figure 3.2).

74	4/22/2019 10:20:46
75	4/24/2019 17:03:12
76	4/26/2019 18:07:54
77	4/26/2019 23:30:07
78	4/27/2019 13:22:52
79	4/29/2019 20:40:29

FIGURE 3.2 - TIMESTAMP GENERATED AUTOMATICALLY

The two different types of online forms utilised – one for post-secondary school students and one for undergraduate, postgraduate students and alumni – generated entries in two separate spreadsheets.

3.5.1.2 Paper format

Two separate spreadsheets were created for paper responses – one for secondary school students and one for post-secondary school students. Once the filled questionnaires were collected from the participating schools, each questionnaire was given a number as a unique identifier (Figure 3.3). This number as well as the responses within the questionnaire, were entered in the spreadsheet.

1	Identifier
2	1
3	2
4	3
5	4
6	5

FIGURE 3.3 - UNIQUE IDENTIFICATION GIVEN TO PAPER RESPONSES

3.5.2 Interviews

Once the interview was completed, the file name of the audio recording was changed to 'Interview X' where X represents the interview number allocated chronologically. At no point did the audio files refer to the name of the interviewee.

Transcripts of these interviews were then prepared to allow familiarisation with the text.

3.5.3 Analysis

Analysis of the questionnaire data was carried out by means of two methods:

- a) Quantification of variables and correlation between variables: using the filter function in the spreadsheets, it was possible to generate information such as percentages of chemistry students who were also studying music, the

percentage of musically trained chemistry students who achieved high marks and grades in the examinations of a selection of academic subjects, the amount of time spent studying chemistry at home, and others.

b) Generation of themes by studying the replies to the open questions.

Interview transcripts were marked, and side notes made, to highlight relevant passages. The transcripts were coded and the themes that emerged were reviewed and compared, both between texts as well as between texts and questionnaire data.

3.6 Conclusion

One of the most challenging aspects of mixed methods is finding a way to integrate the results collected, by finding links between the two sets of data: it is also the most distinctive characteristic of mixed methods methodology, as each set of data enriches the other. The results obtained through the research tools described in this chapter will be presented in Chapter 4.

CHAPTER 4

RESULTS

4 Results

4.1 Introduction

This chapter contains data extracted from the questionnaires and the interviews, that will be used to attempt to answer the research questions proposed at the start of the study.

Initially, data from chemistry students who still study music (CS-SSM), used to study music (CS-USM) and never studied music (CS-NSM) in secondary schools (Year 10) will be compared. This will be repeated for post-secondary school students. CS-USM refers to those students who have studied music but, at the time of responding to the questionnaire, had stopped taking music lessons.

In the second part of this chapter, responses from CS-SSM will be studied in greater detail to highlight the possible links of several variables on the results seen.

There were very few replies returned by University undergraduates, postgraduates and alumni, therefore this chapter will present the replies given to the open-ended questions of the questionnaire in a qualitative manner.

4.2 Numbers of chemistry students based on whether they study music or not

4.2.1 *Secondary school students*

The completed questionnaires received from Year 10 chemistry students were used to obtain the data for the three main categories that will be used in this part of the chapter, namely CS-NSM, CS-USM and CS-SSM. The numbers of students for each of these three categories is presented in Figure 4.1. The total for CS-SSM (59) is composed of those students who attend formal music lessons (52) and those students who are self-taught (7).

The figure shows that approximately one third of the participants still study music, whilst approximately one third have never studied music.

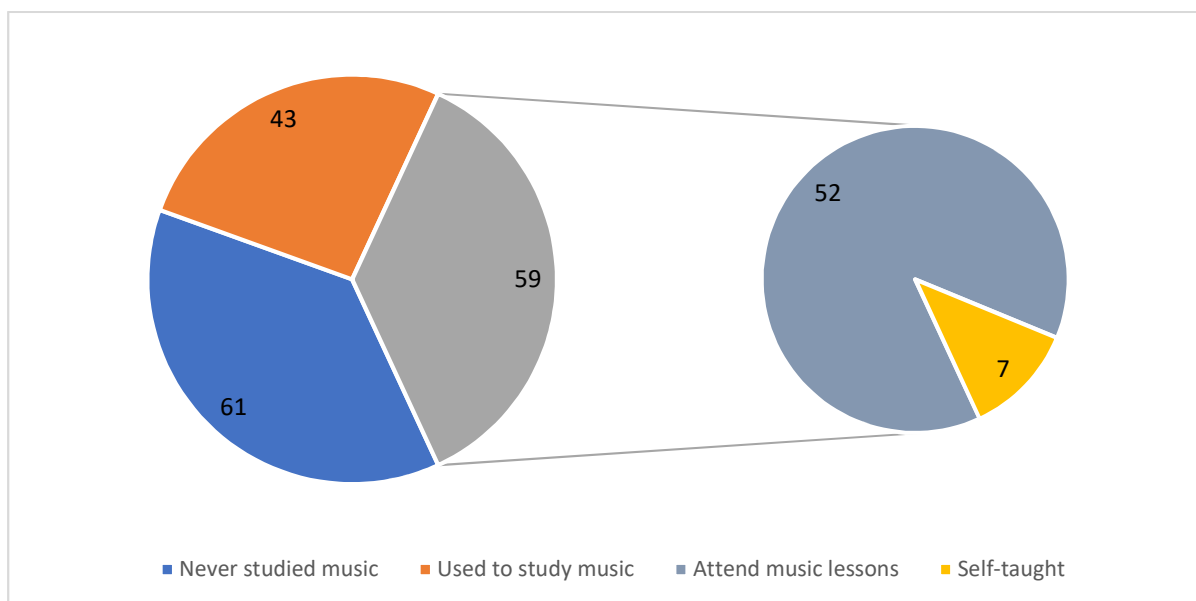


FIGURE 4.1 - CHEMISTRY STUDENTS IN YEAR 10 WHO NEVER STUDIED, USED TO STUDY, AND STILL STUDY MUSIC

4.2.2 Post-secondary school students

The paper and online responses received from post-secondary students were used to obtain the numbers of CS-NSM, CS-USM and CS-SSM. These are shown in Figure 4.2.

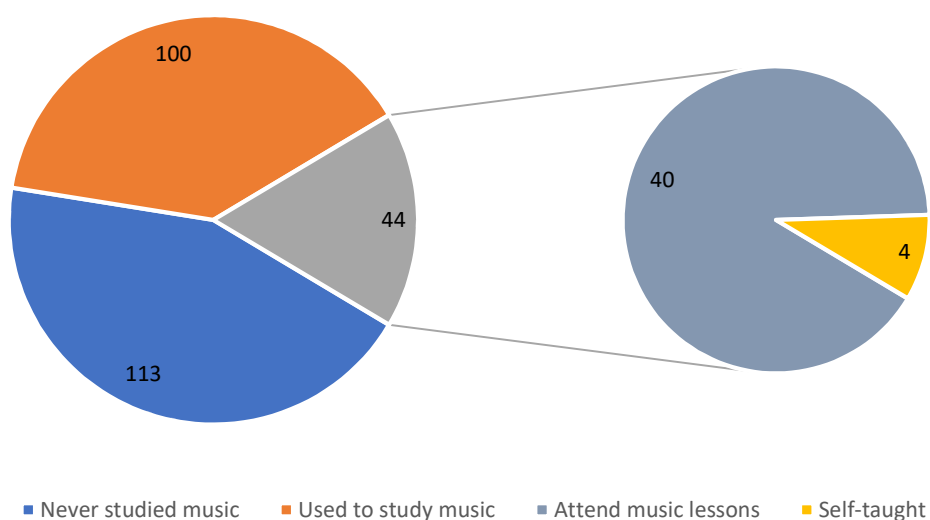


FIGURE 4.2 - NUMBERS OF CHEMISTRY STUDENTS AT POST-SECONDARY LEVEL WHO NEVER STUDIED, USED TO STUDY, AND STILL STUDY MUSIC

At post-secondary level, the numbers of students in each of the three categories are not as uniform as those seen in Figure 4.1. Percentages of CS-SSM drop from 36.2% at secondary school level to 17.1% at post-secondary school level.

CS-USM at post-secondary level were asked for a reason why they stopped their music training. The question read “why did you stop playing your musical instrument?”. Out of a total of 104 CS-USM, 87 students replied to this question. The answers given by the students were grouped into the nine categories listed in Table 4.1. In cases where a student gave more than one reason for stopping music training, each reason was entered as a separate entry, so that all the information given by the students could be represented.

<i>Grouped categories</i>	<i>Number of responses</i>
Not interested any more	13
Student got bored	10
Issues with teacher (clashes, availability)	9
Lack of time (no further details given)	14
Lack of time (due to schoolwork)	27
Lack of time (due to other extra-curricular activities)	7
Stressed by music exams	3
Lack of commitment to music practice	3
Completed all music examinations	2

TABLE 4.1 - REASONS GIVEN BY POST-SECONDARY CS-USM FOR STOPPING MUSICAL TRAINING

At the end of Year 11, students sit for their Secondary Education Certificate (SEC) examinations. It is assumed that more time will be required for studying and therefore less time will be available for extra-curricular activities. This is confirmed by the information in Table 4.1 and may explain the lower participation rate of CS-SSM at post-secondary education.

4.2.3 Undergraduates/postgraduates/alumni

More than half the respondents stated that they used to study music. The reasons given by past and present students of the Department of Chemistry for stopping music tuition had also been mentioned by post-secondary and secondary school students. The range of reasons given by the undergraduates, graduates and alumni was smaller, namely lack of time, lack of interest, and preferring to carry out other activities.

4.3 The link between music training and achievement

The exercise described below was carried out to determine whether there is a link between music training and achievement in several academic subjects. The subjects chosen were mathematics, English and Maltese (due to the mention of a link between musical training and performance in mathematics and languages in the literature), chemistry as the subject of interest in this study, and other commonly chosen science subjects (biology and physics).

4.3.1 Secondary school students

The responses were filtered according to the achievement category stated for the annual examination taken at the end of Year 9 for that subject. The responses obtained were placed into one of three categories, namely CS-NSM, CS-USM and CS-SSM. The total number of responses per category was then calculated. The raw values were then changed into percentages, based on the total number of respondents per population (refer to Table 4.2). This tabulation was carried out for all the academic subjects mentioned above (refer to Tables 4.3 to 4.7). Not all students gave the results for all subjects, which explains why the total number of students in the tables below does not always add up to 163.

MATHEMATICS						
Marks obtained in annual examination in Year 9	Numbers of chemistry students who never studied music (CS-NSM)		Numbers of chemistry students who used to study music (CS-USM)		Numbers of chemistry students who still study music (CS-SSM)	
	Raw values	%	Raw values	%	Raw values	%
0-25	1	1.6	1	2.3	0	0.0
26-50	17	27.9	6	14.0	10	16.9
51-75	22	36.1	21	48.8	19	32.2
76-100	20	32.8	15	34.9	30	50.8
Total number of respondents per population	61		43		59	

TABLE 4.2 - NUMBERS AND PERCENTAGES OF SECONDARY SCHOOL STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND MARKS OBTAINED IN MATHEMATICS

ENGLISH						
Marks obtained in annual examination in Year 9	Numbers of chemistry students who never studied music (CS-NSM)		Numbers of chemistry students who used to study music (CS-USM)		Numbers of chemistry students who still study music (CS-SSM)	
	Raw values	%	Raw values	%	Raw values	%
0-25	0	0.0	0	0.0	0	0.0
26-50	0	0.0	0	0.0	0	0.0
51-75	22	36.1	11	25.6	14	23.7
76-100	39	63.9	32	74.4	45	76.3
Total number of respondents per population	61		43		59	

TABLE 4.3 - NUMBERS AND PERCENTAGES OF SECONDARY SCHOOL STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND MARKS OBTAINED IN ENGLISH

MALTESE						
Marks obtained in annual examination in Year 9	Numbers of chemistry students who never studied music (CS-NSM)		Numbers of chemistry students who used to study music (CS-USM)		Numbers of chemistry students who still study music (CS-SSM)	
	Raw values	%	Raw values	%	Raw values	%
0-25	2	3.3	0	0.0	0	0.0
26-50	2	3.3	1	2.3	5	8.5
51-75	24	39.3	16	37.2	12	20.3
76-100	31	50.8	25	58.1	41	69.5
Total number of respondents per population	59		42		58	

TABLE 4.4 - NUMBERS AND PERCENTAGES OF SECONDARY SCHOOL STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND MARKS OBTAINED IN MALTESE

CHEMISTRY						
Marks obtained in annual examination in Year 9	Numbers of chemistry students who never studied music (CS-NSM)		Numbers of chemistry students who used to study music (CS-USM)		Numbers of chemistry students who still study music (CS-SSM)	
	Raw values	%	Raw values	%	Raw values	%
0-25	1	1.7	1	2.3	0	0.0
26-50	17	28.3	6	14.0	10	16.9
51-75	22	36.7	21	48.8	19	32.2
76-100	20	33.3	15	34.9	30	50.8
Total number of respondents per population	60		43		59	

TABLE 4.5 - NUMBERS AND PERCENTAGES OF SECONDARY SCHOOL STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND MARKS OBTAINED IN CHEMISTRY.

BIOLOGY						
Marks obtained in annual examination in Year 9	Numbers of chemistry students who never studied music (CS-NSM)		Numbers of chemistry students who used to study music (CS-USM)		Numbers of chemistry students who still study music (CS-SSM)	
	Raw values	%	Raw values	%	Raw values	%
0-25	1	2.0	0	0.0	0	0.0
26-50	6	11.8	2	5.0	2	3.8
51-75	20	39.2	17	42.5	16	30.8
76-100	24	47.1	21	52.5	34	65.4
Total number of respondents per population	51		40		52	

TABLE 4.6 - NUMBERS AND PERCENTAGES OF SECONDARY SCHOOL STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT MARKS OBTAINED IN BIOLOGY

PHYSICS						
Marks obtained in annual examination in Year 9	Numbers of chemistry students who never studied music (CS-NSM)		Numbers of chemistry students who used to study music (CS-USM)		Numbers of chemistry students who still study music (CS-SSM)	
	Raw values	%	Raw values	%	Raw values	%
0-25	0	0.0	0	0.0	0	0.0
26-50	6	10.2	2	4.8	0	0.0
51-75	23	39.0	8	19.0	17	29.3
76-100	25	42.4	26	61.9	36	62.1
Total number of respondents per population	59		42		58	

TABLE 4.7 - NUMBERS AND PERCENTAGES OF SECONDARY SCHOOL STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND MARKS OBTAINED IN PHYSICS

The percentages obtained for each achievement category were plotted, whilst differentiating between the main three categories (i.e. Year 10 CS-NSM, CS-USM and CS-SSM). Figure 4.3 shows the graph obtained for mathematics. This figure shows that the largest percentage of students to obtain a mark in the highest achievement category (76-100) were Year 10 CS-SSM.

Graphs for every subject were plotted following the same procedure; results are presented in Figures 4.3 to 4.8.

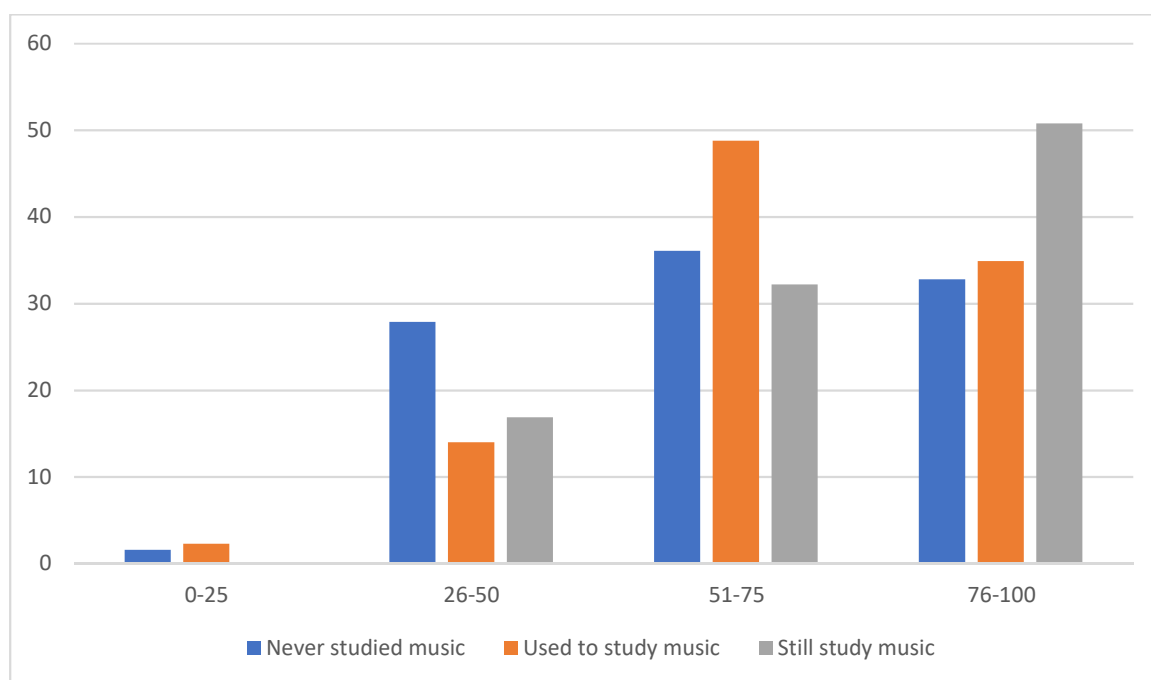


FIGURE 4.3 – PERCENTAGE NUMBER OF CHEMISTRY STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND MARK OBTAINED IN ANNUAL MATHEMATICS EXAMINATION

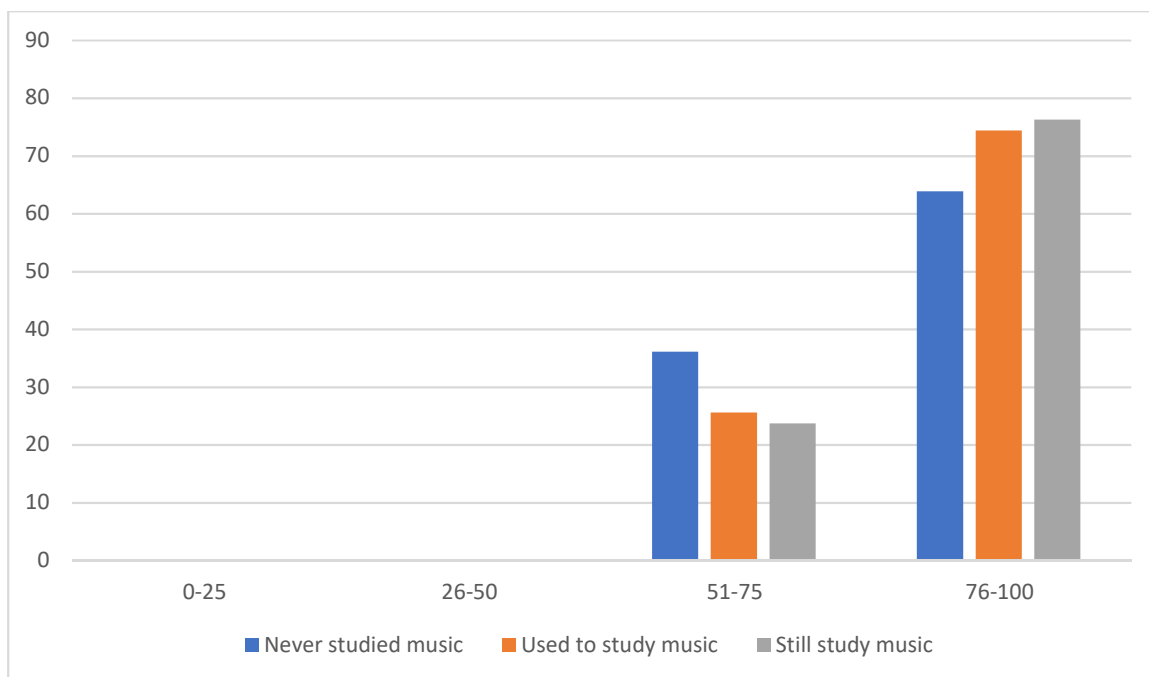


FIGURE 4.4 - PERCENTAGE NUMBER OF CHEMISTRY STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND MARK OBTAINED IN ANNUAL ENGLISH EXAMINATION

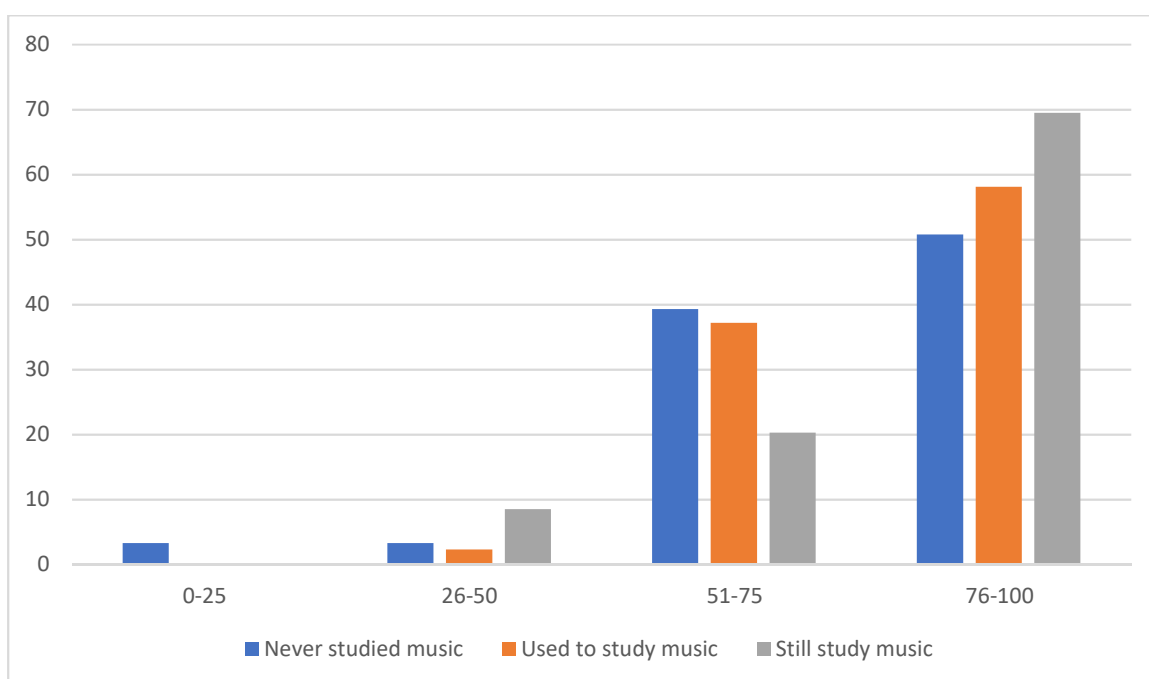


FIGURE 4.5 - PERCENTAGE NUMBER OF CHEMISTRY STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND MARK OBTAINED IN ANNUAL MALTESE EXAMINATION

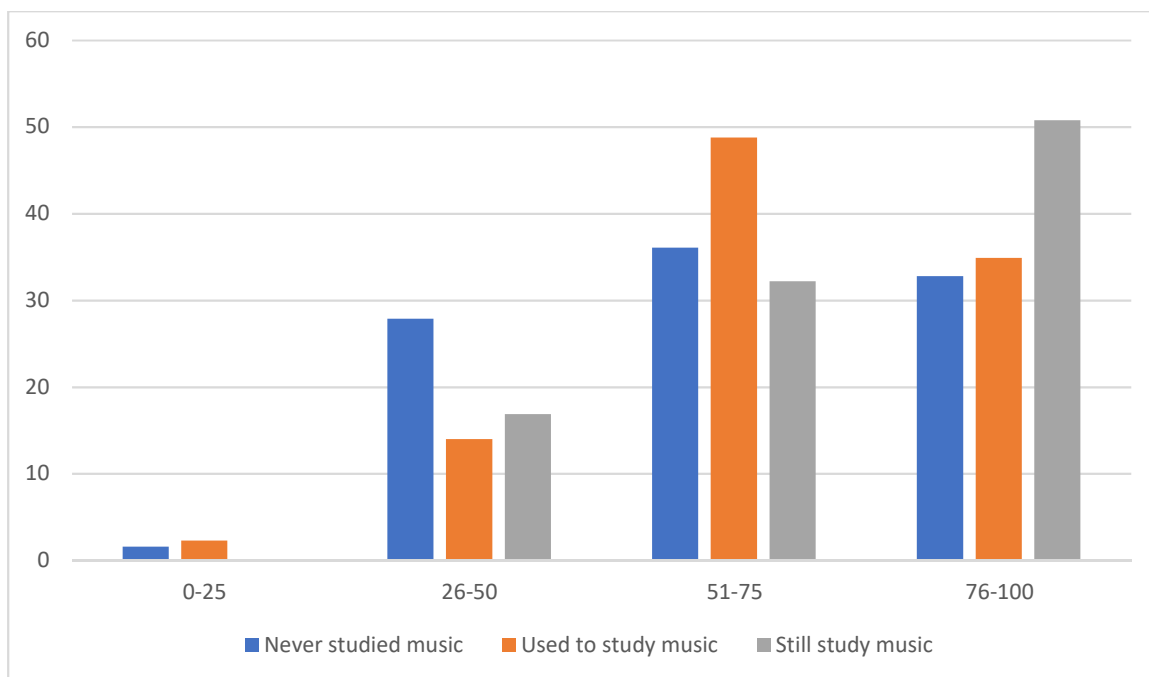


FIGURE 4.6 - PERCENTAGE NUMBER OF CHEMISTRY STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND MARK OBTAINED IN ANNUAL CHEMISTRY EXAMINATION

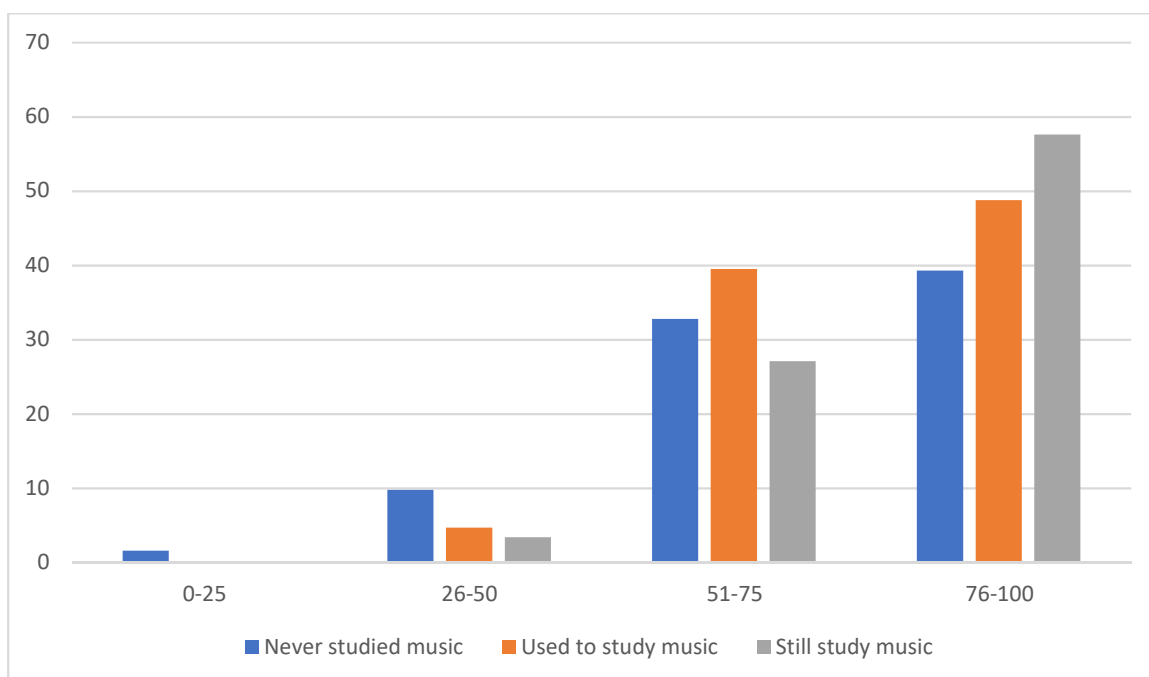


FIGURE 4.7 - PERCENTAGE NUMBER OF CHEMISTRY STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND MARK OBTAINED IN ANNUAL BIOLOGY EXAMINATION

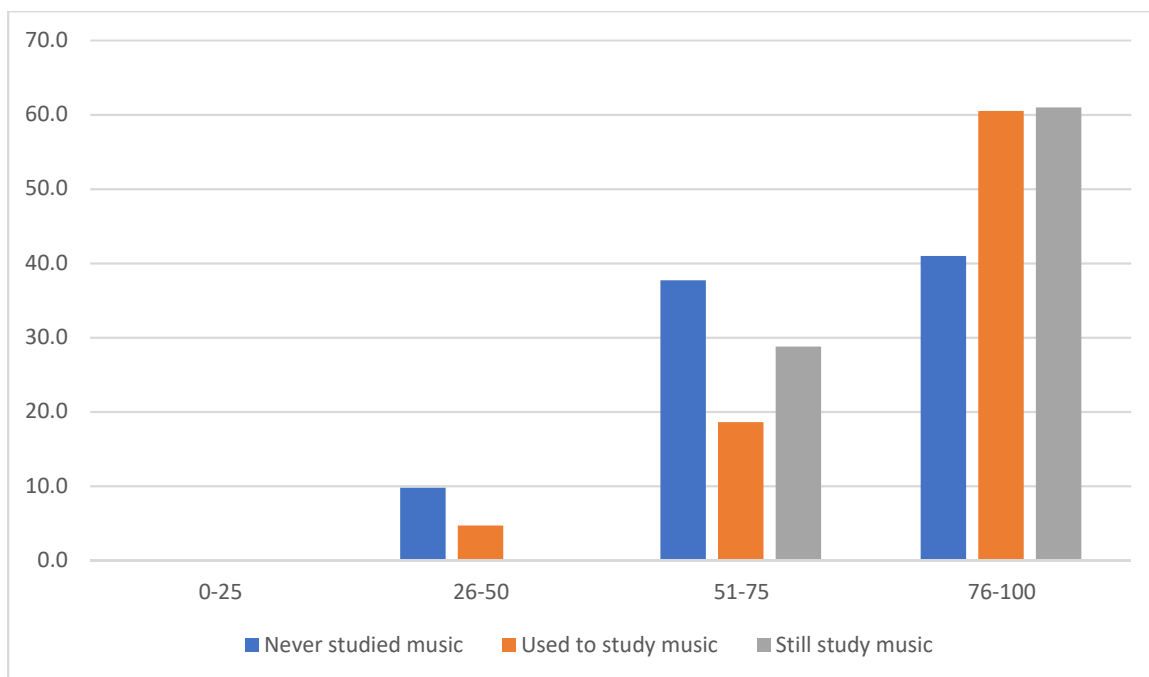


FIGURE 4.8 - PERCENTAGE NUMBER OF CHEMISTRY STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND MARK OBTAINED IN ANNUAL PHYSICS EXAMINATION

Figures 4.3 to 4.8 show that the category CS-SSM consistently has the highest percentage of students that achieve marks in the achievement category (76-100). This is true for all six academic subjects studied. The category with the second highest percentage of students that achieve marks in the achievement category (76-100) are CS-USM; again, this is consistent across all the six academic subjects studied.

4.3.2 Post-secondary schools

The data from post-secondary school students were also used to explore whether there is a link between music training and achievement, across the same academic subjects listed above in Section 4.3.1.

Responses were filtered according to the grade obtained in the SEC examination - from 1 to 7 and then U. The responses obtained were placed into one of three categories, namely CS-NSM, CS-USM and CS-SSM, depending on the information provided in the questionnaire.

The total number of responses per category was then calculated. The raw values were changed into percentages, based on the total actual number of respondents per population (refer to Table 4.8). This tabulation was carried out for each of the six academic subjects. Data are shown in Tables 4.8 to 4.13. Not all students gave their results in all subjects, which explains why the total number of students in the tables below does not always add up to 257.

MATHEMATICS						
Grade obtained in SEC examination	Numbers of chemistry students who never studied music (CS-NSM)		Numbers of chemistry students who used to study music (CS-USM)		Numbers of chemistry students who still study music (CS-SSM)	
	Raw values	%	Raw values	%	Raw values	%
1	43	39.1	37	37.0	21	48.8
2	27	24.5	32	32.0	13	30.2
3	19	17.3	22	22.0	5	11.6
4	17	15.5	9	9.0	2	4.7
5	3	2.7	0	0.0	1	2.3
6	0	0.0	0	0.0	1	2.3
7	1	0.9	0	0.0	0	0.0
U	0	0.0	0	0.0	0	0.0
Total number of respondents per population	110		100		43	

TABLE 4.8 – NUMBERS AND PERCENTAGES OF POST-SECONDARY SCHOOL STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND GRADE OBTAINED IN SEC EXAMINATION.

ENGLISH						
Grade obtained in SEC examination	Numbers of chemistry students who never studied music (CS-NSM)		Numbers of chemistry students who used to study music (CS-USM)		Numbers of chemistry students who still study music (CS-SSM)	
	Raw values	%	Raw values	%	Raw values	%
1	38	34.5	40	40.0	17	39.5
2	42	38.2	40	40.0	12	27.9
3	19	17.3	16	16.0	7	16.3
4	9	8.2	3	3.0	5	11.6
5	1	0.9	1	1.0	1	2.3
6	0	0.0	0	0.0	0	0.0
7	1	0.9	0	0.0	1	2.3
U	0	0.0	0	0.0	0	0.0
Total number of respondents per population	110		100		43	

TABLE 4.9 – NUMBERS AND PERCENTAGES OF POST-SECONDARY SCHOOL STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND GRADE OBTAINED IN THE ENGLISH SEC EXAMINATION

MALTESE						
Grade obtained in SEC examination	Numbers of chemistry students who never studied music (CS-NSM)		Numbers of chemistry students who used to study music (CS-USM)		Numbers of chemistry students who still study music (CS-SSM)	
	Raw values	%	Raw values	%	Raw values	%
1	26	24.5	21	21.2	12	28.6
2	30	28.3	39	39.4	18	42.9
3	28	26.4	22	22.2	9	21.4
4	18	17.0	12	12.1	2	4.8
5	3	2.8	2	2.0	1	2.4
6	0	0.0	0	0.0	0	0.0
7	0	0.0	0	0.0	0	0.0
U	1	0.9	3	3.0	0	0.0
Total number of respondents per population	106		99		42	

TABLE 4.10 - NUMBERS AND PERCENTAGES OF POST-SECONDARY SCHOOL STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND GRADE OBTAINED IN THE MALTESE SEC EXAMINATION

CHEMISTRY						
Grade obtained in SEC examination	Numbers of chemistry students who never studied music (CS-NSM)		Numbers of chemistry students who used to study music (CS-USM)		Numbers of chemistry students who still study music (CS-SSM)	
	Raw values	%	Raw values	%	Raw values	%
1	35	32.1	37	37.0	18	41.9
2	38	34.9	30	30.0	13	30.2
3	22	20.2	21	21.0	5	11.6
4	10	9.2	7	7.0	4	9.3
5	3	2.8	4	4.0	0	0.0
6	0	0.0	0	0.0	1	2.3
7	0	0.0	0	0.0	0	0.0
U	1	0.9	1	1.0	2	4.7
Total number of respondents per population	109		100		43	

TABLE 4.11- NUMBERS AND PERCENTAGES OF POST-SECONDARY STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND GRADE OBTAINED IN THE CHEMISTRY SEC EXAMINATION

BIOLOGY						
Grade obtained in SEC examination	Numbers of chemistry students who never studied music (CS-NSM)		Numbers of chemistry students who used to study music (CS-USM)		Numbers of chemistry students who still study music (CS-SSM)	
	Raw values	%	Raw values	%	Raw values	%
1	33	30.0	38	36.2	16	37.2
2	41	37.3	28	26.7	15	34.9
3	24	21.8	29	27.6	5	11.6
4	11	10.0	7	6.7	4	9.3
5	1	0.9	2	1.9	1	2.3
6	0	0.0	0	0.0	0	0.0
7	0	0.0	0	0.0	1	2.3
U	0	0.0	1	1.0	1	2.3
Total number of respondents per population	110		105		43	

TABLE 4.12 - NUMBERS AND PERCENTAGES OF POST-SECONDARY STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND GRADE OBTAINED IN THE BIOLOGY SEC EXAMINATION

PHYSICS						
Grade obtained in SEC examination	Numbers of chemistry students who never studied music (CS-NSM)		Numbers of chemistry students who used to study music (CS-USM)		Numbers of chemistry students who still study music (CS-SSM)	
	Raw values	%	Raw values	%	Raw values	%
1	46	43.3	67	57.3	20	55.6
2	24	22.6	28	23.9	7	19.4
3	22	20.8	15	12.8	5	13.9
4	11	10.4	5	4.3	1	2.8
5	2	1.9	0	0.0	2	5.6
6	0	0.0	0	0.0	0	0.0
7	0	0.0	0	0.0	1	2.8
U	1	0.9	2	1.7	0	0.0
Total number of respondents per population	106		117		36	

TABLE 4.13 - NUMBERS AND PERCENTAGES OF POST-SECONDARY SCHOOL STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND GRADE OBTAINED IN THE PHYSICS SEC EXAMINATION

The percentages obtained for each grade were plotted, whilst at the same time differentiating between the three main categories (i.e. post-secondary CS-NSM, CS-USM and CS-SSM). Figure 4.9 shows the resultant graph for mathematics. Similar graphs were plotted for the other five subjects following the same procedure. Results are presented in Figures 4.9 to 4.14.

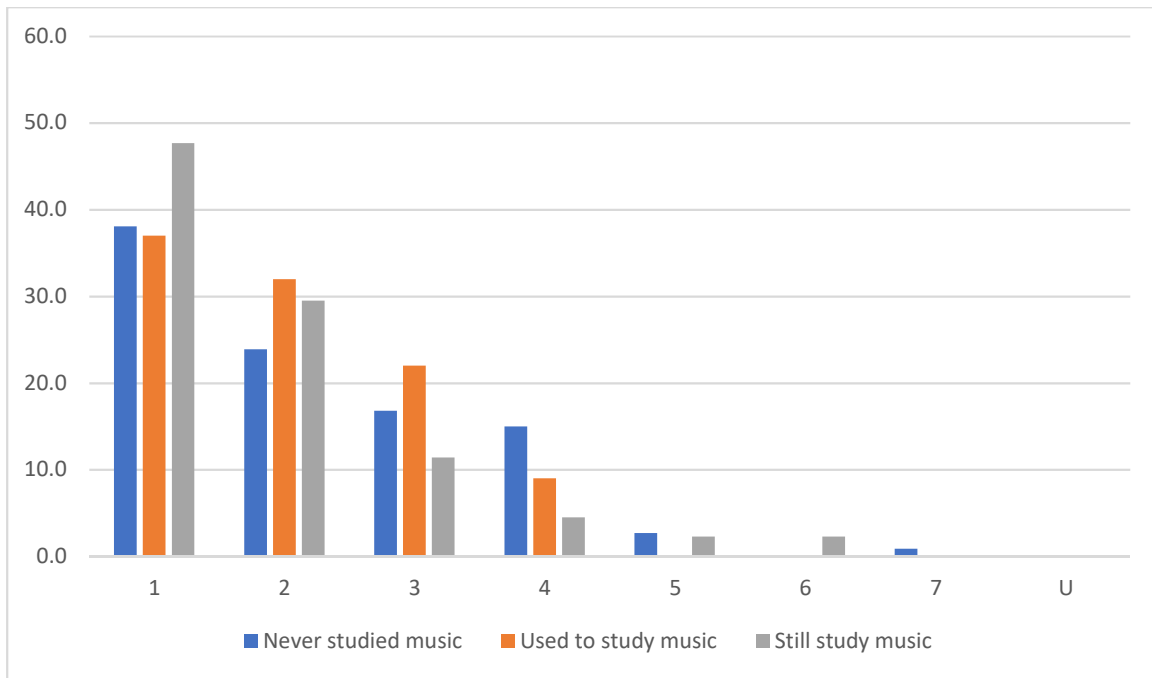


FIGURE 4.9 – PERCENTAGE NUMBER OF CHEMISTRY STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND GRADE OBTAINED IN THE MATHEMATICS SEC EXAMINATION

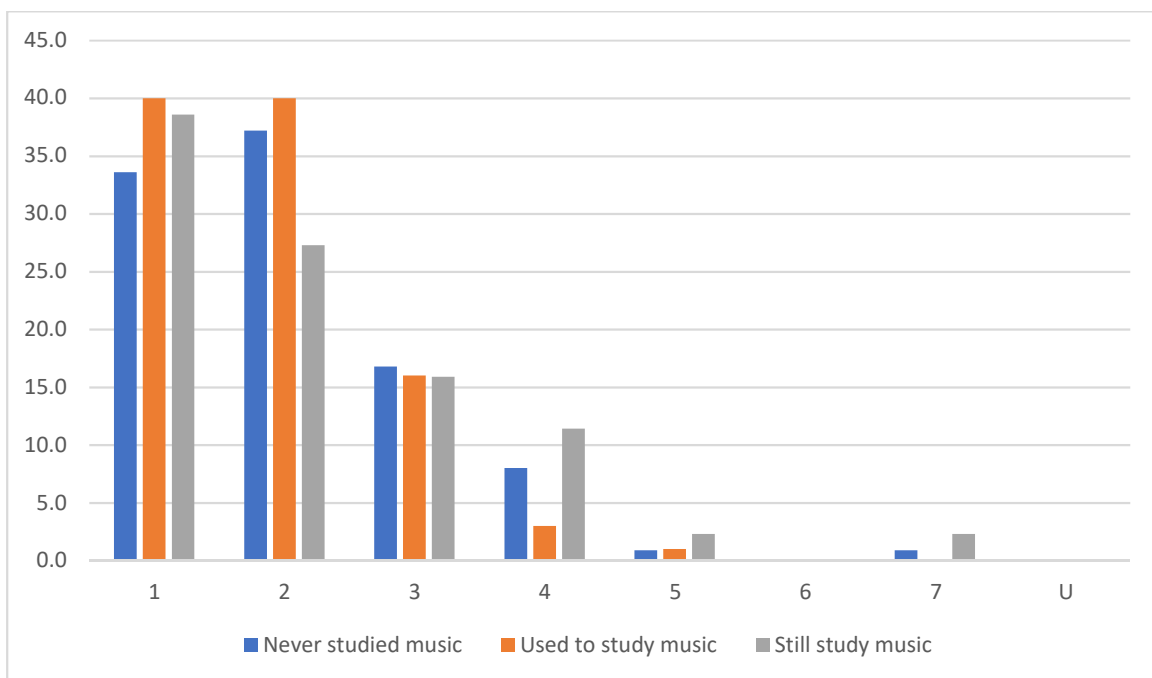


FIGURE 4.10 – PERCENTAGE NUMBER OF CHEMISTRY STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND GRADE OBTAINED IN THE ENGLISH SEC EXAMINATION

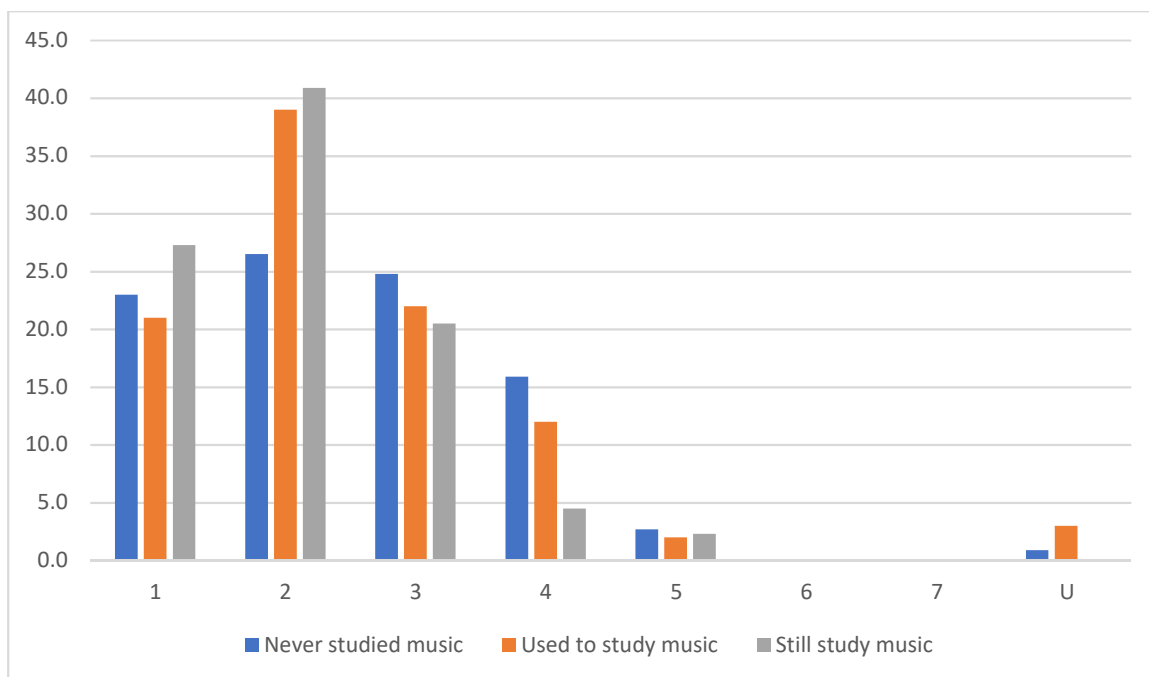


FIGURE 4.11– PERCENTAGE NUMBER OF CHEMISTRY STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND GRADE OBTAINED IN THE MALTESE SEC EXAMINATION

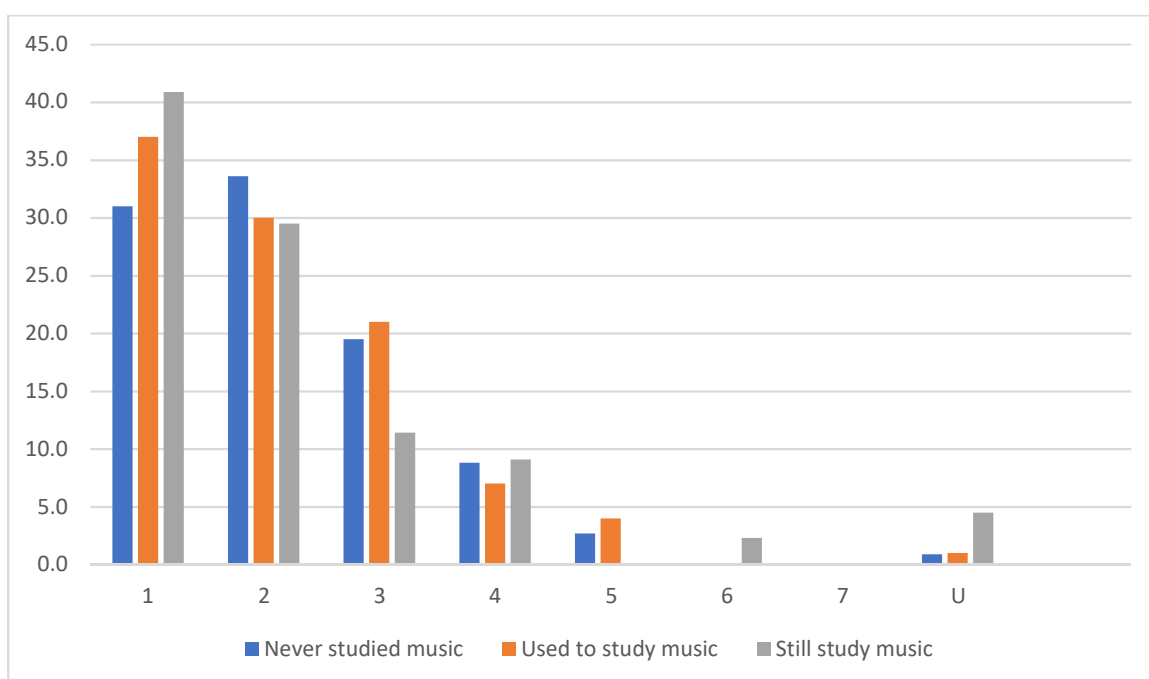


FIGURE 4.12– PERCENTAGE NUMBER OF CHEMISTRY STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND GRADE OBTAINED IN THE CHEMISTRY SEC EXAMINATION

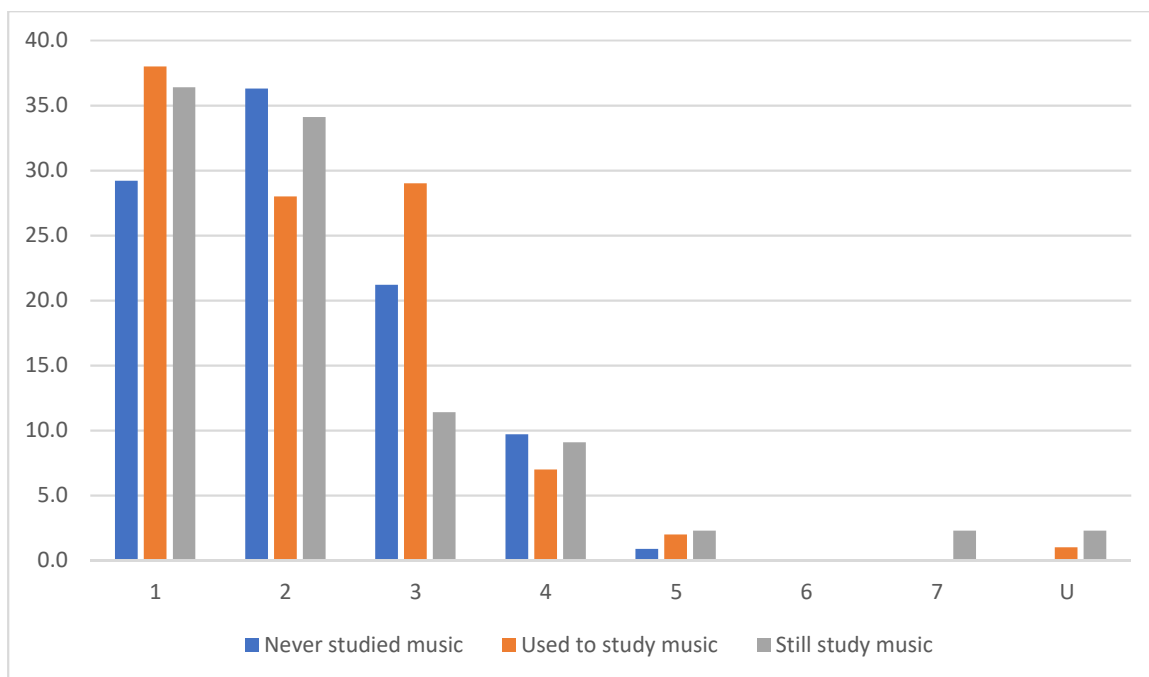


FIGURE 4.13– PERCENTAGE NUMBER OF CHEMISTRY STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND GRADE OBTAINED IN THE BIOLOGY SEC EXAMINATION

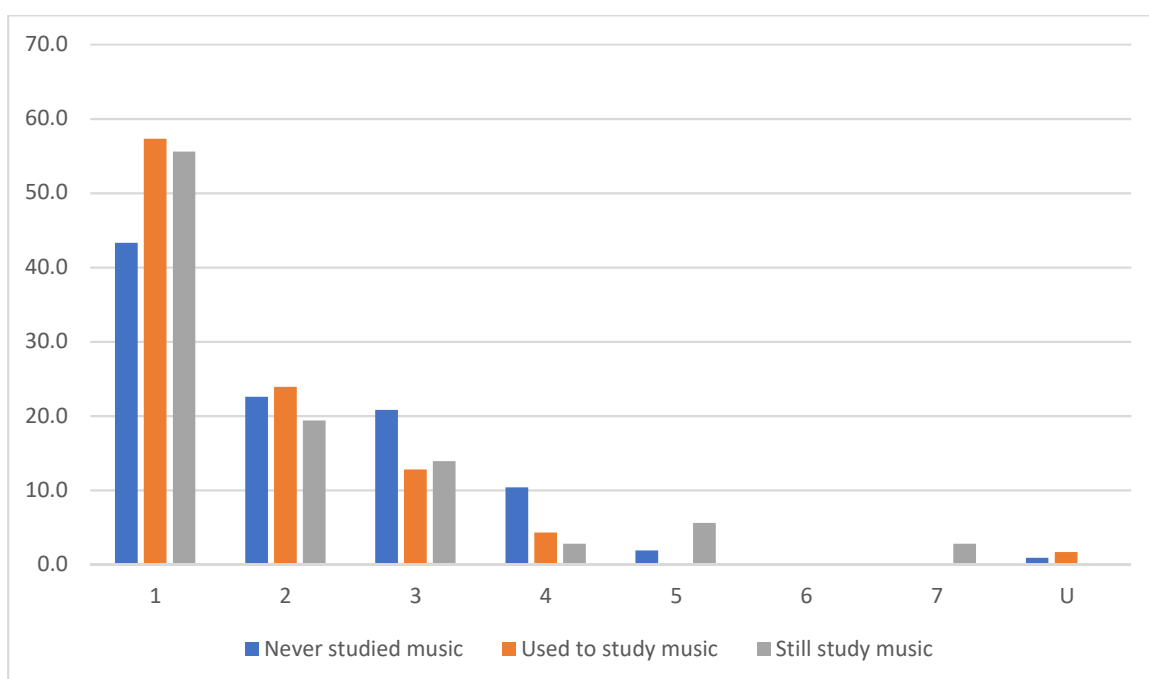


FIGURE 4.14– PERCENTAGE NUMBER OF CHEMISTRY STUDENTS ACCORDING TO WHETHER THEY STUDY MUSIC OR NOT AND GRADE OBTAINED IN THE PHYSICS SEC EXAMINATION

Figures 4.9 to 4.14 show that the largest percentage of students achieving a Grade 1 in each of the six subjects studied belong either to the category post-secondary CS-SSM or to the category post-secondary CS-USM.

Comparing the values for percentages of CS-SSM and CS-NSM in the Grade 1 category shows that in all six subjects, the percentage CS-SSM who obtained a Grade 1 is always larger than the percentage of CS-NSM who obtained the same grade. Table 4.14 shows these percentages, per group of students and per subject, and then shows the difference in percentage of students who achieved a Grade 1, between the groups. Figure 4.15 was then created, to visualise the results obtained in Table 4.14.

Subject	Percentage of students achieving a Grade 1 in SEC examinations		Difference in percentage (CS-SSM – CS-NSM)
	<i>CS-SSM</i>	<i>CS-NSM</i>	
Mathematics	48.8	39.1	9.7
English	39.5	34.5	5.0
Maltese	28.6	24.5	4.1
Chemistry	41.9	32.1	9.8
Biology	37.2	30.0	7.2
Physics	55.6	43.3	12.3

TABLE 4.14 – DIFFERENCE IN PERCENTAGE CS-SSM AND CS-NSM WHO ACHIEVED GRADES OF 1 IN SEC EXAMINATIONS OF VARIOUS SUBJECTS

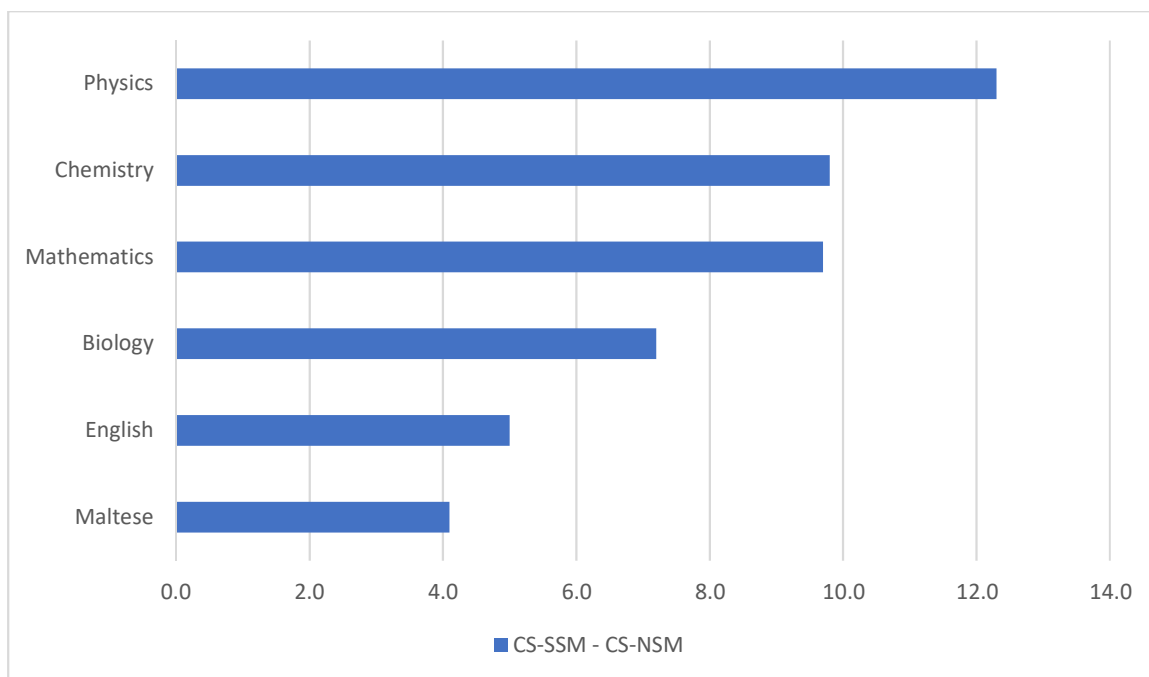


FIGURE 4.15 - DIFFERENCE IN PERCENTAGE ACHIEVEMENT BETWEEN POST-SECONDARY CS-SSM AND CS-NSM WHO ACHIEVED A GRADE 1

It is interesting to note that the subjects where the greatest difference is seen are physics, chemistry and mathematics, subjects which have a strong mathematical content and abstract concepts. Additionally, values for chemistry and mathematics are very similar, possibly due to the heavy mathematical input present in chemistry, such that if there is a link between music and mathematics, there is also one between music and chemistry.

On the other hand, the percentage of CS-USM who obtained a Grade 1 is larger than the percentage of CS-SSM for three of the subjects (English, biology and physics) and smaller than the percentage of CS-SSM for the other three subjects (mathematics, Maltese and chemistry). The individual values and the difference between these two categories are shown in Table 4.15 and Figure 4.16.

	<i>Percentage of CS-USM who achieved a Grade 1 (A)</i>	<i>Percentage of CS-SSM who achieved a Grade 1 (B)</i>	<i>Difference (A-B)</i>
Mathematics	37.0	48.8	-11.8
English	40.0	39.5	0.5
Maltese	21.0	27.9	-6.9
Chemistry	37.0	41.9	-4.9
Biology	38.0	37.2	1.2
Physics	57.3	55.6	1.7

TABLE 4.15 – DIFFERENCE IN PERCENTAGES BETWEEN POST-SECONDARY CS-USM AND CS-SSM WHO ACHIEVED A GRADE 1

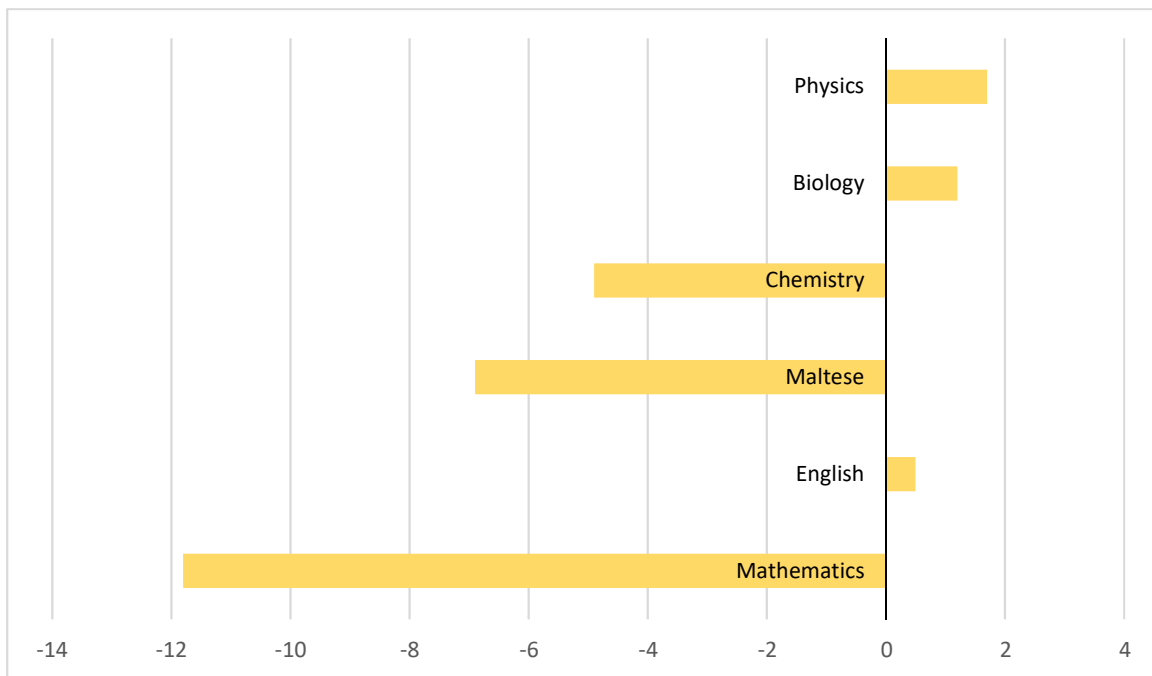


FIGURE 4.16 – DIFFERENCE IN PERCENTAGE ACHIEVEMENT BETWEEN POST-SECONDARY CS-USM AND CS-SSM WHO ACHIEVED A GRADE 1

Due to the lack of a clear pattern in the achievement of post-secondary CS-USM it was decided to focus efforts on comparisons of the other two categories (CS-NSM and CS-SSM). Nonetheless, it is very interesting to note the contrasting results obtained for mathematics and physics in this group, considering how closely related these two subjects are. Trying to explain these results would require an examination of the data for the two populations which unfortunately is beyond the scope of this study.

The comparison of the percentages of CS-NSM and CS-SSM who had achieved a mark in the highest achievement category for each of the six subjects (presented in Figure 4.15 for post-secondary students) was not carried out for Year 10 students. This is because Year 10 students across the three school sectors do not sit for the same examination, therefore it would not be entirely correct to compare the results obtained in each subject in this manner.

4.4 Confounding variables

The data presented in Section 4.3 point at the possible existence of a link between music training and academic achievement in secondary and post-secondary school students. As mentioned in Chapter 2, it is very difficult to prove causality as several confounding variables exist. Section 4.4 examines six such variables by comparing data for chemistry students who never studied music (CS-NSM) and chemistry students who still study music (CS-SSM) at both education levels, separately.

4.4.1 Time spent studying and revising chemistry

Study techniques vary widely and academic success may partly depend on many variables, such as out-of-school support and implementation of effective study skills. However, it is difficult to refute that good grades are the fruit of substantial amount of time spent studying and revising. The differences in achievement seen in Section 4.3 could simply be due to a greater proportion of time dedicated to study and revision. The following analysis of the data examines this argument.

4.4.1.1 Secondary schools

All the responses received were sorted according to the amount of time that students stated they spent studying, revising, and doing chemistry homework per week. The values returned were changed into a percentage of this overall population. This was repeated for the population CS-SSM (30 students) and CS-NSM (20 students), which considered solely those students who had achieved a mark of 76-100 in the annual chemistry examination for both categories. The results are presented in Figure 4.17. Most of CS-NSM spend either between one and three hours (50.0%) or more than three hours (40.0%) on chemistry-related work per week, whilst 43.3% and 36.7% of CS-SSM spend these amounts of time respectively. These data indicate that the higher-achievement results seen in Section 4.3 do not seem to be tied to the time dedicated to studying chemistry, when compared to CS-NSM.

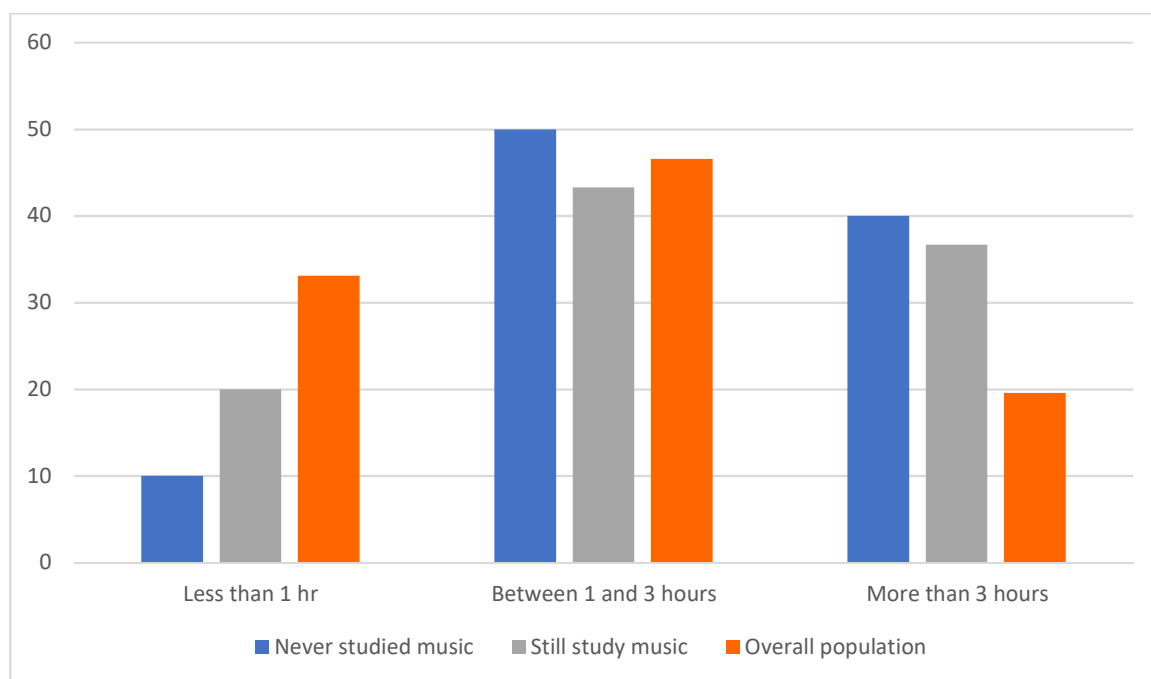


FIGURE 4.17 – PERCENTAGE OF TIME SPENT STUDYING AND REVISING AND DOING CHEMISTRY HOMEWORK PER WEEK – SECONDARY SCHOOL STUDENTS

4.4.1.2 Post-Secondary School Students

The data were analysed as described in Section 4.4.1.1. The data from students who had achieved a Grade 1 in the chemistry SEC examination were used (CS-SSM = 18 students; CS-NSM = 35 students). The results are presented in Figure 4.18. The largest proportion of CS-NSM spend more than three hours on chemistry-related tasks per week (77.1%), whilst the largest proportion of CS-SSM spend between one to three hours doing the same (55.6%). Here too, as for secondary-school students, the higher-achievement results seen in Section 4.3 do not appear to be proportional to the amount of time spent studying, revising and doing chemistry homework.

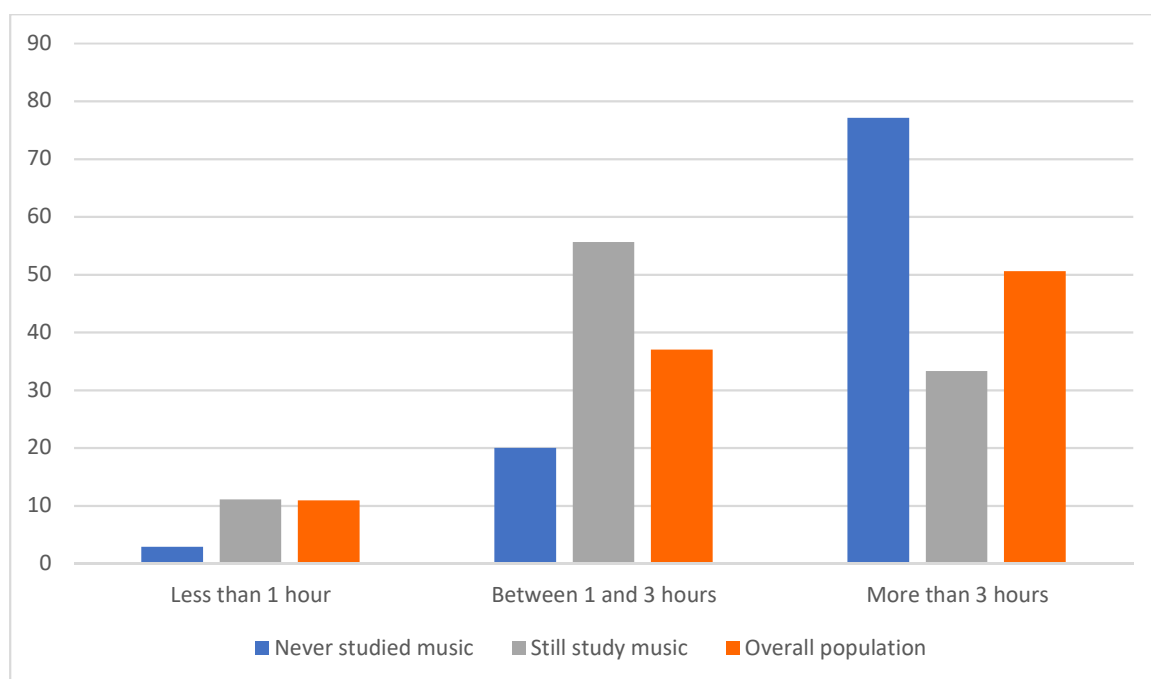


FIGURE 4.18 - PERCENTAGE OF TIME SPENT STUDYING AND REVISING AND DOING CHEMISTRY HOMEWORK PER WEEK BY HIGH-ACHIEVING POST-SECONDARY STUDENTS

4.4.2 Gender

4.4.2.1 Secondary Schools

Gender distribution within the categories CS-NSM, CS-SSM and the overall population of chemistry students in year 10 in secondary schools across Malta and Gozo was also examined.

The responses obtained from chemistry students in Year 10 were filtered for the highest achievement category (76-100) for chemistry and for CS-NSM. The numbers of females and males were noted. Next, all the responses received (163) were again sorted for the highest achievement category and for CS-SSM. The numbers of females and males were again noted. These data are presented in Table 4.16.

Student groups	Students in Year 10 who achieved a mark in the highest achievement category in chemistry	
	<i>Boys</i>	<i>Girls</i>
CS-SSM	15	15
CS-NSM	3	17

TABLE 4.16 - NUMBERS OF STUDENTS IN SECONDARY SCHOOLS SORTED ACCORDING TO GENDER

The gender distribution across all the Year 10 participants (the overall population), irrespective of the mark they obtained in the annual examinations, is 111 girls and 52 boys. The gender distribution of the CS-NSM group is similar to that of the overall population, but the gender distribution of the CS-SSM group is different from the other two groups. A higher number of boys in the high-achieving category studied music compared to those who did not.

4.4.2.2 Post-Secondary Schools

The responses obtained from post-secondary students were filtered to show those students who reported a grade of 1 till 7 and U in their chemistry SEC examination, giving a total of

252 responses. Of these, one respondent returned 'Other' when asked for gender and another respondent did not reply to this question. The remaining entries were sorted according to gender and the numbers of females and males were noted.

The 250 entries that had declared their gender as being either male or female were then filtered for chemistry SEC examination result: only those who had obtained a Grade 1 were considered. These were in turn sorted to return only those students who had never played a musical instrument and the numbers of females and males in this category was noted.

The 250 entries were again filtered for chemistry SEC examination result, considering only those who had obtained a Grade 1 and were still playing music. The entries returned were sorted into females and males. These data are presented in Table 4.17.

<i>Student groups</i>	<i>Students in post-secondary schools who achieved a Grade 1 in the SEC chemistry examination</i>	
	<i>Boys</i>	<i>Girls</i>
<i>CS-SSM</i>	9	9
<i>CS-NSM</i>	16	19

TABLE 4.17 - NUMBERS OF STUDENTS IN POST-SECONDARY SCHOOLS SORTED ACCORDING TO GENDER

The 250 post-secondary students involved in this analysis were composed of 174 females and 76 males. This gender distribution is similar to that seen in Section 4.4.2.1.

At post-secondary level, students who have achieved a high grade in the SEC chemistry examination are more balanced in terms of gender. Both male and female students in the CS-NSM category were equally likely to obtain a Grade 1.

4.4.3 Parental education

Parental education is generally an important factor to consider when discussing academic achievement. Considering this, the highest education levels completed by the mothers and

fathers of chemistry students in Year 10 were examined and compared between categories CS-NSM, CS-SSM and the overall population. The overall population refers to all the students who participated in the study, returning replies for 163 mothers and as many fathers.

4.4.3.1 *Secondary schools*

4.4.3.1.1 MATERNAL EDUCATION

The responses given by secondary school students were analysed by sorting for highest maternal educational level completed. Results are shown in Figure 4.19. Although a category 'not sure' was offered in the questionnaire, three students did not return a reply for this question. The results obtained for each category ('Tertiary', 'Post-secondary', 'Secondary', 'Primary' and 'Not sure') were changed into percentages of the overall population.

All the responses were then sorted for CS-NSM who had achieved a mark that fell in the bracket (76-100). The total number of mothers of CS-NSM was 20. The responses obtained were sorted for the various maternal academic levels. The raw data totals returned for each educational level were converted into percentages of this population.

There were 30 mothers of CS-SSM. The spread of maternal academic levels for CS-SSM who had obtained a mark in the highest achievement category was obtained. These values were converted into percentages of this population.

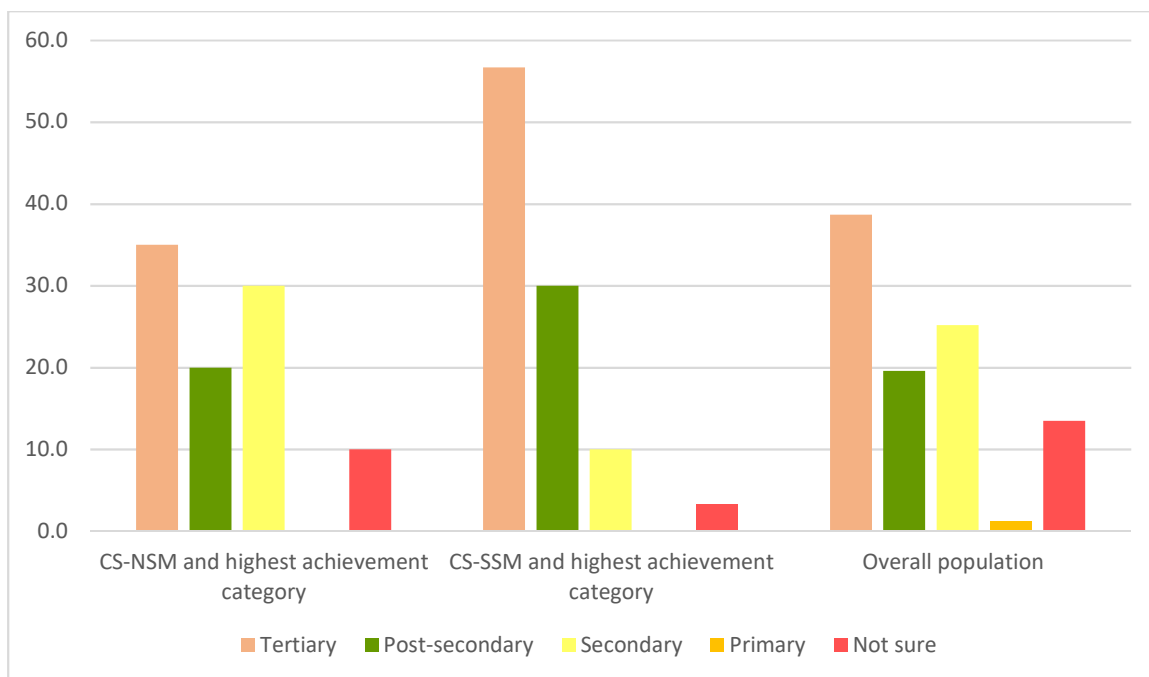


FIGURE 4.19 – PERCENTAGE DISTRIBUTION OF MOTHERS’ EDUCATION LEVEL FOR SECONDARY SCHOOL STUDENTS OBTAINING THE HIGHEST ACHIEVEMENT GRADE IN CHEMISTRY

From Figure 4.19, it seems that the maternal educational profile for CS-NSM follows that of the overall population. This is not so for mothers of the population of CS-SSM who have achieved a mark between 76 and 100 in the annual chemistry examination – there is a substantial decrease in the number of mothers whose education stopped at secondary school level (3 mothers out of 30), and a substantial increase in mothers who achieved post-secondary (9 mothers out of 30) and tertiary qualifications (17 mothers out of 30). Surprisingly, the percentage of mothers of CS-NSM who are in the highest achievement category who completed tertiary education (35%) is below the overall population value (39%) for this educational category.

4.4.3.1.2 PATERNAL EDUCATION

The data for Figure 4.20 was obtained in the same way as detailed in Section 4.4.3.1.1, sorting for paternal rather than maternal highest educational achievement. Here too, a small number of students (4 students) did not return a reply for this question.

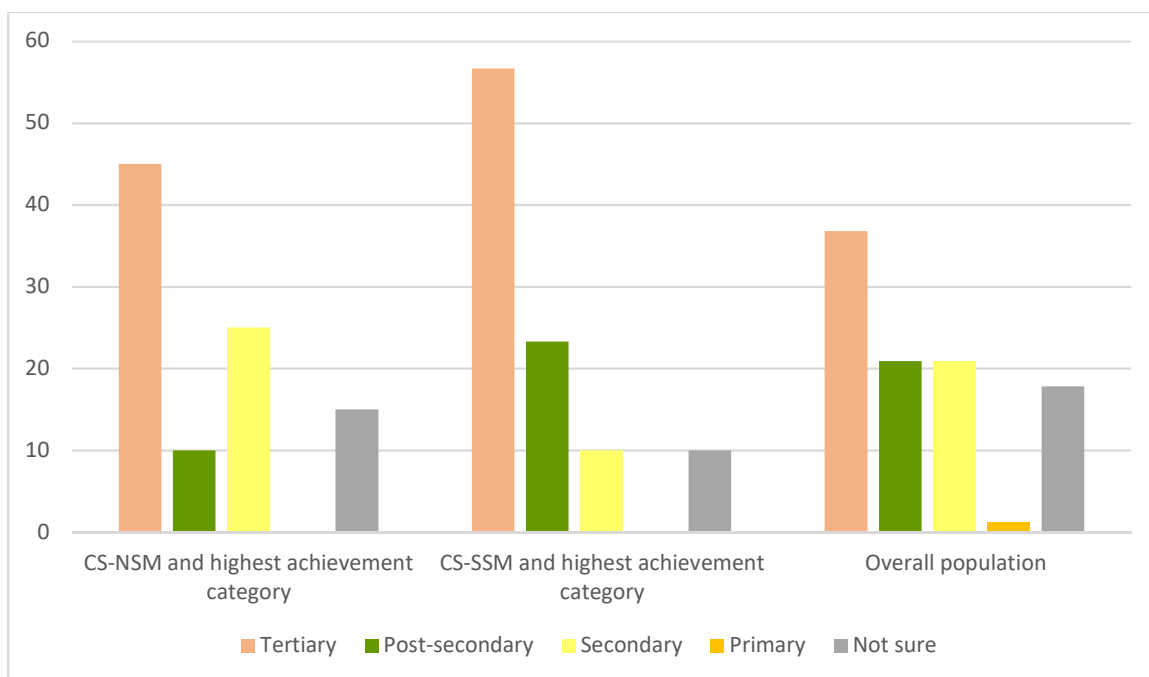


FIGURE 4.20 - PERCENTAGE DISTRIBUTION OF FATHERS' EDUCATION LEVEL FOR SECONDARY SCHOOL STUDENTS OBTAINING THE HIGHEST ACHIEVEMENT GRADE IN CHEMISTRY

There were 30 fathers of CS-SSM, and 20 fathers of CS-NSM.

The profiles of all three groups are distinct. Unsurprisingly, fathers of CS-SSM who are in the highest achievement category are more likely to have completed tertiary education compared to the overall population – the value for these fathers (17 fathers out of 30) is substantially higher than that for the overall population value (60 fathers out of 163). Similarly, fathers of high-achieving CS-NSM are also likely to have completed tertiary education, accounting for 45.0% of that population (9 fathers out of 20).

4.4.3.1.3 STUDENTS' ACHIEVEMENTS WHILST CONTROLLING FOR PARENTAL EDUCATION

In view of the results obtained above, the percentage number of Year 10 students who obtained a high mark in the chemistry annual examination and whose parents had completed tertiary education was analysed. The results are presented in Figure 4.21.

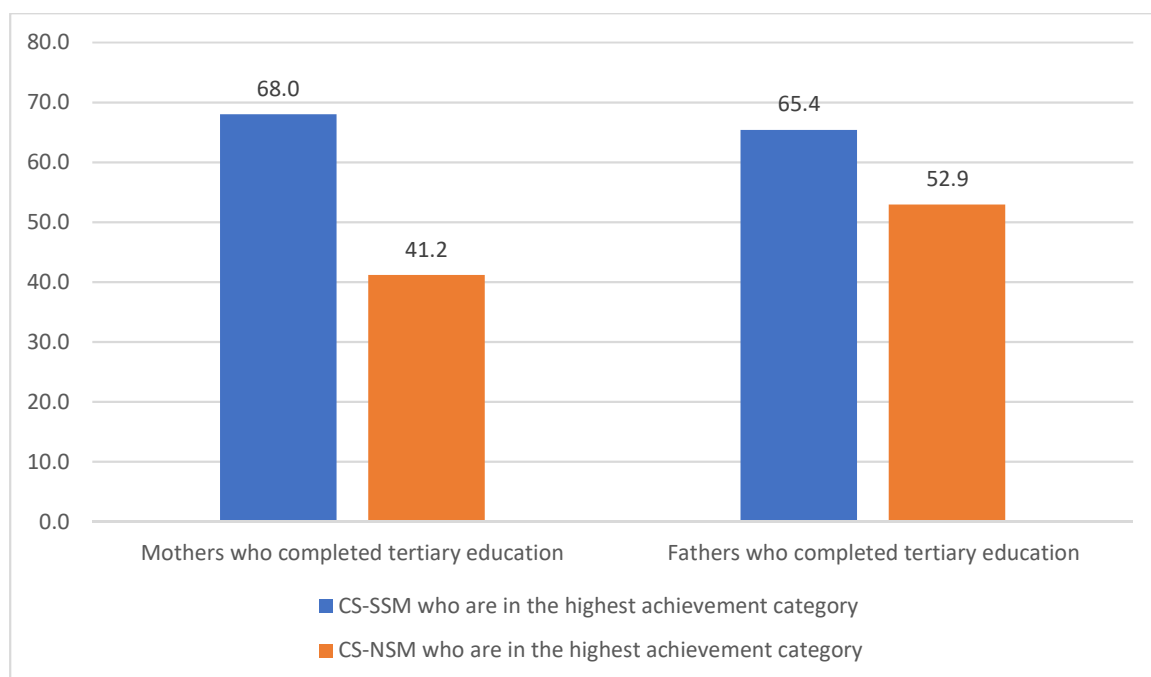


FIGURE 4.21 – PERCENTAGE OF HIGH-ACHIEVING CS-SSM AND CS-NSM WHOSE PARENTS HAVE COMPLETED TERTIARY EDUCATION

The results show that, even though parental education is kept constant, CS-SSM show higher percentages of students who achieve a high mark in the chemistry examination.

4.4.3.2 *Post-Secondary Schools*

4.4.3.2.1 MATERNAL EDUCATION

The data obtained from post-secondary school students were sorted to obtain an educational profile of mothers of post-secondary students.

Figure 4.22 shows the results obtained when examining the highest maternal educational level achieved. The responses given by post-secondary school students were sorted for the highest maternal educational level completed. Three students did not return a reply for this question. The results obtained for each category ('Tertiary', 'Post-secondary', 'Secondary', 'Primary' and 'Not sure') were changed into percentages of the population (257 students).

All the responses were then sorted for CS-NSM who had achieved a Grade 1 in their chemistry SEC examination (35 students). The responses obtained were analysed for the various maternal academic levels. The raw data totals returned for each educational level were changed into percentages of this population.

Similarly, the profile of maternal academic levels for CS-SSM who had obtained a Grade 1 in the chemistry SEC examination (18 students) was obtained and changed into percentages of this population.

The results obtained show a marked difference between the percentage number of mothers who completed their tertiary education, within the CS-NSM population (10 mothers) and the CS-SSM population (10 mothers).

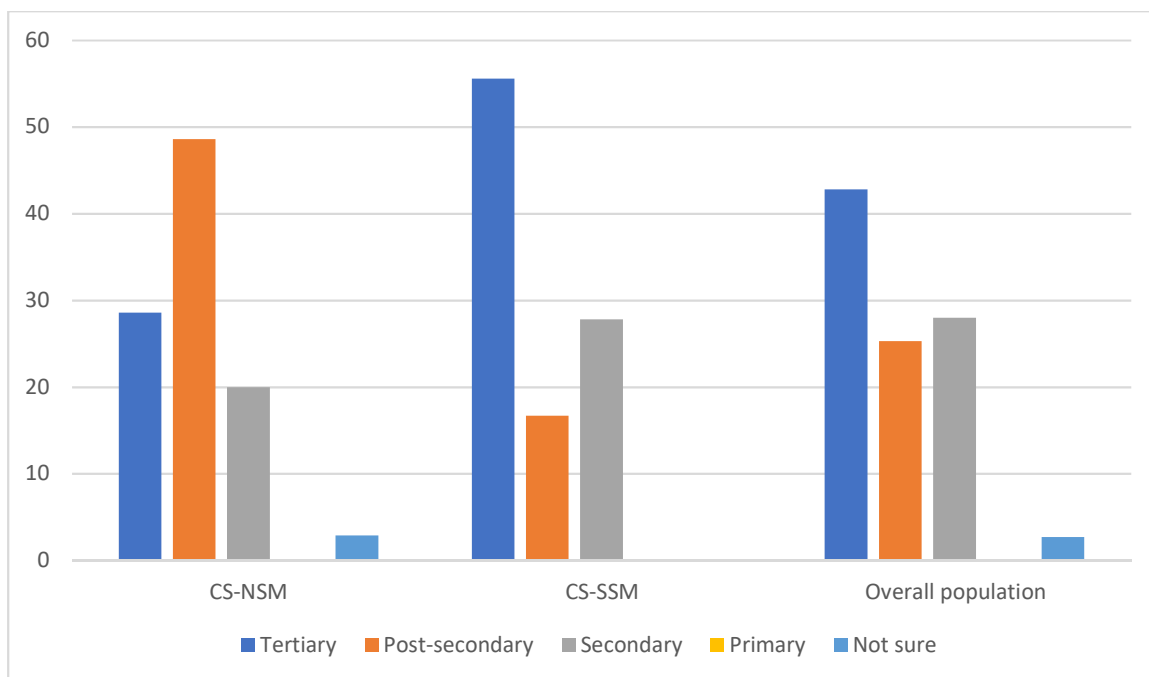


FIGURE 4.22 - PERCENTAGE DISTRIBUTION OF MOTHERS' EDUCATION LEVEL FOR POST-SECONDARY SCHOOL STUDENTS

4.4.3.2.2 PATERNAL EDUCATION

The procedure carried out in Section 4.4.3.2.1 was repeated to obtain paternal education profiles. The total number of fathers was 257. The results are presented in Figure 4.23, showing an unusual profile for fathers of CS-SSM. This population does not contain any fathers who stopped at post-secondary school level. Rather, it has the highest percentage of fathers who continued to tertiary education (11 fathers). The profile of fathers of CS-NSM follows that of the general population, with 18 fathers (51.4%) completing tertiary education compared with the 123 fathers (47.9%) obtained for the overall population of chemistry students.

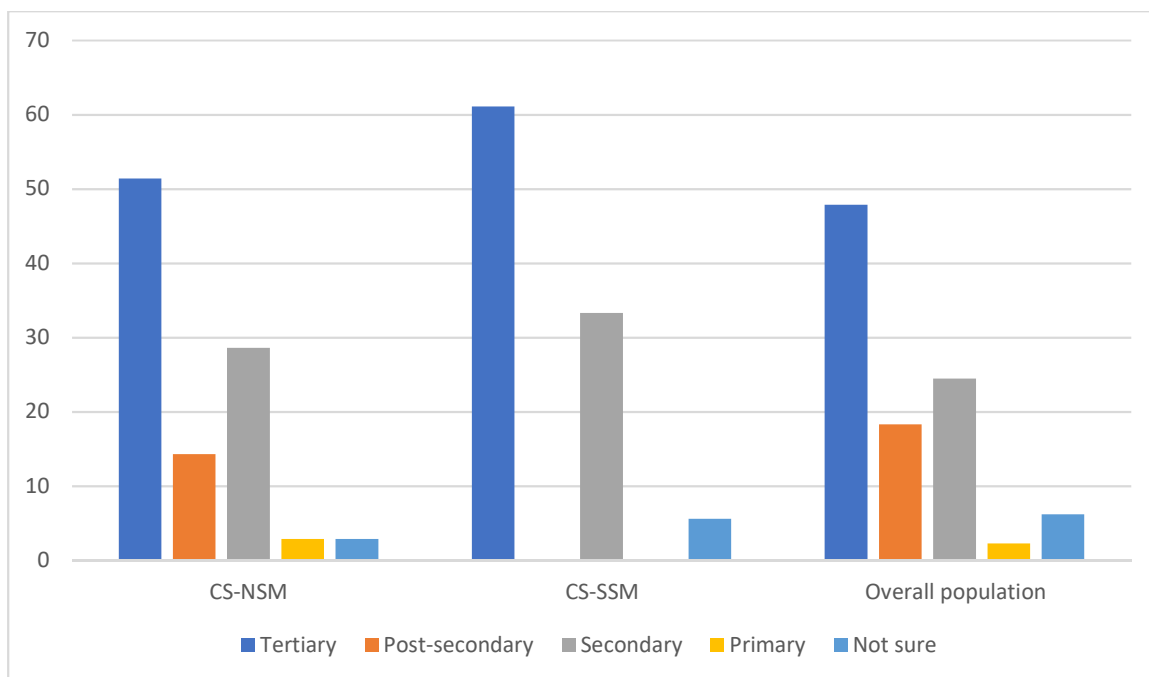


FIGURE 4.23 - PERCENTAGE DISTRIBUTION OF FATHERS' EDUCATION LEVEL FOR POST-SECONDARY SCHOOL STUDENTS

4.4.3.2.3 STUDENTS' ACHIEVEMENTS WHILST CONTROLLING FOR PARENTAL EDUCATION

The percentage number of post-secondary students who obtained a Grade 1 in the chemistry SEC examination, and whose parents had completed tertiary education was analysed. The results are presented in Figure 4.24.

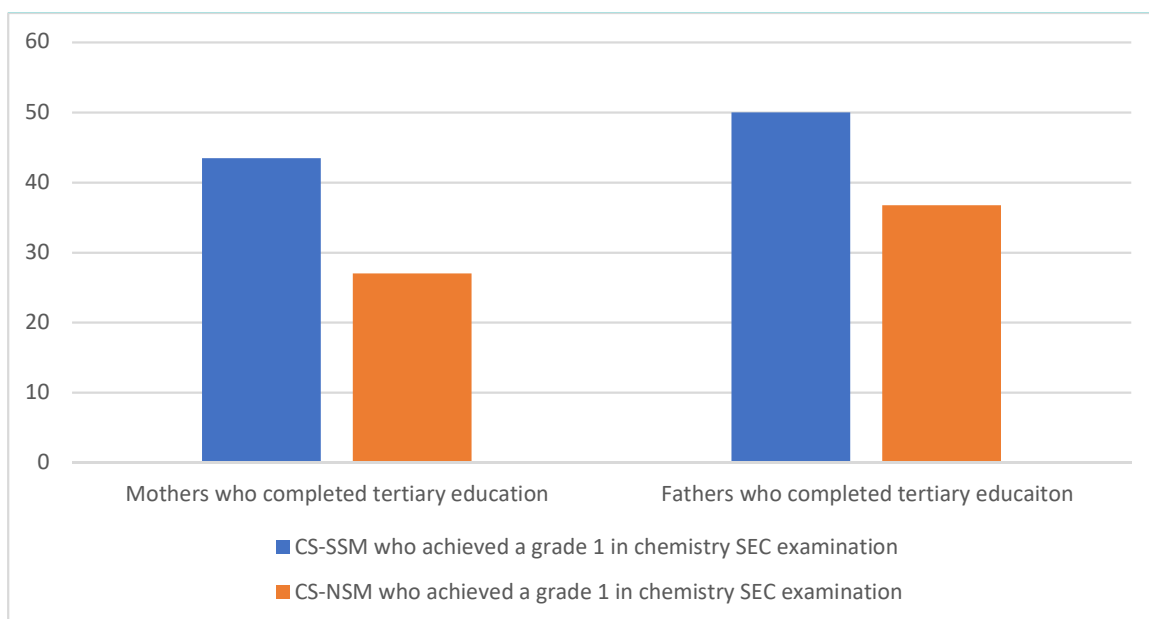


FIGURE 4.24 – PERCENTAGE OF CS-SSM AND CS-NSM WHO OBTAINED A GRADE 1 IN THE CHEMISTRY SEC EXAMINATION AND WHOSE PARENTS HAVE COMPLETED TERTIARY EDUCATION

Similarly to what was seen in the case of secondary school students (Section 4.4.3.1.3), the group CS-SSM has higher percentages of students who achieve a Grade 1 in the chemistry SEC examination than the group CS-NSM. In both cases, only parents who had completed their tertiary education were considered.

4.4.4 Student motivations to learn music

In view of the results above, it was decided to investigate the reasons why students commence music training, and why they continue to study music, if applicable.

4.4.4.1 Secondary school students

Information can be obtained about this if the replies returned by CS-SSM to the statements “Starting music was totally my choice” and “On most days, I would like to stop practising my musical instrument” are considered. The population of CS-SSM were presented with these two statements in a Likert scale item, with five possible answers ranging from ‘Strongly agree’ to ‘Strongly disagree’. The replies of all CS-SSM were changed into percentages, as were the replies of the highest-achieving group of the population CS-SSM. The results are presented in Figure 4.25 and Figure 4.26.

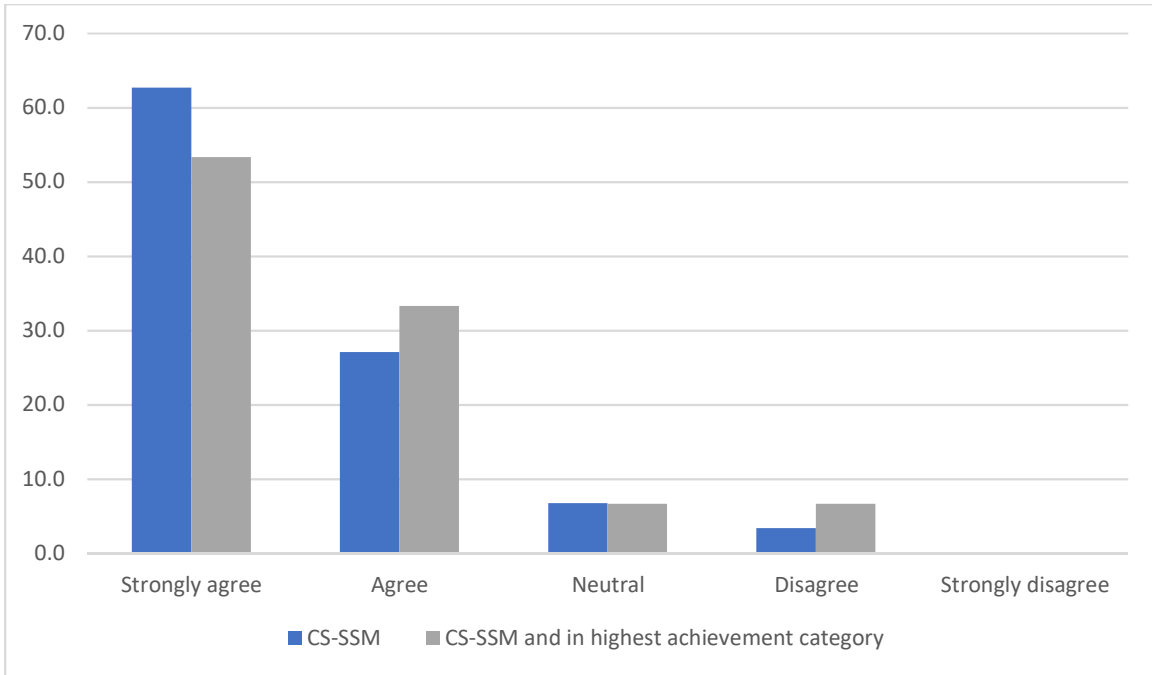


FIGURE 4.25 - REPLIES TO THE STATEMENT "STARTING MUSIC WAS TOTALLY MY CHOICE"

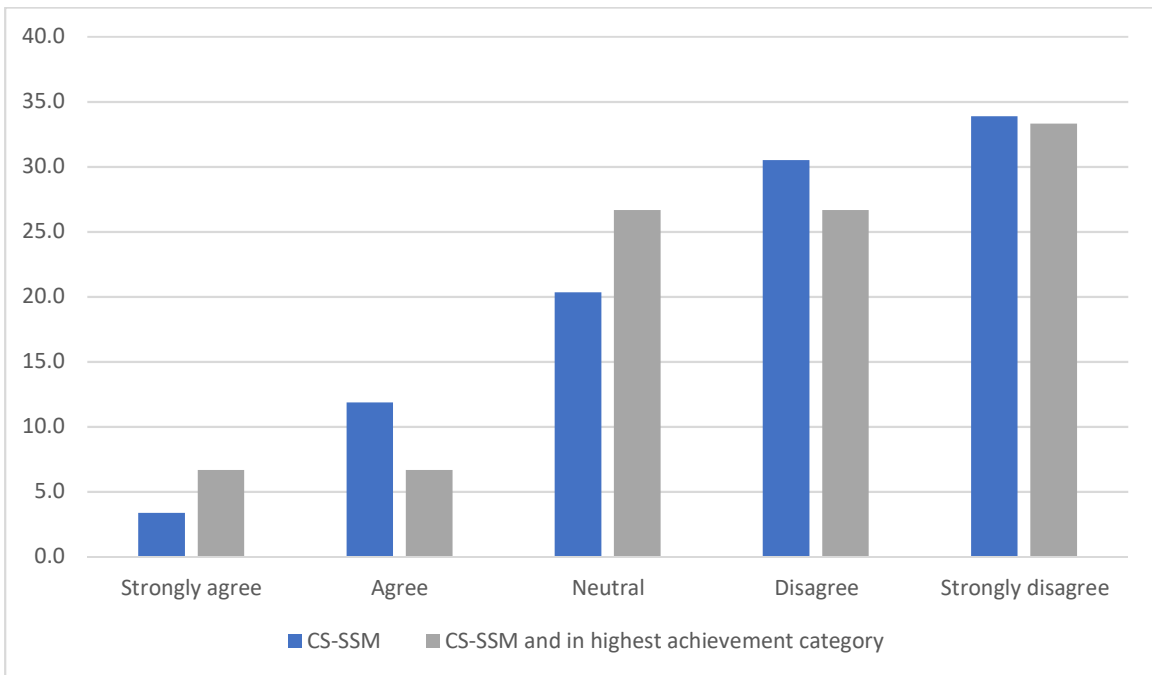


FIGURE 4.26 - REPLIES TO THE STATEMENT "ON MOST DAYS, I WOULD LIKE TO STOP PRACTISING MY MUSICAL INSTRUMENT"

Figure 4.25 indicates that both populations report that starting music was a personal choice, with the totals for the 'Strongly agree' and 'Agree' responses being 89.8% for the population of CS-SSM and 86.6% for those CS-SSM who additionally achieved a mark between 76-100 in their annual chemistry examination. Similarly, Figure 4.26 indicates that neither population would like to stop playing a musical instrument, with the totals for 'Disagree' and 'Strongly disagree' being 64.4% for all CS-SSM and 60.0% for those CS-SSM who additionally achieved a mark between 76-100 in their annual chemistry examination. Having an indication that the majority of CS-SSM have not been pressured into starting to play a musical instrument and would not like to stop playing music, the issue of what motivates them to continue their training is dealt with in Section 4.4.4.3.

4.4.4.2 *Post-secondary school students*

Once again, students' replies to the statements "Starting music was totally my choice" and "On most days, I would like to stop practising my musical instrument" can help understand the motivators that encourage these chemistry students to continue playing music. The replies to the Likert scale item in the questionnaire were changed into percentages of two separate populations: CS-SSM and CS-SSM who had additionally achieved a Grade 1 in the chemistry SEC examination. The results are presented in Figure 4.27 and Figure 4.28. These two figures follow generally similar profiles: both sets of students decided to start practising a musical instrument of their own accord. When presented with "Starting music was totally my choice", a total of 76.7% of CS-SSM replied "Strongly agree" and "Agree", whilst 83.3% for CS-SSM who had achieved a grade of 1 in chemistry gave the same replies. Similarly, Figure 4.28 indicates that CS-SSM are not in a hurry to stop practising music – a total of 74.4% for CS-SSM and 77.8% for CS-SSM who had achieved a Grade 1 in the chemistry SEC

exam replied “Disagree” or “Strongly disagree” when presented with “On most days, I would like to stop practising my musical instrument”.

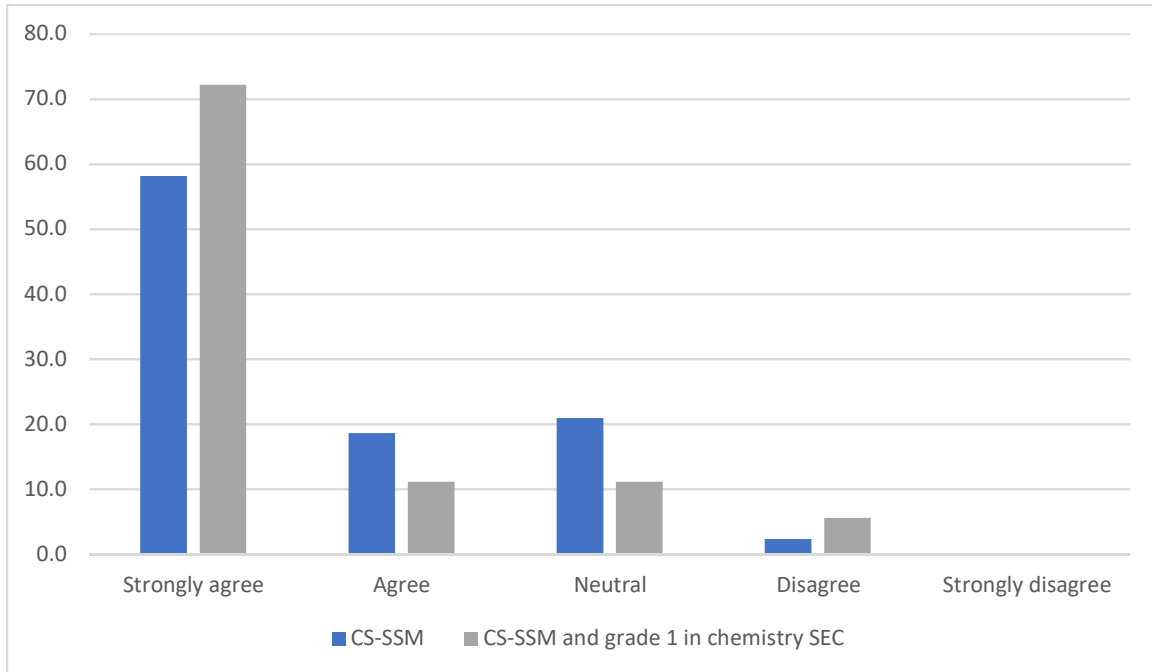


FIGURE 4.27 – REPLIES TO THE STATEMENT “STARTING MUSIC WAS TOTALLY MY CHOICE”

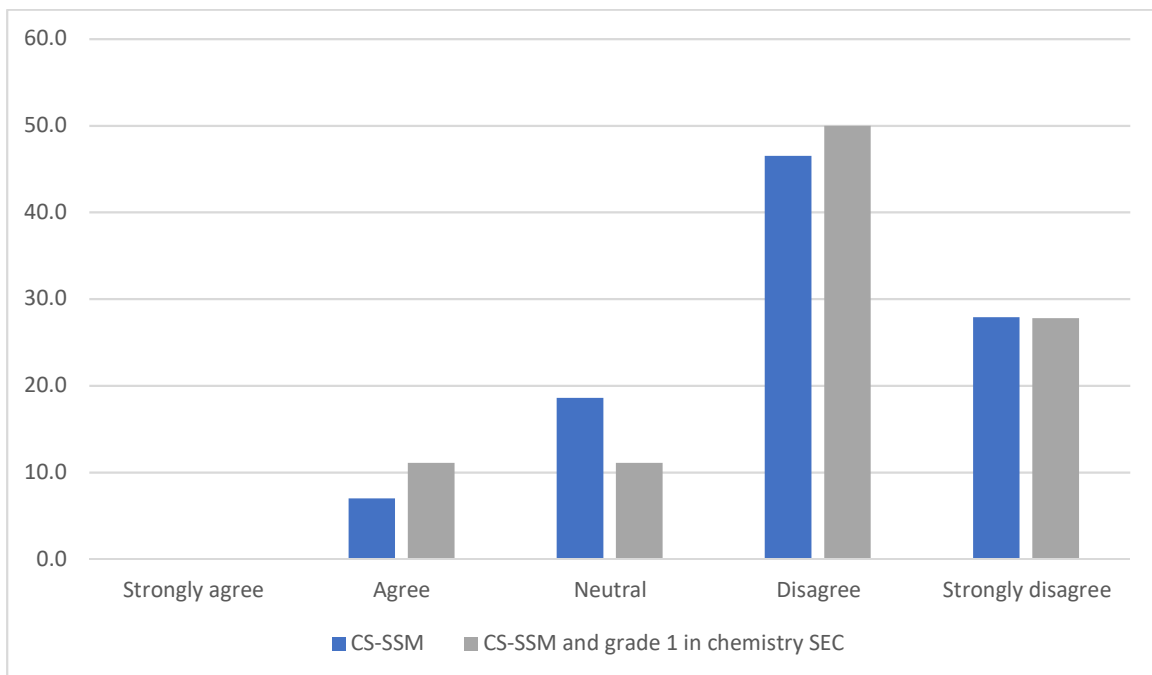


FIGURE 4.28 – REPLIES TO THE STATEMENT “ON MOST DAYS, I WOULD LIKE TO STOP PRACTISING MY MUSICAL INSTRUMENT”

4.4.4.3 *Motivators for secondary school and post-secondary school students*

The data in Figure 4.26 and Figure 4.28 indicate that students continue to practice music out of their own free will. Considering this, it is reasonable to look at the reasons why students continue to practice music. Looking at the motivating factors will allow us to see whether these motivators are also helping students in their academic studies, particularly chemistry.

The responses to Question 19 given to both secondary and post-secondary students are very similar and will therefore be reported in one table. In total, 53 students at secondary and 40 students at post-secondary level replied to this question out of a possible 59 and 43 CS-SSM respectively. The nine commonest answers given by students are listed in Table 4.18. In cases where a student gave more than one reason for continuing music training, each reason was entered as a separate entry, so that all the information given by the students could be represented.

<i>Grouped categories</i>	<i>Number of responses</i>	
	<i>Secondary schools</i>	<i>Post-secondary schools</i>
<i>Music is a stress-reliever</i>	19 (36%)	15 (38%)
<i>Love making music / Music is fun</i>	21 (40%)	11 (28%)
<i>Opens various opportunities</i>	3	4
<i>Means of self-expression</i>	2	8
<i>Makes others happy</i>	2	2
<i>Succeeding at a new task</i>	7 (13%)	10 (25%)
<i>Music exams are recognised qualifications</i>	2	2
<i>Future/current source of income</i>	3	2
<i>Helps develop/maintain social skills/relationships</i>	2	3

TABLE 4.18 - REASONS GIVEN BY CS-SSM FOR CONTINUING TO LEARN MUSIC

The three main motivators are the same at both educational levels, however their relative importance seems to vary. Music is a stress-reliever for both sets of students, however post-secondary chemistry students seem to place more importance on the feelings of success associated with completing a task. This aspect was also mentioned in the interviews carried out with the four chemistry graduates who have also received musical training (Section 4.6).

4.4.4.4 *Motivators for undergraduates/postgraduates/alumni*

Undergraduates, postgraduates and alumni enjoy playing music because it tends to put them in a good mood most of the time. They enjoy its relaxing and soothing effect. One participant very eloquently explained:

“Music helps me relax and unwind after a stressful day at work. It also helps me quietly and calmly contemplate any pressing thoughts which I have and decisions which I must make in a logical, sensible, and clear manner.”

4.4.5 *Effect of instrument on achievement in chemistry*

Playing music is not an easy task – the musician must read musical notation and translate the notes into physical movements, whilst actuating changes in speed, loudness and mood. When part of an ensemble or orchestra, the musician must also be aware of the conductor and fellow musicians and adjust his or her playing accordingly. Nonetheless, certain instruments are traditionally said to be more difficult to play or require more musical aptitude than others. In this section, students’ achievement and the instrument they play will be analysed, to try and understand whether there is a relationship between these two factors.

4.4.5.1 *Secondary school students*

All the respondents who play a musical instrument, irrespective of the grades obtained in examinations, were presented with a question listing six instrument groups and were asked to mark all the instruments they play. The replies indicate that 43 students play one musical instrument, 11 play two instruments, four students play three instruments whilst one student plays five instruments. The responses of all CS-SSM were then sorted according to the replies given and these were then changed into percentages of the total population of CS-SSM. The responses were then filtered for CS-SSM who were in the highest achievement category. The number of respondents who played each of the six instrument groups were noted and then changed into percentages of the population of CS-SSM who were in the highest achievement category. The results presented in Figure 4.29 therefore show the percentages CS-SSM and CS-SSM who are in the highest achievement category who play each instrument. The data in Figure 4.29 indicate that there is no substantial difference in the profiles of the two populations, possibly indicating that the type of instrument played did not influence achievement.

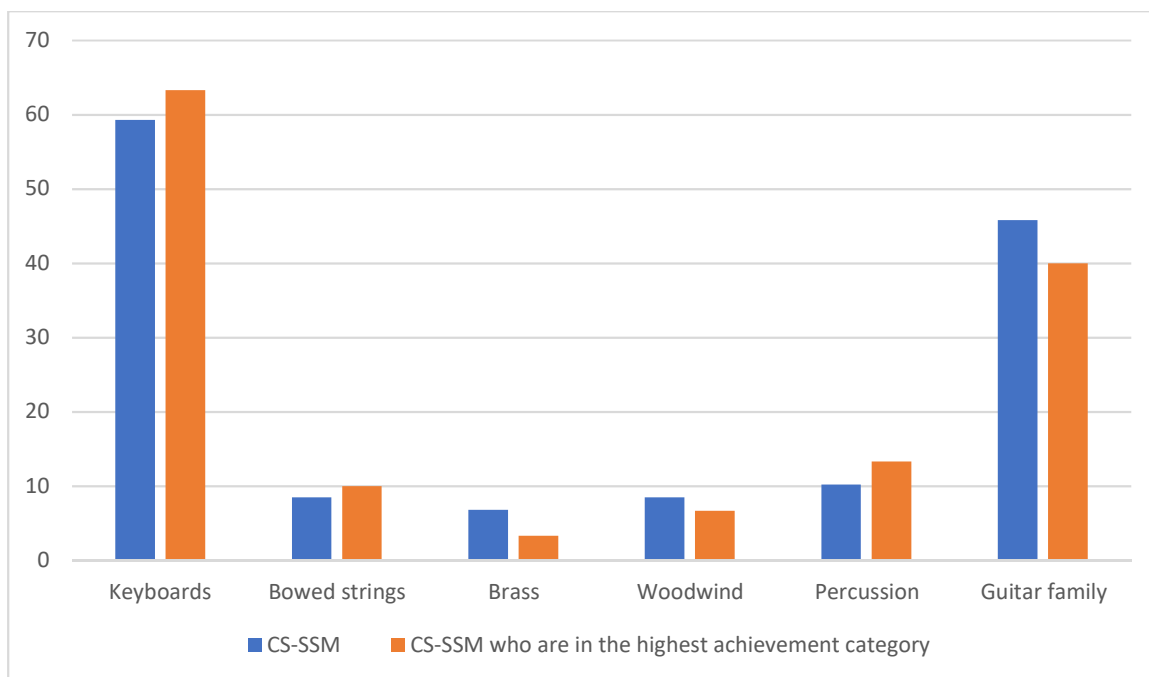


FIGURE 4.29 – PERCENTAGE SECONDARY CS-SSM ACCORDING TO THE INSTRUMENT GROUP PLAYED

4.4.5.2 *Post-secondary school students*

The instrument groups played by all post-secondary CS-SSM were noted and then changed into percentages; 29 students play one musical instrument, 11 play two instruments, and one student plays four instruments. The same was done for CS-SSM who had achieved a Grade 1 in the chemistry SEC examination. The results presented in Figure 4.30 therefore show the percentages CS-SSM and CS-SSM who obtained a Grade 1 in the chemistry SEC examination who play each instrument. The data presented in Figure 4.30 indicate that there is no substantial difference in the profiles of the two populations

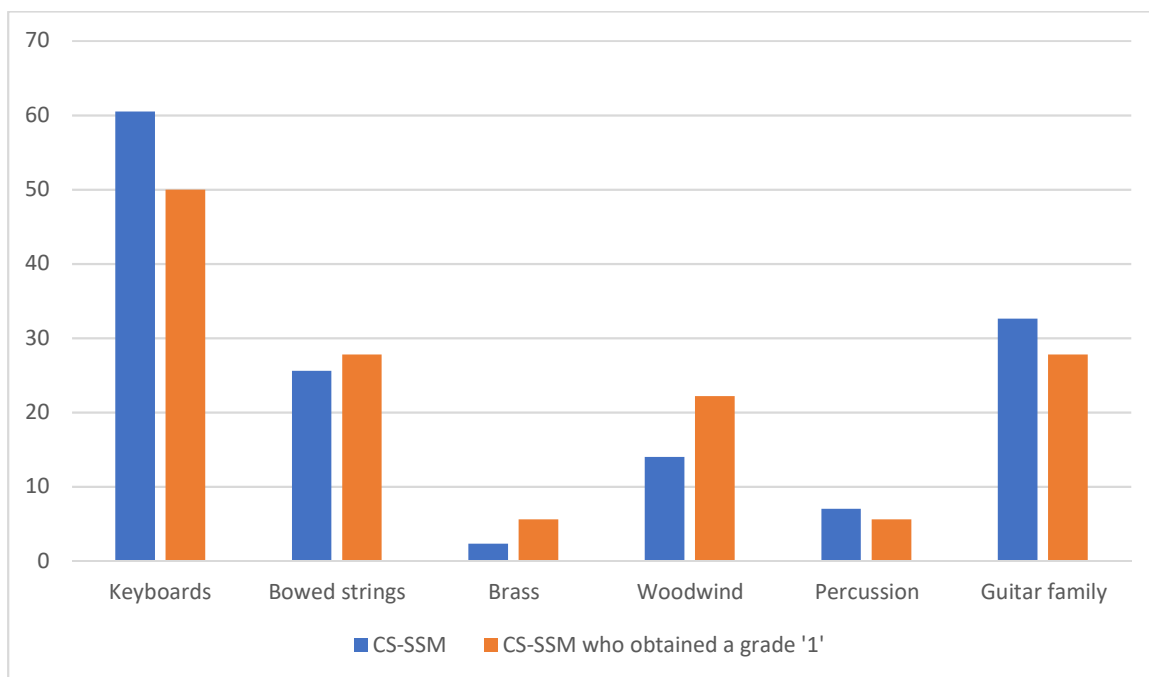


FIGURE 4.30 – PERCENTAGE POST-SECONDARY CS-SSM ACCORDING TO THE INSTRUMENT GROUP PLAYED

4.4.6 Age at which musical tuition commenced

The age at which music tuition starts might make a difference to the possible intensity of effect seen on academic results. To test this, the study looked at the result obtained in the chemistry examinations and the age at which the students started their music tuition, to observe whether any patterns would emerge.

The group of CS-SSM were sorted according to the age at which they started music training. All the results obtained were then grouped according to the mark they had obtained in the chemistry annual examination. The results are presented in Table 4.19.

Age started	Grades obtained in chemistry annual examination			
	0-25	26-50	51-75	76-100
2	0	0	1	0
3	0	0	0	0
4	0	1	3	0
5	0	2	3	1
6	0	3	2	10
7	1	2	7	9
8	0	0	9	6
9	0	3	8	4
10	0	2	3	3
11	0	2	0	2
12	0	0	5	3
13	0	0	3	3
14	0	1	1	0

TABLE 4.19 – MARK OBTAINED BY SECONDARY SCHOOL STUDENTS IN THE ANNUAL CHEMISTRY EXAMINATION BASED ON THE AGE OF STARTING MUSICAL TUITION

Post-secondary students were grouped according to age at which they started music tuition and the grades obtained in the chemistry SEC examination. The results are presented in

Table 4.20.

Age started	Grades obtained in chemistry SEC examination							
	1	2	3	4	5	6	7	8
3	0	0	1	0	0	0	0	0
4	3	2	0	0	0	0	0	0
5	4	1	2	1	0	0	0	1
6	10	7	4	1	0	1	0	0
7	14	12	4	2	1	0	0	1
8	9	7	5	1	0	0	0	0
9	9	2	3	0	0	0	0	1
10	2	4	3	1	0	0	0	0
11	3	2	0	2	2	0	0	0
12	0	1	0	2	0	0	0	0
13	0	1	2	1	1	0	0	0
14	0	2	1	0	0	0	0	0
15	0	0	0	0	0	0	0	0

TABLE 4.20 – GRADE OBTAINED BY POST-SECONDARY SCHOOL STUDENTS IN THE CHEMISTRY SEC EXAMINATION BASED ON THE AGE OF STARTING MUSICAL TUITION

It seems possible that early exposure to music lessons might be associated with higher grades.

4.4.7 Time spent practising music

The time spent practising a musical instrument might be one of the factors that impact on the academic results obtained by the students. The link between time spent practising music and the mark or grade obtained in chemistry examination is presented in Table 4.21 (secondary school students) and Table 4.22 (post-secondary school students).

The responses returned by the students were sorted for the total amount of time they spend practising music, per week. These results were grouped in five categories indicating time. The numbers of students in each time category were then sorted for the result obtained in the chemistry examination.

Mark obtained in chemistry annual examination	Time spent practising a musical instrument per week (minutes)				
	135 - 264	265 - 394	395 - 524	525 - 654	655 - 784
76 – 100	8 (53%)	7 (50%)	9 (56%)	3 (50%)	1 (25%)
51 – 75	4	5	5	3	1
26 – 50	3	2	2	0	2
0 – 25	0	0	0	0	0
Total number of students	15	14	16	6	4

TABLE 4.21-THE MARK OBTAINED IN THE CHEMISTRY ANNUAL EXAMINATION BY YEAR 10 CS-SSM AND THE TIME SPENT PRACTISING MUSIC

Mark obtained in chemistry SEC examination	Time spent practising a musical instrument per week (minutes)				
	135 - 264	265 - 394	395 - 524	525 - 654	655 - 784
1	5 (42%)	3 (38%)	4 (36%)	2 (50%)	4 (50%)
2	4	5	2	0	2
3	1	0	4	0	0
4	2	0	0	1	1
Total number of students	12	8	*11	*4	*8

The asterisk signifies that some students achieved a grade below 4 and are therefore not shown in the table

TABLE 4.22 – THE MARK OBTAINED IN THE CHEMISTRY SEC EXAMINATION BY POST-SECONDARY CS-SSM AND THE TIME SPENT PRACTISING MUSIC

The results obtained do not show a clear trend across secondary and post-secondary educational levels.

4.5 The link between music training and achievement in chemistry – students’ opinions

Chemistry students who play a musical instrument were presented with the statement “Learning music has helped me in my school subjects” in a Likert scale item. They were asked to respond, depending on their level of agreement with the statement.

4.5.1 Secondary school

The replies returned were sorted into two separate populations – the overall population of CS-SSM (59 students) and those who additionally were in the highest achievement category for chemistry (30 students). The numbers obtained were then changed into percentages and compared, as shown in Figure 4.31.

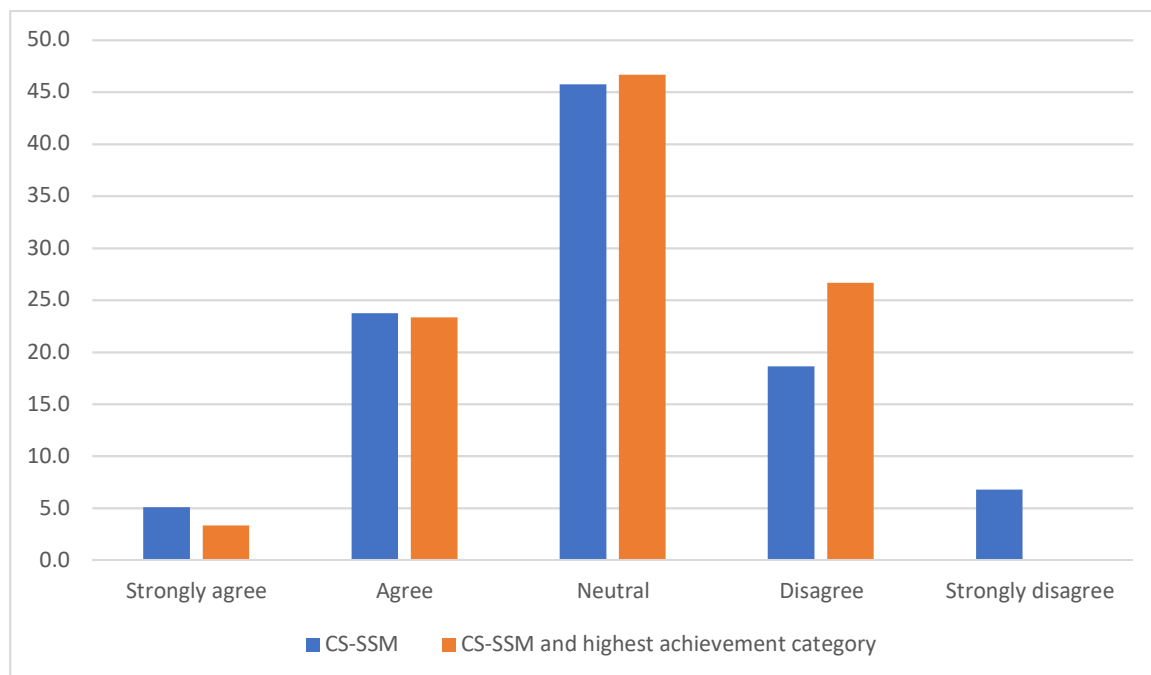


FIGURE 4.31 - SECONDARY SCHOOL STUDENTS' OPINIONS ABOUT THE LINK BETWEEN MUSIC AND CHEMISTRY (“LEARNING HAS HELPED ME IN MY SCHOOL SUBJECTS”)

Of the four students in the population CS-SSM (all grades) who entered 'Strongly disagree', one student left the following comment when asked why s/he continues playing music:

"Seeing other guitarists play really motivates me to keep going and push my limits to learn other new skills..."

Another student, who entered 'Disagree' wrote:

"It relaxes me, and I find it cool. I also think that music would help me to develop my communication skills. I also enjoy playing and meeting with new people through music."

Out of 11 students who disagreed, five stated that it relaxes them.

These replies indicate that students took a narrow perspective when considering how extra-curricular activities can be beneficial to academic education. Surely, learning "to keep going and push [one's] limits" is an important skill to possess and can be used when learning chemistry and other subjects. The same can be said about the value of having an activity which relaxes and recharges the mind, in between bouts of studying.

4.5.2 Post-secondary school

The replies returned for post-secondary school students were sorted as per Section 4.5.1.

Two populations were compared – the overall population of CS-SSM (43 students) and those who additionally had achieved a Grade 1 in their chemistry SEC examination (18 students).

Within the overall population of CS-SSM, two students did not give an answer to this question. The numbers obtained were changed into percentages and compared. The results are presented in Figure 4.32.

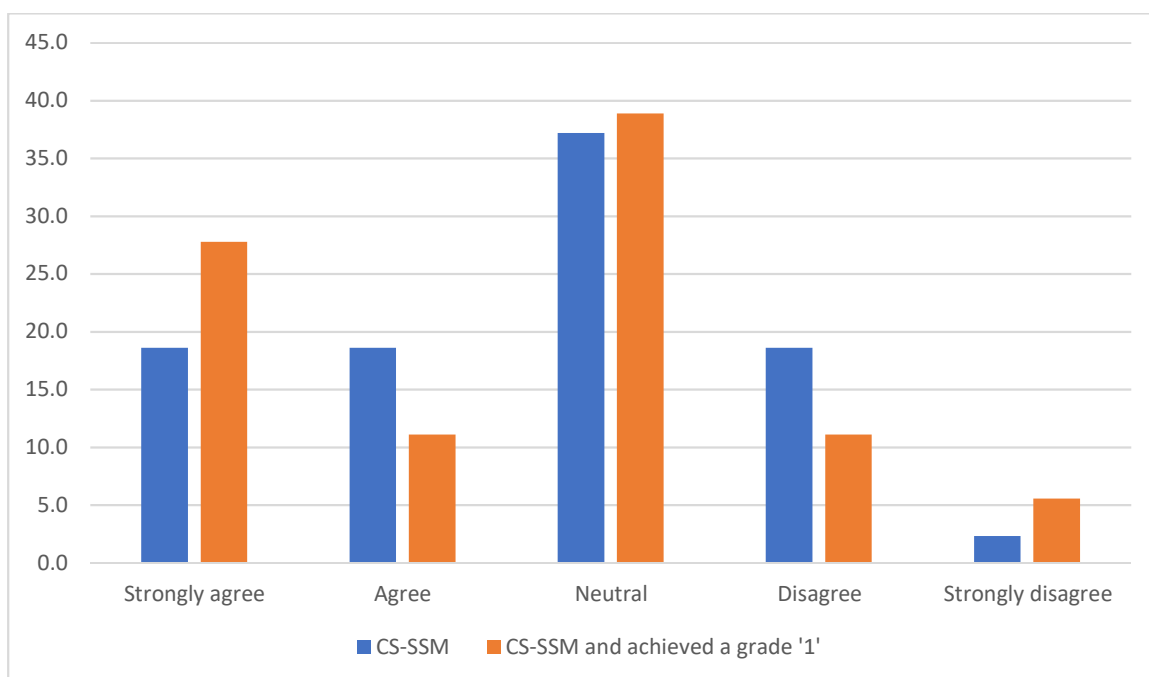


FIGURE 4.32 - POST-SECONDARY SCHOOL STUDENTS' OPINIONS ABOUT THE LINK BETWEEN MUSIC AND CHEMISTRY ("LEARNING MUSIC HAS HELPED ME IN MY SCHOOL SUBJECTS")

At this educational level, one student strongly disagrees that music has helped in school subjects; however, the main motivator to continue playing music is:

"The satisfaction I get from achieving a particular technique"

Examining some of the main motivators to continue musical training for those students who 'Strongly agree' or 'Agree' (16 in total) that music has helped them academically, presents the following statements:

"I have reached the final stages of learning the instrument and my fellowship exam motivates me to improve my technique."

"[music] improves the way I think about life in general."

"The joy of continuing to learn the depth of thought that goes into writing music..."

“I know that if I keep practising, I will sound better and be able to play harder pieces well.”

Six students out of 16 say that music calms them down and puts them in a good mood.

From these replies, students at post-secondary level seem capable of linking the peripheric benefits obtained from playing music with improvements in the academic arena.

4.6 The interviews

Four individuals accepted to sit for an interview. All four participants have studied chemistry at the University of Malta and have a strong background in music. More details about the interviewees was presented in Table 3.1.

4.6.1 Family background

There was variety in the degree of presence of music in the families of the interviewees; P1, P2 and P3 all had family members who played, or used to play a musical instrument: P1's mother and father had received musical training, whilst P2's and P3's mothers used to play a musical instrument. Additionally, members of P1's and P3's extended family were musically active. On the other hand, the parents of P4 did not play a musical instrument, although her father was musically inclined.

In two cases, mothers were the driving force behind P2 and P4's reasons to start music:

Int: What lead to your musical training?

P2: *“Heh, my mother! My mother was musically inclined, she always loved music.*

However, in terms of training, she was the one who pushed me towards official

certifications.” “Music was a part of her life – she used to play the piano herself when she was younger.”

P4: “Mhux mummy wanted me to go!”

In the other two cases, mothers were the ones who approached music tuition cautiously:

P3: “I used to visit my cousins and play the piano by ear, but my parents wanted to start me off at 8 [years old], so I had no choice but to start the lessons at 8.... I was really keen to start earlier; I was very enthusiastic to start.”

Interestingly, not all siblings in the family were sent to music lessons:

P1: “...my elder brother never played anything, because he never showed interest, so I was never pushed into it....it was my decision.”

P2: “She didn’t do it [send son/daughter to music lessons] to all my brothers and sisters. I was the only one to be sent to piano lessons.”

4.6.2 Chemistry - attitudes and grades

All the interviewees had engaged well with chemistry in secondary school. They found it enjoyable, despite - and sometimes because of - it being challenging and managed to obtain the highest grade in their chemistry SEC examination. For the most part, the satisfaction they felt when studying chemistry did not change appreciably during their post-secondary school years, although they did find the material increasingly challenging and “*grades started slipping*” (P2) through post-secondary education and into tertiary education. The attitudes towards chemistry at university were more diverse among the participants:

P2: "I always had an aptitude and a natural curiosity about how things work.

Chemistry was my favourite [science subject] and still is today, because it helps me understand the world around me and be in control of what is happening."

Int: Did your feelings toward the subject change throughout the years?

P2: "No, in fact throughout my years at sixth form and university, I was not only involved in learning, but I was also promoting science to others."

P3: "[Chemistry] was good fun for me. I love challenges and it was a really cool challenge for me."

"I studied very hard for my O levels, and I remember – going to the exams – telling my mum 'ok, I'm going to go in and enjoy myself, it's going to be like a game.'

Chemistry to me was like a maze – one thing leads to the other and it's all connected. It was never about remembering things."

Int: Did these feelings change on going to university?

P3: "It was always like that. It was always a game. Always more complex, but I have fond memories, even of the exams. I never was afraid of the exams. I went and enjoyed myself... always being very well prepared because then things were very complex. It was always about having a challenge and if you like challenges, it is something that you enjoy doing."

P1: "Chemistry was always my primary choice. I loved chemistry. At 6th form, things changed a bit – I think I started loving biology more – but nonetheless I was always set for B.Sc., whatever the grade, because I thought that the syllabi at 6th form were touching too little on the questions I had. I found chemistry to be tough at university, to say the least."

P1's attitude towards the subject suffered after having failed an examination without fully understanding why.

4.6.3 Managing both commitments

The three participants who were actively playing – at times semi-professionally – during their undergraduate studies emphasised that they were extremely busy, both musically and academically.

P1: "It was very tough but ironically, it was the busiest time in my musical career.... If I had a lecture at 10am, I would wake up at 07:30am and study 07:30am to 09:30am, my mother would drive me so I wouldn't lose time on the bus. If I had three consecutive free hours, I would go home to play piano."

P3: "I used to play a lot of piano at the time. I was a very busy girl, but I was a very good time manager." "I learnt the essential skill of time management at a young age. Rather than wasting time playing video games and things like that...I still had a healthy childhood and I did things like sports and all that... I think time management is an essential skill. And it [practising music and studying] takes a lot of time, so being efficient in what you do [is important]."

The commonality between these three participants was the recognition of the importance of good time-management skills, and “being stubborn” (P1).

P2: “I’m a very determined and ambitious person.” “The passion for music was always there – I was assertive enough to drive it.”

4.6.4 The motivation to continue playing

Three of the participants (P1, P2, and P3) felt that music was a priority for them, even though they did not take up music at university.

P1: “I think it was ambition: you sit for one thing and you think – what’s next?... One concert leads to something else, and you’re always on the go, on the go, on the go. I had to prepare for [the concerts], but I enjoyed it! So, this was not like something that was keeping me back. I was very happy to be busy musically. It was a very positive experience.”

P3: “Music challenges me a lot, just like chemistry if not more. You have the cognitive aspect, you have the technical aspect in the fingers, and then you have the emotional aspect, which doesn’t come into science. Maybe you show some love for science but the things you express when you play a piece of music is not something you experience in science in my opinion. So I would say the mixture of having the challenge and the passion involved in music making gave me the motivation.”

Music was a means of releasing tension and maintain level-headedness throughout the arduous years at university. P1 says that a music lesson in-between lectures used to refresh her and give her the energy she needed to continue studying chemistry.

P1: "I would say I would have failed the course if I didn't have music. If it wasn't for music I wouldn't have graduated. With the demands of the course, you need to have an escape...an escape subject...an escape something. I think all my classmates did something. You are either an athlete, or a musician...Something! I think it is impossible for someone to be on chemistry and biology in my case, from 08:00am to 08:00pm".

P3: "There's so many pieces of music that can help you express any mood, in any situation that you are. Music to me is my love, I cannot live without music. In terms of understanding and learning, it is again that natural curiosity and that push towards understanding something. So I needed to get on top of this, not just play."

Throughout the interviews, all the participants mentioned how music allowed them to express feelings and be in touch with their emotions - it was a new language, a way of communicating with others.

P4: "It was an excellent way of releasing my emotions. After Grade 6, the piano pieces I had to study became very interesting, and very emotionally charged."

4.6.5 Transfer of skills

The responses in the interviews continue to develop on those received from secondary and post-secondary school students. The interviewees talk about transfer of skills in a more abstract and holistic manner. Aspects such as time management and planning are mentioned, but also factors such as communication and performance skills, self-expression, and knowledge and control over one's emotions.

P1: "I think time management, order, proper planning, like order, structure. Music is always very structured, and it put a level of extra structure to my already structured schedule. It also made me very sensitive. I experience it even more nowadays, so I am even more aware of it now that I teach.... Music helped me keep track of my feelings and appreciate other personalities as well at the same time".

P3: "Music teaches you an essential skill. Not just music, even if you do ballet or sports, any discipline. It teaches you a very important life skill not just to be able to play something. It teaches you how to communicate. It's a language, right? It has taught me how to connect with people. When you make chamber music for example, when you are playing with someone. And then there's the element of the actual art of playing – it's very complex. There are a lot of technical aspects. It's being able to read a new language. In piano it's more complex than in a single line instrument. You have to read vertically. Harmonically, it is very complex, so I think that stretches your brain. It stretches your abilities, I think. And not just the playing...the coordination of the hands, of the feet. And being under control in very anxious situations, it has

taught me how to face a public. It has taught me how to speak to the public. These are things you start doing at a young age. You start facing an audience at a very young age, and that's something...school was a piece of cake after this!"

P2: "In music you need to be very aware of the environment, and what you are creating in others. Music stirs up emotions in me – well, music stirs up emotions in others as well, who are hearing. When you are playing, writing, interpreting or singing, you are creating emotions in other people. Moreover, when they are listening to you, they are transferring back the emotions to you – whether they like it or they don't like it. So it's really communication and my job today is all about communication. How to read patterns and read people and adjust to their likes. It is also about performing. In my musical exams I used to perform in front of an examiner. You need to be really, really calm. If you are trembling in front of a chemistry paper, you can compose yourself. But if you are trembling and your hands are on the keyboard, you don't get a second chance! That skill of learning how to cope under pressure and still be composed and cool, I think I use it a lot as well. Music, as in musical theory, is something that is very abstract at first but when you dig below the surface, there is a structure to it. The more you dig, the more you realise that it's a language as well. There's a lot of pattern, there are a lot of ratios."

P4: "My music teacher always said, 'I am not teaching you an instrument, I am teaching you for life'".

4.7 Conclusion

This chapter has presented the results obtained from chemistry students in Year 10, post-secondary schools, and past and present students of the Department of Chemistry by means of questionnaires. The themes that emerged during the four interviews have also been included in this chapter. The results have been presented according to themes, to try and address the research questions as well as looking into other interesting aspects that emerged.

The following chapter, Chapter 5, will present a discussion of the results obtained in this chapter, whereby these results will be examined and compared with findings reported in the literature.

CHAPTER 5

DISCUSSION

5 Discussion

The main target for this study was to find out whether there is a link between musical training and achievement in chemistry. From the initial Mozart effect to the more recent studies in this field, this idea has intrigued many researchers and parents alike.

In order to address the main research question, a mixed methods study was proposed: chemistry students in secondary schools, post-secondary schools, and the University of Malta and alumni of this same University were asked a series of questions, to learn about their behaviours and attitudes toward chemistry and music, where applicable. Additionally, four interviews were carried out with chemistry graduates who also had extensive musical training.

5.1 Link between music and academic results

Students who study music and other academic subjects and are in Year 10 or post-secondary education seem to be more likely to obtain results or grades at the highest end of the achievement spectrum. This is true for mathematics, English, Maltese, chemistry, biology and physics, and is measured according to the results students obtained in examinations held at the end of Year 9 in secondary schools and in the SEC examinations for the same subjects.

The three subjects where the greatest percentage difference exists between CS-SSM and CS-NSM, both of which are in the highest achievement categories, are physics, chemistry and mathematics, followed by biology, English, and Maltese. Contrary to what is presented in the literature, students did not register the greatest gains in languages.

5.2 Proposed mechanisms

The differences in percentages of CS-SSM and CS-NSM students, both of which achieved a Grade 1 in the SEC examination, is shown in Figure 4.15. As seen in Chapter 2, music training changes the brain's anatomy and, in the words of one of the interviewees (P3), it "stretches the brain".

Rather unexpectedly, the differences between percentages of CS-SSM and CS-NSM who obtained a Grade 1 in English and Maltese are towards the bottom of the graph, with values of 5.0 and 4.3% respectively. Physics, chemistry and mathematics on the other hand, are at the top of the graph, with differences of 12.3%, 9.9% and 9.6% respectively. This is interesting because, although many articles have disputed the benefit of music in the study of mathematics, many more articles have been written describing the benefit that music has on listening and literacy skills.

It is suggested that the linguistic benefit arises from the development of "perceptual processing systems which facilitate the encoding and identification of speech sounds and patterns" (Hallam, 2010, p. 272). Additionally, "transfer of these skills is automatic and contributes not only to language development but also to literacy." (Hallam, 2010, p 272).

Admittedly, there are 5.0% more CS-SSM who obtained a Grade 1 in their language SEC examinations and these should not be overlooked; however, one might expect that the benefit registered in the languages would be towards the top end of the scale.

The effect of music on mathematics described in the literature is supposedly more constrained: the transfer of skills only occurs when they are 'near'. Near transfer occurs when the training context and the skill learnt is almost identical to the context in which the new skill needs to be applied. The contradictory results obtained by various researchers

have been taken to imply that the variables needed to secure this relationship are still unknown and fleeting.

As has been mentioned in Chapter 2, the relationship between music and chemistry has not been delved into appreciably. Certain topics contained within the chemistry syllabus indubitably have a strong mathematical component, as does physics. Moreover, these two subjects are linked by their oft abstract nature. Could this explain the similarity in the results referred to in Section 5.1?

Visual-spatial intelligence is defined as “the capacity to perceive the visual world accurately, and/or perform transformations and modification on perceptions, construct mental representations of visual information, and use the representations to perform activities is often considered visual-spatial intelligence.” (Zimmerman & Dean, 2011). This is not to be confused with Gardner’s Spatial Intelligence which is “the capacity to envision, reason with, and recall nonverbal, symbolic information” (Levi, 2011). If music truly leads to pronounced benefits in visual-spatial intelligence then the results seen in Section 4.3, where large differences in achievement were registered in abstract subjects like physics, chemistry and mathematics between music and non-music players, are consistent with this proposed mechanism.

Irrespective of the differences in calculated gains obtained between subjects, the results corroborate those obtained by Morrison (1994); musically trained high-school sophomores (students aged 15-16) reported higher grades in a variety of academic subjects than their non-musically trained peers.

5.3 Confounding variables

It is difficult to separate the possible effect of music on achievement from other variables.

The variables discussed below are those mentioned most commonly in the international literature.

5.3.1 Gender

The gender distribution within the Year 10 cohort shows that there are fewer males than females in the category CS-NSM. This reflects the gender distribution present in the overall population of Year 10 students, that is, all the students who completed the questionnaire, irrespective of the marks obtained during their annual examination. These results therefore correspond to each other.

The result which seems out of trend is that obtained for CS-SSM. Here, the number of males is equal to the number of females (Table 4.16). Articles presenting research on the effect of music on academic achievement do not highlight any differences in achievement between males and females, therefore the results obtained in this study are novel.

The high number of males in the group CS-SSM could be due to several reasons. There is a possibility that music is indeed helping these students develop mental processes that help them understand chemistry topics better. These elusive near- and far-transfer skills were mentioned in Section 5.2. Possibly, musically trained males develop skills, such as time-management and determination (Section 4.6), that help them in their academic studies. These students might have extra help at home tackling academic difficulties. Additionally these chemistry students, who are taking music lessons, might be more academically gifted

than the other males. The most probable reason is unclear and therefore might merit further research.

The gender distribution amongst post-secondary students shows different trends in the results (Table 4.17). Although the gender distribution of all the post-secondary students who participated in this study still shows a higher female participation, those chemistry students who achieved a Grade 1 in their chemistry SEC examination are distributed almost equally between males and females. This is true for CS-SSM and CS-NSM. Having an equal number of males and females does not seem to be the exception, as seen in secondary school students, but rather the norm in the case of high-achieving chemistry students. Possibly, these students have matured physically and mentally, and those chemistry topics which were challenging at secondary school are not a challenge anymore.

5.3.2 Age at which musical tuition commenced

The results obtained in Section 4.4.6 show a slight indication that children who start their musical training at the age of six years stand a better chance to do well in their chemistry examination. This is a popular age for students to start taking music lessons in Malta. Coincidentally – or maybe not - this is also the age at which students start their formal education. These preliminary findings agree well with what is stated in the literature. For example, Rauscher & Hinton (2011) conclude that, if music instruction starts before the age of seven, certain cognitive domains will benefit, and students demonstrate near- and far-transfer effects.

From a neurological perspective, at the ages of seven and earlier the brain shows a high degree of plasticity and therefore the processes that are enhanced by music (enhanced

auditory, motor, and language processing) benefit the most when music training starts at these ages. The benefits are claimed to last into adulthood. Incidentally, it is suggested that music training extends this plasticity to the teenage years, and possibly even to the mature brain (Ker & Nelson, 2019).

The results obtained seem to agree with what Ker and Nelson (2019) report, but unfortunately the small numbers of CS-SSM at both secondary and post-secondary levels do not allow claims to be made about the possible link between the age at which music tuition starts on academic achievement in chemistry – additional work and more data, possibly spanning a few years, would be required in order to arrive at more conclusive results. For this same reason, there are no indications about how long these potential transfer effects can be detected, after the discontinuation of musical training.

5.3.3 Parents

Mothers of CS-SSM are more likely to have completed tertiary education than mothers of CS-NSM and the mothers of all the participants in the study. This is also true for fathers and is seen at both educational levels. These results reflect what was found in the literature (Winter, 2016; Corrigan et al, 2013). Better education is typically correlated with higher income, and since music lessons and music instruments are at times expensive, they are within reach only of wealthier families.

Having parents of a higher educational level might also explain why CS-SSM are more likely to achieve marks or grades in the highest achievement categories compared with other students – CS-SSM might have more help readily available at home or reside in a dwelling

which is more conducive to studying. The effects of socio-economic background and the different cultural capitals conferred by the different families also cannot be ignored.

The results shown in Figure 4.21 and 4.24 indicate that there might be more to study in this respect. Keeping the secondary school parents' education constant at tertiary level and selecting for CS-SSM and CS-NSM who had achieved marks in the highest category in their chemistry examination, the data show that CS-SSM are still more likely to achieve a higher grade than their CS-NSM counterparts. This is seen at post-secondary level as well. These data seem to show that having parents qualified at a tertiary level is not the only factor at play in the attainment of a high mark or grade in chemistry for CS-SSM.

5.3.4 Time spent practising music

If music training has a certain degree of influence on academic achievement – as the results seem to indicate - then are the benefits proportional to the time spent practising music?

Table 4.21 and 4.22 present conflicting data. In the case of secondary school students, the percentage of students who obtain a high mark does not seem to correlate with the amount of time they spend practising their musical instrument. This is true for all but the students in the category denoting the largest amount of time spent practising.

The opposite is true for post-secondary students. Post-secondary students seem to have obtained better grades in their chemistry SEC examination the more they practised their musical instrument.

The literature says that the abilities transferred from music to academic subjects are “larger with longer periods of training” (Schellenberg, 2005, p. 319). Unfortunately, the data can neither confirm nor negate this finding for a number of reasons, for example:

- a) The numbers of students in each category are too small to allow conclusions to be drawn.
- b) The information gathered from students described the amount of time they dedicate to music at the time of completing the questionnaire – it did not ask students how much time they dedicated to music before and during studying for their annual or SEC examinations.

At some point, the amount of time spent practising a musical instrument may impinge on the time that is available for studying and revision. Is there an optimal amount of time that should be dedicated to studying chemistry to obtain high marks and grades?

5.3.5 Effect of choice of instrument

Hallam (2010) lists some of the changes that occur in brain functionalities, depending on the type of instrument that a musician plays. Indeed, it is possible that particular instruments give the students playing them academic advantages in particular subjects. The local data do not lend themselves to this type of treatment however, for two reasons:

- (i) the numbers of students playing each different type of instrument is too small to be able to draw such conclusions, especially at post-secondary level where the proportion of CS-SSM is quite small and
- (ii) students' achievement was measured by means of the overall score or grade obtained in a general examination paper, rather than administering standard psychological tests targeting specific areas such as spatial abilities, and others.

Nonetheless, the results seem to indicate that the academic advantage of CS-SSM is not due to which instrument the students played. The data presented in Section 4.4.5 show that the

profiles of percentages of CS-SSM, and CS-SSM who are in the highest achievement category show little variation when categorised according to the instrument played. This is true for secondary school and post-secondary school students. The small size of both populations make it difficult to interpret the fluctuations that are seen in the results obtained; however, the profiles for the two populations appear to be substantially the same.

5.3.6 Effect of time dedicated to studying chemistry

Better grades in chemistry are typically obtained by students who dedicate more time to academic work, outside of school. This assumption was tested by asking the students who achieve the highest marks or grades in their examinations how much time they spend studying, revising and doing chemistry homework per week. The question did not restrict students to consider only school-based chemistry tasks – students were free to include any time dedicated to chemistry work originating from private tuition.

The results returned were surprising – CS-SSM do not lead the way in terms of time dedicated to work at home; this is true for both educational levels. The students who spend more than three hours working on chemistry at home are CS-NSM, and the greatest difference between CS-SSM and CS-NSM is seen at post-secondary level.

If high-achieving CS-SSM students are not dedicating a substantial amount of time to chemistry tasks, then it is fair to assume that this must be true for other subjects as well, especially since chemistry notoriously requires consistent revision and practice.

Do CS-SSM do well at school because of the influence of music on their brain and personality, or does music training attract those students who are already showing signs of being high-achieving students? Corrigan, Schellenberg and Misura (2013) state that

“musically trained children are particularly good students, which points to individual differences in non-cognitive abilities or in cognitive abilities other than IQ” (p. 2). In reality, it is not possible to separate achievement from other areas of a student’s life, so the link remains tentative, at best.

This aspect is particularly interesting however, since many CS-USM who participated in this study claim to have stopped practising music due to lack of time because of academic commitments. Admittedly, preparing for SEC examinations is a very intense period in a student’s life, but does the student really need to choose between one and the other? Can the student achieve results which are just as good by dedicating less time to academic study, and leaving at least a small portion of time to music training? Can there be periods when academic studying takes over, but does not annihilate the musical practice?

5.3.7 Effect of music on behaviour and personality

Musicians’ brains have been the subject of interest since the early 20th century (Ker & Nelson, 2019). “In recent decades, studies have observed the contributions of musical training in enhancing auditory, motor, and language processing areas” (Ker & Nelson, 2019, p.1).

There is however, another aspect to the impact of music on the brain – the impact of music on behaviour and critical-thinking skills. The following sections will discuss these facets, and introduce motivation, grit and other personality characteristics as a means to academic success.

5.3.7.1 *Students' opinions*

Most students are not aware, nor probably are they concerned with, possible near-and far-transfer effects of music on their academic achievements. Yet, they are happy with their own choice of starting music lessons and would not want to stop (Figures 4.25, 4.26, 4.27 and 4.28). Among their reasons, most students quoted across the three educational levels identify music as a:

- a) stress reliever
- b) source of fun and
- c) source of satisfaction when a new task has been accomplished

Comparing the percentage preferences for these reasons between CS-SSM at secondary school and post-secondary school levels (Table 4.18) seems to indicate that the second reason (fun) is less important for post-secondary school students than for secondary school students - the difference of 12% in these replies is the same percentage by which "Succeeding at a new task" increased on going from secondary to post-secondary. This is reiterated in other studies (Kokotsaki & Hallam as quoted in Hallam, 2010) wherein high-school students reported that music helped them in the development of skills such as "discipline and concentration and provided a relaxation outlet during demanding study periods" (p. 279).

These results are not difficult to comprehend in view of the different realities experienced by these two levels of students - post-secondary students have been through their first set of high-stakes examinations and succeeded in moving on to post-secondary education. They have savoured the rewards resulting from hard work and this, in addition to a greater level of personal maturity, might explain the greater importance given to mastering a new task.

These findings are also reflected in Section 4.5.2, whereby post-secondary students are more cognisant of the indirect benefits of music.

These ideas are elaborated to a greater extent by the interviewees who, probably due to the benefit of maturity and hindsight, mention seven main skills that they believe were developed further by means of their music training. These are:

- a) Time-management skills
- b) Determination and ambition
- c) Being challenged and working towards a goal
- d) Relief of stress
- e) Self-expression
- f) Communication with others
- g) Performance skills

These behavioural aspects will be discussed in the section below.

5.3.7.2 *The effect of motivation and grit*

All the skills listed above are applicable outside the realm of music and have been the subject of research. Broh, as quoted in Hallam (2010) states that music students tend to engage more with parents and teachers, linking these behaviours to “higher self-esteem in the children in turn leading to increased motivation and self-efficacy” (p.278). This would seem to match the points ‘communication with others’, ‘determination and ambition’ and ‘being challenged and working towards a goal’, mentioned above. The latter two aspects would then naturally impinge on ‘time-management skills’, out of necessity.

Quoting from Hallam (2010) “motivation is a crucial factor in how well children perform at school. Motivation is closely linked to self-perceptions of ability, self-efficacy and aspirations. If active engagement with music increases positive perceptions of self, this may transfer to other areas of study and increase motivation to persist in the light of initial failure.” If students perceive themselves in a more positive light, then they are less fearful of judgement and this might possibly make it easier for them to express their feelings through music.

Dos Santos-Luiz (2016) speaks about a correlation between motivation and academic performance. This is also linked to a better chance of being successful in school by Lillemyr (as in Hallam, 2010). Other studies quoted in Hallam’s article (2010) additionally link music training with greater levels of self-esteem, self-awareness, positive self-attitudes, self-perception, self-image, confidence, and a greater desire to study, which have an impact on the area of ‘performance skills’, among others.

Another area that has been explored in recent years is the personality characteristic referred to as grit and its influence on success in different individuals. Grit is defined as “the tenacious pursuit of a dominant superordinate goal despite setbacks” by Duckworth and Gross (2014). This aspect emerged very clearly during the interviews, especially when talking to P3 and P1, the two participants who are both professional musicians.

Many of the behavioural aspects reported in the literature were encountered in the interviews and are clearly beneficial to the person possessing them, beyond the benefits of near- and far- transfer effects.

5.4 Conclusion

This chapter has presented a discussion of the results extracted from the questionnaires and the interviews, including information published in the literature. The research questions were addressed with the aim of learning more about the possible link between music training and achievement in chemistry. Proposed mechanisms were discussed, whilst examining information from confounding variables.

The following Chapter draws some conclusions, based on the work carried out thus far.

CHAPTER 6

CONCLUSION

6 Conclusion

6.1 Summary of results

The main aim of this study was to investigate whether there is a link between music training and academic achievement in chemistry. This was done by considering three research questions, described in more detail in the following sections. In order to examine this possible link, the two groups of students studied were those at opposite ends of the music-making spectrum, that is, those students who still study music and those students who never studied music. The data collected about students who used to study music but had stopped at the time of the study were presented up until Section 4.3.2, when it was shown that, unlike CS-NSM, no clear pattern existed in the academic achievement of CS-USM when compared to CS-SSM. Additionally, several variables would need to be considered when analysing a possible link between music tuition and achievement in the subset CS-USM, and this would have gone beyond the scope of this study. Moreover, it was decided that links and differences may be more evident by comparing chemistry students who still study music and chemistry students who never studied music.

When no specific educational level is specified in the following sections, this should be taken as applying to chemistry students at both secondary and post-secondary levels.

6.1.1 What proportion/percentage of chemistry students at SEC, A-level and undergraduate/postgraduate level also study/have studied music?

The data obtained from the questionnaires distributed to chemistry students in Year 10 and in post-secondary schools show that 59 (36.2%) of the chemistry students in Year 10 and 44 (17.1%) of the chemistry students at post-secondary level were still playing music.

The 43 chemistry students in Year 10 who used to study music are 26.4% of the total number of Year 10 chemistry students who participated in the study. Similarly, there were 100 (38.9%) post-secondary chemistry students out of all the chemistry post-secondary students who participated in the study, who used to study music but had stopped.

The number of responses returned from undergraduate and postgraduate students, and alumni was poor, therefore it was not possible to infer details about the population based on the sample available.

6.1.2 Will the percentage change on going to a higher level?

The percentage of CS-SSM decreases on going to a higher level. The main reasons for stopping music training given by post-secondary students were presented in Section 4.2.2, with the commonest reason being lack of time due to school commitments.

The reasons reported by students that encourage them to continue studying music are reported in Section 4.4.4 and are similar for secondary school CS-SSM, post-secondary school CS-SSM as well as university students, past and present. Students state that music is fun, that it helps them de-stress and that they feel a sense of accomplishment when they manage to succeed at a new task. The importance given to each of these three factors varies according to the educational level (Section 4.4.4). The love for music itself is the commonest reason among Year 10 students, whilst music as a stress-reliever is the commonest reason amongst post-secondary students, and undergraduates, graduates and alumni of the Department of Chemistry.

Those who do continue to study music were distributed evenly amongst males and females (Sections 4.4.2 and 5.3.1) even though the overall population of chemistry students participating in the study is made up of a larger number of females overall.

Chemistry students who still study music are more likely to have parents who completed tertiary education (Section 4.4.3).

Starting music training was the students' choice in more than 85% of the cases at Year 10 level and in more than 75% of the students at post-secondary level. Students possibly grow more affectionate of their music skills with time. In fact, approximately 60% of the respondents at secondary level would decline the option to stop playing their musical instrument when compared with more than 74% at post-secondary level.

6.1.3 Is there a link between music training (instrument practised, length of course, age at which tuition starts) and achievement in chemistry?

The CS-SSM participants showed a greater likelihood of getting a better mark or grade in exams for mathematics, English, Maltese, chemistry, biology and physics when compared to CS-NSM. The subjects where the greatest difference was registered between percentages of post-secondary chemistry students who achieved a Grade 1 in their SEC examinations were physics, chemistry and mathematics (Section 4.3.2). The percentage differences in the number of students achieving a Grade 1 result between CS-SSM and CS-NSM were least for English and Maltese.

The greater likelihood of obtaining a higher mark or grade for the CS-SSM does not seem to be the result of more academic work done outside school hours. In fact, the CS-SSM participants seem to do less chemistry-related work than their CS-NSM peers.

In this study, male students in Year 10 who score high marks are more likely to be music players. This is not so in the group CS-NSM, as females outnumber males by five times. This trend is not seen at post-secondary level however, as males in the CS-NSM and CS-SSM categories who achieved a Grade 1 in the chemistry SEC examination are balanced in terms of gender with the females in the same groups.

As mentioned in Section 5.3.3, CS-SSM are more likely to have parents who completed their tertiary education. This, however, is not the only possible reason why CS-SSM have a greater chance of doing well in their examinations. When the maternal and paternal educational level was kept constant, CS-SSM still had a greater chance of obtaining high marks and grades than CS-NSM. Maternal influence might be conducive to starting music tuition however, seeing that three out of four interviewees had mothers and other family members who played a musical instrument (Section 4.6.1). In the case of two out of the four interview participants, it was the mother who decided to send these same participants to music lessons.

Although more data would be desirable in this area, it does not seem that the choice of musical instrument impinges on academic achievement (Section 5.3.5).

Due to the small number of CS-SSM, especially at post-secondary level, it was not possible to observe a trend between the age of starting musical training and the result obtained in annual or SEC examinations. There are indications however, that starting at age six or seven confers to the student a greater academic advantage than starting later.

Does the time spent practising a musical instrument influence academic achievement? The results presented in Section 5.3.4 show conflicting data for secondary school and post-secondary school students. At post-secondary level, the best grades are obtained by those

students who spend the most time playing their instruments. However, this is not reflected in the data obtained for secondary school students.

The degree by which students believe that music helps them academically (Section 4.5) increases on going from secondary to post-secondary education. This was reconfirmed even more emphatically by the interviewees (Section 4.6.5). The interview participants believe that studying music whilst still involved in academic studies required the development of skills such as time-management skills, determination, ambition, and communication skills, whilst also serving as an outlet for stress relief and self-expression. Conversely, the development of motivation and grit (Section 5.3.7.2) through the study of music might also result in better academic grades.

6.2 Implications of the study

This study has indicated that there is a possibility that the link between music training and academic achievement in chemistry (and most other core academic and scientific subjects) does exist in the Maltese student population at Year 10 and post-secondary education.

Irrespective of these findings, and because of these findings, it is sad to note that approximately one third of the chemistry student population at Year 10 and almost one half of the chemistry student population in post-secondary education have never studied music. The study of music should not be an experience that only few students have access to. It is a very enriching experience and opens a door onto a very different world to the one that students are used to during their academic endeavours. Whether the limitations to this are financial, familial or otherwise, music tuition should be made accessible to all Maltese students. Even though the state offers free, high-quality music tuition across Malta and

Gozo via the Malta School of Music, this opportunity is still not being as utilised as it could be.

6.3 Strengths and limitations

To the best of my knowledge, this was the first study of its kind to be carried out in the Maltese Islands. Although a few studies about this subject have been done in other countries, the local scenario had not yet been explored.

The results obtained from questionnaires and interviews allow for triangulation of these two data sources – convergence across the two data sources allows for integration of data. This idea goes further than simply using two different methods to neutralise the weakness of each form of data collection. Hence, the study explored both the near- and far- transfer effects as well as the behavioural changes that occur through the study of a musical instrument, and how these effects might possibly impact academic achievement.

The participants were sampled from almost all the colleges in Malta and Gozo, thus avoiding localised results. Similarly, interviewees were chosen from different walks of life.

Post-secondary students were asked for the grades they obtained in various subjects during the SEC examination sessions. The examination papers were the same for everyone, therefore results can legitimately be compared. This is not true of the secondary school students. Only students in state schools would have answered identical examination papers. Students in church and independent schools are examined by means of examination papers which the schoolteacher would have set her/himself. This makes comparison of results across sectors more problematic. To counter this, the categories created to capture the

marks obtained by students were quite wide – marks from zero to 100 were divided in just four categories.

There was a poor response obtained from University students studying chemistry and alumni of the Faculty of Science. The data returned by this population via the questionnaire were therefore used solely qualitatively.

My position as a musically trained mother to two musically trained children might have been a limitation to the study. Although I was not aware of the cognitive benefits of music before consulting the literature, I believe - as did my mother before me - that a child with a holistic education should be knowledgeable of this whole other world of music. My belief that music teaches self-discipline and emotional self-regulation might have affected the presentation of quotes from the interviews and the discussion of these features.

6.4 Recommendations for further work

The group of participants earlier labelled as CS-USM were largely not considered in this study. Any possible effects of music on academic achievement in this group of participants would depend on a few but significant variables, such as the length of time for which they studied music, the age at which they started and stopped, and others. Since many students take up a musical instrument in their younger years but a large proportion stop practising at the time of their SEC examinations, it would be interesting to study whether CS-USM benefited from their musical training, especially since the literature presents widely varying results, with beneficial effects reported as spanning one day (Rauscher et al., 1997) to two years (Hurwitz, Wolff, Bortnick, & Kokas, 1975; Rauscher & Hinton, 2011) after discontinuation of music lessons.

The gender distribution at Year 10 amongst chemistry students shows that there is a large number of CS-SSM boys that are achieving high marks in their chemistry examination. It would be interesting to study this in more detail, especially in view of the local scenario which sees many more girls taking up chemistry than boys.

Similarly, it would be interesting to study how long students would need to be enrolled in music lessons for before benefitting from possible advantages, both transfer and behavioural effects.

The relatively small number of CS-SSM, both at secondary school but more significantly at post-secondary education, made it difficult to make comparisons on factors such as the age at which music training was started and academic achievement. More data are required in this area to be able to draw conclusions.

6.5 Conclusion

The results obtained in this study indicate that there seems to be a link between academic high-achievement and music training. These results could be arising due to near- and far-transfer effects, personality factors as well as several other confounding variables that have been investigated.

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APPENDICES

APPENDIX 1

Thank you for taking part in this questionnaire. We will try and measure some key features regarding music. This survey should only take about 15-20 minutes to complete. Rest assured that all the answers you provide will be completely anonymous. Completion of the questionnaire means that you agree to take part in this study.

If you have any questions about the questionnaire, please email us at annette.coppini.97@um.edu.mt

Questions for all participants:

Question 1 What is your gender?

- a) Female ₁
- b) Male ₂
- c) Other ₃

Question 2 What is the highest level of education completed by your mother or female guardian?

Tick one box only

- a) Primary education ₁
- b) Secondary education e.g. trade school, junior lyceum, secondary ₂
- c) Post-secondary non-tertiary education e.g. 6th Form ₃
- d) Tertiary education (Bachelor, master or doctoral degree) ₄
- e) Not sure ₅

Question 3 What is the highest level of education completed by your father or male guardian?

Tick one box only

- a) Primary education ₁
- b) Secondary education e.g. trade school, junior lyceum, secondary ₂
- c) Post-secondary non-tertiary education e.g. 6th Form ₃
- d) Tertiary education (Bachelor, master or doctoral degree) ₄
- e) Not sure ₅

Question 4 This question is about your parents'/guardians' behaviours with regards to music.

- | | <i>Yes</i> | <i>No</i> | <i>Not sure</i> | <i>Not applicable</i> |
|------------------------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|
| a) Has your mother ever played a musical instrument? | <input type="checkbox"/> ₁ | <input type="checkbox"/> ₂ | <input type="checkbox"/> ₃ | <input type="checkbox"/> ₄ |
| b) Has your father ever played a musical instrument? | <input type="checkbox"/> ₁ | <input type="checkbox"/> ₂ | <input type="checkbox"/> ₃ | <input type="checkbox"/> ₄ |
| c) Does your mother still play a musical instrument? | <input type="checkbox"/> ₁ | <input type="checkbox"/> ₂ | <input type="checkbox"/> ₃ | <input type="checkbox"/> ₄ |
| d) Does your father still play a musical instrument? | <input type="checkbox"/> ₁ | <input type="checkbox"/> ₂ | <input type="checkbox"/> ₃ | <input type="checkbox"/> ₄ |

Question 5 Considering the last annual exam you sat for, which grade did you obtain for each of the following subjects? Tick one answer for each subject. If you did not sit for the exam of a particular subject, tick 'n/a'.

	0-25	26-50	51-75	76-100	n/a
a) Mathematics	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
b) English	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
c) Maltese	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
d) Chemistry	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
e) Biology	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
f) Physics	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

Question 6 Why did you decide to start studying chemistry? Tick the answer that best fits this question

- a) I liked the chemistry topics we learned in science during Year 7 and 8/Form 1 and 2 ₁
- b) I need a qualification in chemistry to get into a particular course of studies/career path ₂
- c) I wanted to try it out ₃
- d) I was pressured into taking chemistry - it wasn't my choice at all ₄
- e) I didn't have a preference regarding which subjects to choose, so I just chose at random ₅
- f) My friend/s chose chemistry and I wanted to be with them, so I chose it too. ₆
- g) I really like the teacher/s who teach chemistry, so I chose it as an option. ₇
- h) Other, please give details:

Question 7 Apart from music, which of these extra-curricular activities do you attend? Tick all the answers that apply:

- a) Dancing ₁
- b) Singing ₂
- c) Drama ₃
- d) Sports ₄
- e) Technology-related activities e.g. coding, robotics ₅
- f) Community-related activities e.g. youth groups, voluntary work ₆
- g) Other, please specify:

Question 8 Keeping in mind the events in the past 3 weeks, how much time did you spend studying and revising chemistry, and doing chemistry homework per week?

- a) Less than 1 hour ₁
- b) Between 1 and 3 hours ₂
- c) More than 3 hours ₃

The following questions are for those participants who used to, or are currently still taking music lessons. This section also applies to those who taught themselves to play a musical instrument. If you have never played a musical instrument, you do not need to answer any more questions and can stop here. Thank you.

Question 9 How old were you when you started taking music lessons/started learning to play a musical instrument?

_____ years

Question 10 How old were you when you stopped taking music lessons, if at all? If you are still taking music lessons, write 'n/a' in the space provided. If you taught yourself to play a musical instrument, write 'self-taught' in the space provided.

_____ years

Question 11 Using the past 3 weeks as a time-frame, how many times did you have music lessons per week? Please consider only instrument practice lessons, not theory lessons. A music lesson which is part theory and part practice is to be considered as 1 lesson.

- a) I stopped taking music lessons ₁
- b) I never attended music lessons ₂
- c) I had no lessons ₃
- d) 1 lesson ₄
- e) 2 lessons ₅
- f) 3 lessons ₆
- g) More than 3 lessons ₇

Question 12 During a typical music lesson, how long do you spend practising your instrument with your teacher?

- a) 30 minutes or less ₁
- b) Between 31 and 60 minutes ₂
- c) Between 61 and 90 minutes ₃
- d) More than 91 minutes ₄
- e) I do not attend music lessons ₅

Question 13 Using the past three weeks as a timeframe, what is the average time you spent practising your instrument every day? Do not include time spent during the music lesson with your music teacher.

- a) 15 minutes a day or less ₁
- b) Between 16 minutes and 30 minutes a day ₂
- c) Between 31 minutes and 1 hour a day ₃
- d) More than 1 hour a day ₄
- e) I do not practice any more ₅

Question 14 Which of the following instrument groups does the instrument/s you play (or used to play) belong to? If you play more than one instrument, tick all the answers that apply.

- a) Keyboards ₁
- b) Bowed strings ₂
- c) Brass ₃
- d) Woodwind ₄
- e) Percussion ₅
- f) Guitar family ₆

Question 15 Where are you currently taking instrument practice lessons? If you play more than one instrument, please consider the instrument you have been playing the longest.

- a) I do not take music lessons anymore ₁
- b) I taught myself to play ₂
- c) Band club ₃
- d) Malta School of Music ₄
- e) Malta Society of Arts ₅
- f) Private tuition by a music teacher and/or a family member ₆
- g) Other, please specify:

Question 16 Are your instrument practice lessons held in a group or individually? If you stopped taking music lessons, choose the answer which reflects the situation when you did attend lessons.

- a) In a group ₁
- b) Individually ₂
- c) I never attended lessons ₃

Question 17 How much do you agree or disagree with these statements?

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
a) Starting music was totally my choice	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
b) On most days, I would like to stop practicing my musical instrument	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
c) Playing music puts me in a good mood most of the times	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
d) I enjoy my chemistry lessons most of the times	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
e) Learning music has helped me in my school subjects	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
f) Playing music relaxes me and calms me down	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

Question 18 This question applies to those participants who used to play a musical instrument but have stopped playing for 6 months or longer. This question should not be answered by participants who are currently still playing a musical instrument, with or without formal music lessons. If you stopped playing less than 6 months ago, do not answer this question.

a) Why did you stop playing your musical instrument?

Question 19 This question applies to those participants who are still taking music lessons and/or who still practice their instrument.

What motivates you to keep playing music?

APPENDIX 2

Thank you for taking part in this questionnaire. We will try and measure some key features regarding music. This survey should only take about 15-20 minutes to complete. Rest assured that all the answers you provide will be completely anonymous. Completion of the questionnaire means that you agree to take part in this study.

If you have any questions about the questionnaire, please email us at annette.coppini.97@um.edu.mt

Questions for all participants:

Question 1 What is your gender?

- a) Female ₁
- b) Male ₂
- c) Other ₃

Question 2 What is the highest level of education completed by your mother or female guardian?

Tick one box only

- a) Primary education ₁
- b) Secondary education e.g. trade school, junior lyceum, secondary ₂
- c) Post-secondary non-tertiary education e.g. 6th Form ₃
- d) Tertiary education (Bachelor, master or doctoral degree) ₄
- e) Not sure ₅

Question 3 What is the highest level of education completed by your father or male guardian?

Tick one box only

- a) Primary education ₁
- b) Secondary education e.g. trade school, junior lyceum, secondary ₂
- c) Post-secondary non-tertiary education e.g. 6th Form ₃
- d) Tertiary education (Bachelor, master or doctoral degree) ₄
- e) Not sure ₅

Question 4 This question is about your parents'/guardians' behaviours with regards to music.

- | | <i>Yes</i> | <i>No</i> | <i>Not sure</i> | <i>Not applicable</i> |
|------------------------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|
| a) Has your mother ever played a musical instrument? | <input type="checkbox"/> ₁ | <input type="checkbox"/> ₂ | <input type="checkbox"/> ₃ | <input type="checkbox"/> ₄ |
| b) Has your father ever played a musical instrument? | <input type="checkbox"/> ₁ | <input type="checkbox"/> ₂ | <input type="checkbox"/> ₃ | <input type="checkbox"/> ₄ |
| c) Does your mother still play a musical instrument? | <input type="checkbox"/> ₁ | <input type="checkbox"/> ₂ | <input type="checkbox"/> ₃ | <input type="checkbox"/> ₄ |
| d) Does your father still play a musical instrument? | <input type="checkbox"/> ₁ | <input type="checkbox"/> ₂ | <input type="checkbox"/> ₃ | <input type="checkbox"/> ₄ |

Question 5 Considering the last SEC exam you sat for, which grade did you obtain for each of the following subjects? Tick one answer for each subject. If you did not sit for the exam of a particular subject, tick 'n/a'.

	1	2	3	4	5	6	7	U	n/a
a) Mathematics	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇	<input type="checkbox"/> ₈	<input type="checkbox"/> ₉
b) English	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇	<input type="checkbox"/> ₈	<input type="checkbox"/> ₉
c) Maltese	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇	<input type="checkbox"/> ₈	<input type="checkbox"/> ₉
d) Chemistry	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇	<input type="checkbox"/> ₈	<input type="checkbox"/> ₉
e) Biology	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇	<input type="checkbox"/> ₈	<input type="checkbox"/> ₉
f) Physics	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇	<input type="checkbox"/> ₈	<input type="checkbox"/> ₉

Question 6 Why did you decide to start studying chemistry? Tick the answer that best fits this question

- a) I liked the chemistry topics we learned in science during Year 7 and 8/Form 1 and 2 ₁
- b) I need a qualification in chemistry to get into a particular course of studies/career path ₂
- c) I wanted to try it out ₃
- d) I was pressured into taking chemistry - it wasn't my choice at all ₄
- e) I didn't have a preference regarding which subjects to choose, so I just chose at random ₅
- f) My friend/s chose chemistry and I wanted to be with them, so I chose it too. ₆
- g) I really like the teacher/s who teach chemistry, so I chose it as an option. ₇
- h) Other, please give details:

Question 7 Apart from music, which of these extra-curricular activities do you attend? Tick all the answers that apply:

- a) Dancing ₁
- b) Singing ₂
- c) Drama ₃
- d) Sports ₄
- e) Technology-related activities e.g. coding, robotics ₅
- f) Community-related activities e.g. youth groups, voluntary work ₆
- g) Other, please specify:

Question 8 Keeping in mind the events in the past 3 weeks, how much time did you spend studying and revising chemistry, and doing chemistry homework per week?

- a) Less than 1 hour ₁
- b) Between 1 and 3 hours ₂
- c) More than 3 hours ₃

The following questions are for those participants who used to, or are currently still taking music lessons. This section also applies to those who taught themselves to play a musical instrument. If you have never played a musical instrument, you do not need to answer any more questions and can stop here. Thank you.

Question 9 How old were you when you started taking music lessons/started learning to play a musical instrument?

_____ years

Question 10 How old were you when you stopped taking music lessons, if at all? If you are still taking music lessons, write 'n/a' in the space provided. If you taught yourself to play a musical instrument, write 'self-taught' in the space provided.

_____ years

Question 11 Using the past 3 weeks as a time-frame, how many times did you have music lessons per week? Please consider only instrument practice lessons, not theory lessons. A music lesson which is part theory and part practice is to be considered as 1 lesson.

- a) I stopped taking music lessons ₁
- b) I never attended music lessons ₂
- c) I had no lessons ₃
- d) 1 lesson ₄
- e) 2 lessons ₅
- f) 3 lessons ₆
- g) More than 3 lessons ₇

Question 12 During a typical music lesson, how long do you spend practising your instrument with your teacher?

- a) 30 minutes or less ₁
- b) Between 31 and 60 minutes ₂
- c) Between 61 and 90 minutes ₃
- d) More than 91 minutes ₄
- e) I do not attend music lessons ₅

Question 13 Using the past three weeks as a timeframe, what is the average time you spent practising your instrument every day? Do not include time spent during the music lesson with your music teacher.

- a) 15 minutes a day or less ₁
- b) Between 16 minutes and 30 minutes a day ₂
- c) Between 31 minutes and 1 hour a day ₃
- d) More than 1 hour a day ₄
- e) I do not practice any more ₅

Question 14 Which of the following instrument groups does the instrument/s you play (or used to play) belong to? If you play more than one instrument, tick all the answers that apply.

- a) Keyboards ₁
- b) Bowed strings ₂
- c) Brass ₃
- d) Woodwind ₄
- e) Percussion ₅
- f) Guitar family ₆

Question 15 Where are you currently taking instrument practice lessons? If you play more than one instrument, please consider the instrument you have been playing the longest.

- a) I do not take music lessons anymore ₁
- b) I taught myself to play ₂
- c) Band club ₃
- d) Malta School of Music ₄
- e) Malta Society of Arts ₅
- f) Private tuition by a music teacher and/or a family member ₆
- g) Other, please specify:

Question 16 Are your instrument practice lessons held in a group or individually? If you stopped taking music lessons, choose the answer which reflects the situation when you did attend lessons.

- a) In a group ₁
- b) Individually ₂
- c) I never attended lessons ₃

Question 17 How much do you agree or disagree with these statements?

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
g) Starting music was totally my choice	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
h) On most days, I would like to stop practicing my musical instrument	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
i) Playing music puts me in a good mood most of the times	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
j) I enjoy my chemistry lessons most of the times	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
k) Learning music has helped me in my school subjects	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
l) Playing music relaxes me and calms me down	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

Question 18 This question applies to those participants who used to play a musical instrument but have stopped playing for 6 months or longer. This question should not be answered by participants who are currently still playing a musical instrument, with or without formal music lessons. If you stopped playing less than 6 months ago, do not answer this question.

b) Why did you stop playing your musical instrument?

Question 19 This question applies to those participants who are still taking music lessons and/or who still practice their instrument.

What motivates you to keep playing music?

APPENDIX 3

Musical Training and Achievement in Chemistry - Is There a Link?

Questionnaire for post-secondary students

* Required

Section 1

This Section is to be answered by all participants

1. **Question 1 What is your gender? *** *Mark only one oval.*

- Female
- Male
- Other

2. **Question 2 What is the highest level of education completed by your mother/female guardian? *** *Mark only one oval.*

- Primary education
- Secondary education e.g. trade school, junior lyceum, secondary
- Post-secondary non-tertiary education e.g. 6th Form
- Tertiary education (Bachelor, master or doctoral degree)
- Not sure

3. **Question 3 What is the highest level of education completed by your father/male guardian? ***

Mark only one oval.

- Primary education
- Secondary education e.g. trade school, junior lyceum, secondary
- Post-secondary non-tertiary education e.g. 6th Form
- Tertiary education (Bachelor, master or doctoral degree)
- Not sure

4 **Question 4 This question is about your parents'/guardians' behaviours with regards to music ***

Mark only one oval per row.

	Yes	No	Not sure	Not applicable
Has your mother ever played a musical instrument?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Has your father ever played a musical instrument?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Does your mother still play a musical instrument?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Does your father still play a musical instrument?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

5. **Question 5** Considering the last SEC exam you sat for, which grade did you obtain for each of the following subjects? If you did not sit for the exam of a particular subject, click 'n/a' *

Mark only one oval per row.

	1	2	3	4	5	6	7	U	n/a
Mathematics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
English	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maltese	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Chemistry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Biology	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Physics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6. **Question 6** Why did you decide to start studying chemistry? Click one answer that best fits this question * Mark only one oval.

- I liked the chemistry topics we learned in science during Year 7 and 8/Form 1 and 2
- I need a qualification in chemistry to get into a particular course of studies/career path
- I wanted to try it out
- I was pressured into taking chemistry - it wasn't my choice at all
- I didn't have a preference regarding which subjects to choose, so I just chose at random
- My friend/s chose chemistry and I wanted to be with them, so I chose it too
- I really like the teacher/s who teach chemistry, so I chose it as an option
- _____ Other:

7. **Question 7** Apart from music, which of these extra-curricular activities do you attend? Click all the answers that apply * Check all that apply.

- Dancing
- Singing
- Drama
- Sports
- Technology-related activities e.g. coding, robotics
- Community-related activities e.g. youth groups, voluntary work
- _____ Other:

8 Question 8 Keeping in mind the events in the past 3 weeks, how much time did you spend studying and revising chemistry, and doing chemistry homework per week * *Mark only one oval.*

- Less than 1 hour
- Between 1 and 3 hours
- More than 3 hours

9. This selection will take you to the next step of the questionnaire * *Mark only one oval.*

- I am taking music lessons *Skip to question 10.*
- I used to take music lessons *Skip to question 10.*
- I never played a musical instrument *Stop filling out this form.*
- I taught myself to play a musical instrument *Skip to question 10.*

Musical Training and Achievement in Chemistry - Is There a Link?

Questions for participants who used to, or are currently still taking music lessons. This section also applies to those who taught themselves to play a musical instrument

10. Question 9 How old were you when you started taking music lessons/started learning to play a musical instrument *

11. Question 10 How old were you when you stopped taking music lessons, if at all? If you are still taking music lessons, write 'n/a' in the space provided. If you taught yourself to play a musical instrument, write 'self-taught' in the space provided. *

12. Question 11 Using the past 3 weeks as a time-frame, how many times did you have music lessons per week? Please consider only instrument practice lessons, not theory

lessons. A music lesson which is part theory and part practice is to be considered as 1 lesson * *Mark only one oval.*

- I stopped taking music lessons
- I never attended music lessons
- I had no lessons
- 1 lesson
- 2 lessons
- 3 lessons
- More than 3 lessons

13 Question 12 During a typical music lesson, how long do you spend practising your instrument with your teacher? * *Mark only one oval.*

- 30 minutes or less
- Between 31 and 60 minutes
- Between 61 and 90 minutes
- More than 91 minutes
- I do not attend music lessons

14. Question 13 Using the past three weeks as a timeframe, what is the average time you spent practising your instrument every day? Do not include time spent during the music lesson with your music teacher. * *Mark only one oval.*

- 15 minutes or less a day
- Between 16 minutes and 30 minutes a day
- Between 31 minutes and 1 hour a day
- More than 1 hour a day
- I do not practice any more

15. Question 14 Which of the following instrument groups does the instrument/s you play (or used to play) belong to? If you play more than one instrument, tick all the answers that apply. *

Check all that apply.

- Keyboards
- Bowed strings
- Brass
- Woodwind
- Percussion
- Guitar family

16. **Question 15** Where are you currently taking instrument practice lessons? If you play more than one instrument, please consider the instrument you have been playing the longest *
Mark only one oval.

- I do not take music lessons anymore
- I taught myself to play
- Band club
- Malta School of Music
- Malta Society of Arts
- Private tuition by a music teacher and/or a family member
- _____ Other:

17 **Question 16** Are your instrument practice lessons held in a group or individually? If you stopped taking music lessons, choose the answer which reflects the situation when you did attend lessons. * *Mark only one oval.*

- In a group
- Individually
- I never attended lessons

18. **Question 17** How much do you agree or disagree with these statements? * *Mark only one oval per row.*

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Starting music was totally my choice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
On most days, I would like to stop practicing my musical instrument	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Playing music puts me in a good mood most of the times	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I enjoy my chemistry lessons most of the times	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Learning music has helped me in my school subjects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Playing music relaxes me and calms me down	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

19. **This selection will take you to the next step of the questionnaire** * *Mark only one oval.*

- I used to play a musical instrument but have stopped playing for 6 months or longer *Skip to question 20.*
- I am still playing a musical instrument, with or without formal music lessons. *Skip to question 21.*
- I stopped playing a musical instrument less than 6 months ago *Skip to question 21.*

Musical Training and Achievement in Chemistry - Is There a Link?

This section is for those participants who used to play a musical instrument but have stopped playing for 6 months or longer.

20. **Question 18 Why did you stop playing your musical instrument? ***

Stop filling out this form.

Musical Training and Achievement in Chemistry - Is There a Link?

This section is for those participants who are still taking music lessons and/or who still practice their instrument

21 **Question 19 What motivates you to keep playing music? ***

APPENDIX 4

Musical Training and Achievement in Chemistry - Is There a Link?

Questionnaire for students/alumni of the University of Malta.

Thank you for clicking the link that brought you here. I am carrying out research to study the significance and effect of music training in students vis-a-vis academic achievement - particularly in chemistry - under the supervision of Dr Josette Farrugia (Department of Mathematics and Science Education, Faculty of Education).

You can participate if you are studying (or used to study) chemistry at University. You don't need to have played a musical instrument at any point in time. Obviously, you can stop filling in the questionnaire at any point, without giving a reason.

If you need more information, you can contact me on annette.coppini.97@um.edu.mt.

THANK YOU!!

* Required

Section 1

This Section is to be answered by all participants

1. **Question 1 What is your gender?** * *Mark only one oval.*

- Female
- Male
- Other

2. **Question 2 What is the highest level of education completed by your mother/female guardian?** * *Mark only one oval.*

- Primary education
- Secondary education e.g. trade school, junior lyceum, secondary
- Post-secondary non-tertiary education e.g. 6th Form
- Tertiary education (Bachelor, master or doctoral degree)
- Not sure

3. **Question 3 What is the highest level of education completed by your father/male guardian? ***

Mark only one oval.

- Primary education
- Secondary education e.g. trade school, junior lyceum, secondary
- Post-secondary non-tertiary education e.g. 6th Form
- Tertiary education (Bachelor, master or doctoral degree)
- Not sure

4 **Question 4 This question is about your parents'/guardians' behaviours with regards to music ***

Mark only one oval per row.

	Yes	No	Not sure	Not applicable
Has your mother ever played a musical instrument?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Has your father ever played a musical instrument?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Does your mother still play a musical instrument?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Does your father still play a musical instrument?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

5. **Question 5 Considering the last A-level/Intermediate exams you sat for, which grade did you obtain for each of the following subjects? If you did not sit for the exam of a particular subject, click 'n/a' *** Mark only one oval per row.

	1	2	3	4	5	6	7	U	A	B	C	D	E	n/a
Mathematics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
English	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maltese	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Chemistry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Biology	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Physics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6. **Question 6 Why did you decide to start studying chemistry? Click one answer that best fits this question *** Mark only one oval.

- I liked the chemistry topics we learned in science during Year 7 and 8/Form 1 and 2
- I need a qualification in chemistry to get into a particular course of studies/career path
- I wanted to try it out
- I was pressured into taking chemistry - it wasn't my choice at all
- I didn't have a preference regarding which subjects to choose, so I just chose at random
- My friend/s chose chemistry and I wanted to be with them, so I chose it too
- I really like the teacher/s who teach chemistry, so I chose it as an option
- _____ Other:

7. **Question 7** Apart from music, which of these extra-curricular activities do you attend?
Click all the answers that apply * Check all that apply.

- Dancing
- Singing
- Drama
- Sports
- Technology-related activities e.g. coding, robotics
- Community-related activities e.g. youth groups, voluntary work
- _____ Other:

8 **Question 8** Keeping in mind the events in the past 3 weeks, how much time did you spend studying and revising chemistry, and doing chemistry assignments per week (graduates kindly enter 'n/a'). * Mark only one oval.

- Less than 1 hour
- Between 1 and 3 hours
- More than 3 hours n/a
-

9. **This selection will take you to the next step of the questionnaire** * Mark only one oval.

- I am taking music lessons Skip to question 10.
- I used to take music lessons Skip to question 10.
- I never played a musical instrument Stop filling out this form.
- I taught myself to play a musical instrument Skip to question 10.

Musical Training and Achievement in Chemistry - Is There a Link?

Questions for participants who used to, or are currently still taking music lessons. This section also applies to those who taught themselves to play a musical instrument

10. **Question 9** How old were you when you started taking music lessons/started learning to play a musical instrument *

11. **Question 10** How old were you when you stopped taking music lessons, if at all? If you are still taking music lessons, write 'n/a' in the space provided. If you taught yourself to play a musical instrument, write 'self-taught' in the space provided. *

12. **Question 11** Using the past 3 weeks as a time-frame, how many times did you have music lessons per week? Please consider only instrument practice lessons, not theory lessons. A music lesson which is part theory and part practice is to be considered as 1 lesson. * Mark only one oval.

- I stopped taking music lessons
- I never attended music lessons
- I had no lessons
- 1 lesson
- 2 lessons
- 3 lessons
- More than 3 lessons

13 **Question 12** During a typical music lesson, how long do you spend practising your instrument with your teacher? * Mark only one oval.

- 30 minutes or less
- Between 31 and 60 minutes
- Between 61 and 90 minutes
- More than 91 minutes
- I do not attend music lessons

14. **Question 13** Using the past three weeks as a timeframe, what is the average time you spent practising your instrument every day? Do not include time spent during the music lesson with your music teacher. * Mark only one oval.

- 15 minutes or less a day
- Between 16 minutes and 30 minutes a day
- Between 31 minutes and 1 hour a day
- More than 1 hour a day
- I do not practice any more

15. **Question 14** Which of the following instrument groups does the instrument/s you play (or used to play) belong to? If you play more than one instrument, tick all the answers that apply. *

Check all that apply.

- Keyboards
- Bowed strings
- Brass
- Woodwind
- Percussion
- Guitar family

16. **Question 15** Where are you currently taking instrument practice lessons? If you play more than one instrument, please consider the instrument you have been playing the longest * *Mark only one oval.*

- I do not take music lessons anymore
- I taught myself to play
- Band club
- Malta School of Music
- Malta Society of Arts
- Private tuition by a music teacher and/or a family member
- _____ Other:

17 **Question 16** Are your instrument practice lessons held in a group or individually? If you stopped taking music lessons, choose the answer which reflects the situation when you did attend lessons. * *Mark only one oval.*

- In a group
- Individually
- I never attended lessons

18. **Question 17** How much do you agree or disagree with these statements? * *Mark only one oval per row.*

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Starting music was totally my choice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
On most days, I would like to stop practicing my musical instrument	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Playing music puts me in a good mood most of the times	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I enjoy(ed) my chemistry lessons most of the times	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Learning music has helped me in my school subjects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Playing music relaxes me and calms me down	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

19. **This selection will take you to the next step of the questionnaire** * *Mark only one oval.*

I used to play a musical instrument but have stopped playing for 6 months or longer *Skip to question 20.*

I am still playing a musical instrument, with or without formal music lessons. *Skip to question 21.*

I stopped playing a musical instrument less than 6 months ago *Skip to question 21.*

Musical Training and Achievement in Chemistry - Is There a Link?

This section is for those participants who used to play a musical instrument but have stopped playing for 6 months or longer.

20. **Question 18 Why did you stop playing your musical instrument?** *

Stop filling out this form.

Musical Training and Achievement in Chemistry - Is There a Link?

This section is for those participants who are still taking music lessons and/or who still practice their instrument

21 **Question 19 What motivates you to keep playing music?** *

APPENDIX 5

Interview Questions

1. At which age did you start/stop music training?
2. What lead to your musical training?
3. Did you grow up in a musical family?
4. Why did you stop (if at all)?
5. What can you tell me about your music lessons? Duration, relationship with the teacher?
6. What were your reasons for choosing chemistry?
7. How did you feel about this subject at the time?
8. And did this change throughout the years?
9. How well did you do in chemistry exams?
10. How did you balance scholastic work and commitments with musical and other extracurricular activities?
11. What motivation were you getting at the time out of music training?
12. Would you say that you excelled in music?
13. Would you say that you excelled in chemistry?
14. Looking back, where there any skills that were transferred from your musical training to other areas in your education/life?

APPENDIX 6

Dear participant,

I am a student at the University of Malta reading for a Masters in Teaching and Learning. I am carrying out research to study the significance and effect of music training in people who have studied or are studying chemistry under the supervision of Dr Josette Farrugia (Department of Mathematics and Science Education, Faculty of Education).

I would appreciate your help in this study. This would involve participating in one interview which should last around 30 minutes. You will be asked about your memories and experiences as a chemistry student who also undertook musical training.

The interview will be audio-recorded and then transcribed and analysed. The audio recordings themselves will be kept for 1 year after publication of the dissertation, and then destroyed. Your identity will not be divulged and any details that might lead to your identification will be changed. You are free to opt out of the study at any point without giving a reason. Results of this analysis will be reported in my dissertation, which will then be submitted to the Faculty of Education.

Should you be interested, I will gladly send you an abstract of the final work.

I would really appreciate your participation! To participate, please get in touch with me on annette.coppini.97@um.edu.mt (mobile: 79461346) or with Dr Josette Farrugia (josette.farrugia@um.edu.mt). I will be happy to answer any questions or difficulties you might have.

Thank you for your help.

Best regards,

Annette Coppini

APPENDIX 7

I have read the information letter provided with details about the study on the significance and effect of music training on those students studying chemistry.

I understand that my identity will not be divulged and any details that can identify me will be changed.

I understand that I am free not to participate and that I can stop participating at any point without giving a reason.

I give my consent to the audio-recorded interview.

Name

Signature

Date

Thank you - your consent is greatly appreciated.

Annette Coppini

APPENDIX 8

Dear (Head of Church Secretariat),

I am a student at the University of Malta, reading for a Masters in Teaching and Learning. As part of my course requirements, I am carrying out a study to determine whether there is a link between musical training and achievement in chemistry under the supervision of Dr Josette Farrugia (Department of Mathematics and Science Education, Faculty of Education).

Students in form 4/Year 10 and sixth form from church, state and independent schools as well as the University of Malta will be participating in this study. Students who are studying chemistry will be asked to fill in an anonymous questionnaire, which will take approximately 15 to 20 minutes to complete. This will help us understand whether there is a link between achievement in chemistry and musical training and, if such a link exists, whether it is influenced by the age at which music training started, the instrument played, the amount of time spent practicing, and other similar factors. The responses of the questionnaires will be analysed by myself and reported in my dissertation.

I would really appreciate your permission to distribute questionnaires in eight Church Secondary Schools (four of which are boys' schools and four are girls' schools), namely School 1, School 2, School 3, School 4 as well as School 5, School 6, School 7, and School 8. Additionally, I kindly ask your permission to carry out this research at School 9 Sixth Form and School 10 Sixth Form.

Parents will be asked to give their consent and students will be free to decide whether to participate or not. They are free to decline or to withdraw from the study right up to the point where the completed questionnaire is being collected, without the need to give any justification.

You may rest assured that neither the identity of the participants nor that of any school will be disclosed. The questionnaires collected will remain confidential and will only be used for research purposes.

In case of any difficulty, do not hesitate to contact me on annette.coppini.97@um.edu.mt (mobile: 79461346) or Dr Josette Farrugia on josette.farrugia@um.edu.mt.

Best regards,

Annette Coppini

APPENDIX 9

Dear Head of School,

I am a student at the University of Malta, reading for a Masters in Teaching and Learning. As part of my course requirements, I am carrying out a study to determine whether there is a link between musical training and achievement in chemistry under the supervision of Dr Josette Farrugia (Department of Mathematics and Science Education, Faculty of Education).

Students in form 4/Year 10 and sixth form from church, state and independent schools as well as the University of Malta will be participating in this study. Students who are studying chemistry will be asked to fill in an anonymous questionnaire, which will take approximately 15 to 20 minutes to complete. This will help us understand whether there is a link between achievement in chemistry and musical training and, if such a link exists, whether it is influenced by the age at which music training started, the instrument played, the amount of time spent practicing, and other similar factors. The results of the questionnaires will be analysed and reported in my dissertation.

I would really appreciate your assistance in distributing questionnaires to form 4/year 10 students who are studying chemistry. Parents will be asked to give their consent and students will be free to decide whether to participate or not. They are free to decline or to withdraw from the study right up to the point where the completed questionnaire is being collected, without the need to give any justification.

You may rest assured that neither the identity of the participants nor that of the school will be disclosed. The questionnaires collected will remain confidential and will only be used for research purposes.

In case of any difficulty, do not hesitate to contact me on annette.coppini.97@um.edu.mt (mobile: 79461346) or Dr Josette Farrugia on josette.farrugia@um.edu.mt.

Best regards,

Annette Coppini

APPENDIX 10

Dear (Registrar),

I am a student at the University of Malta, reading for a Masters in Teaching and Learning. As part of my course requirements, I am carrying out a study to determine whether there is a link between musical training and achievement in chemistry under the supervision of Dr Josette Farrugia (Department of Mathematics and Science Education, Faculty of Education).

Students in form 4/Year 10 and sixth form from church, state and independent schools as well as the

University of Malta will be participating in this study. Students who are studying chemistry at Junior College and the University of Malta will be asked to fill in an online anonymous questionnaire, which will take approximately 15 to 20 minutes to complete. This will help us understand whether there is a link between achievement in chemistry and musical training and, if such a link exists, whether it is influenced by the age at which music training started, the instrument played, the amount of time spent practicing, and other similar factors. The responses of the questionnaires will be analysed by myself and reported in my dissertation.

I would be very appreciative if you could act as an intermediary by forwarding the link to my questionnaire to all the undergraduate students attending the courses for Bachelor of Science (Honours) in Chemistry, Bachelor of Science (Honours) in Biology and Chemistry, Bachelor of

Science (Honours) in Chemistry with Materials, Bachelor of Science (Honours) in Chemistry and

Physics, Bachelor of Science (Honours) in Chemistry and Mathematics, Bachelor of Science (Honours) in Chemistry and Statistics and Operations Research, and the Bachelor of Science (Honours) in Science for Education and Communication with specialisation in Chemistry.

Students will be free to decide whether to participate or not. They are free to decline or to withdraw from the study right up to the point where the completed questionnaire is submitted, without the need to give any justification. You may rest assured that the responses will remain anonymous and confidential, and will only be used for research purposes.

In case of any difficulty, do not hesitate to contact me on annette.coppini.97@um.edu.mt (mobile:

79461346) or Dr Josette Farrugia on josette.farrugia@um.edu.mt.

Best regards,

Annette Coppini

APPENDIX 11

Dear (Administrator),

I am a student at the University of Malta, reading for a Masters in Teaching and Learning. As part of my course requirements, I am carrying out a study to determine whether there is a link between musical training and achievement in chemistry under the supervision of Dr Josette Farrugia (Department of Mathematics and Science Education, Faculty of Education).

Students in form 4/Year 10 and sixth form from church, state and independent schools as well as the University of Malta will be participating in this study. Students who studied chemistry at the University of Malta will be asked to fill in an online anonymous questionnaire, which should take approximately 15 to 20 minutes to complete. This will help us understand whether there is a link between achievement in chemistry and musical training and, if such a link exists, whether it is influenced by the age at which music training started, the instrument played, the amount of time spent practicing, and other similar factors. The responses of the questionnaires will be analysed by myself and reported in my dissertation.

I would be very appreciative if you could act as an intermediary by forwarding the link to my questionnaire to all the graduate students of the Department of chemistry.

Participants will be free to decide whether to participate or not. Should they agree to participate, they are free to choose not to submit the completed questionnaire.

You may rest assured that the responses will remain anonymous and confidential, and will only be used for research purposes.

In case of any difficulty, do not hesitate to contact me on annette.coppini.97@um.edu.mt (mobile: 79461346) or Dr Josette Farrugia on josette.farrugia@um.edu.mt.

Best regards,

Annette Coppini

APPENDIX 12

Dear Parents and Guardians,

I am a student at the University of Malta, reading for a Masters in Teaching and Learning. As part of my course requirements, I will be studying the significance and effect of music training in students on their academic achievement under the supervision of Dr Josette Farrugia (Department of Mathematics and Science Education, Faculty of Education)

I would appreciate your consent for you son/daughter to fill a short, anonymous questionnaire at school, which should take about 15-20 minutes to complete. The students will not be required to write their name, nor the name of the school they attend. The questionnaire will be completed at a convenient time chosen by the school. Students are free not to participate and to withdraw at any point, without the need for justification.

The responses of the questionnaire will be analysed by myself and the collective results will be reported in my dissertation. The dissertation will be submitted to the Faculty of Education at the University of Malta.

I would greatly appreciate having your consent by filling the form attached and sending it to school with your son/daughter.

In case of any difficulty, do not hesitate to contact me on annette.coppini.97@um.edu.mt (mobile: 79461346) or Dr Josette Farrugia on josette.farrugia@um.edu.mt.

Best regards,

Annette Coppini

Għeżież ġenituri u kustodji

Jiena studenta tal-Universita' ta' Malta u qegħda nistudja għal 'Masters' fit-Tagħlim u t-Taħriġ. Bħala parti mil-kors, ser inkun qed nhejji studju dwar l-effett li għandu t-tagħlim tal-mużika fuq is-sugġetti akkademiċi taħt is-superviżjoni ta' Dr Josette Farrugia (Dipartiment tal-Edukazzjoni tal-Matematika u x-Xjenza, Fakultà tal-Edukazzjoni).

Nixtieq il-kunsens tagħkom, sabiex it-tifel/tifla tagħkom i/tkun j/tista' j/timla kwestjonarju qasir. Dan għandu jieħu madwar 15-20 minuta, u ser iseħħ l-iskola stess. L-istudenti mhumiex ser jintalbu jnizzlu isimhom u lanqas isem l-iskola. Il-kwestjonarju ser jimtela f'hin magħżul mill-iskola. L-istudenti għandhom dritt ma jieħdux sehem jew, jekk jieħdu sehem, għandhom dritt jieqfu meta jridu mingħajr bżonn ta' spjegazzjoni.

Jien ser ngħarbel ir-risposti li jingħataw fil-kwestjonarji. Ir-riżultati li joħorgu mill-kwestjonarji kollha ser jingabru u jidhlu fit-tezi tiegħi. Imbagħad, it-tezi tiġi ppreżentata lill-Fakultà tal-Edukazzjoni tal-Università ta' Malta.

Napprezza ħafna jekk tagħtu l-kunsens tagħkom, billi tiffirmaw l-formula tal-kunsens u tibgħatuha l-iskola mat-tifel/tifla tagħkom.

F'każ ta' diffikultà, nitlobkom tikkuntattjaw lili fuq annette.coppini.97@um.edu.mt (cellulari: 79461346) jew lil Dr Josette Farrugia fuq josette.farrugia@um.edu.mt.

Dejjem tagħkom,

Annette Coppini

APPENDIX 13

I have read the information letter provided with details about the study on the significance and effect of music training on students' achievement.

I understand that my daughter/son will not be asked to write down her/his name or the name of the school on the questionnaire.

I understand that my daughter/son is free not to participate and that s/he may choose not to submit the completed questionnaire without giving a reason.

I give my consent for my daughter/son to fill a short questionnaire.

Name of parent/guardian

Signature of parent/guardian

Date

Name of student

Student's class

Thank you - your consent is greatly appreciated.

Annette Coppini

Jien qrajt l-ittra ta' informazzjoni bid-dettalji dwar l-istudju fuq l-effett tat-taħriġ fil-mużika fl-istudenti.

Nifhem li t-tifel/tifla tiegħi mhux ser jintalab/tintalab j/tniżżel ismu/isimha jew isem l-iskola fuq il-kwestjonarju.

Nifhem li t-tifel/tifla tiegħi j/tista' ma j/tieħux sehem jew jekk j/tieħu sehem, j/tista' j/tieqaf meta j/trid sal-mument li j/tkun ser i/trodd il-kwestjonarju komplut lura, mingħajr ma j/tagħti raġuni.

Permezz tal-firma tiegħi hawn taħt, nagħti permess biex it-tifel/tifla tiegħi jimla/timla l-kwestjonarju.

Isem tal-ġenitur/kustodju

Firma tal-ġenitur/kustodju

Data

Isem tal-istudent

Klassi tal-istudent

Grazzi ħafna tal-kunsens tiegħek.

Annette Coppini

APPENDIX 14

Dear student,

I am a student at the University of Malta reading for a Masters in Teaching and Learning. I am carrying out research to study the significance and effect of music training in students under the supervision of Dr Josette Farrugia (Department of Mathematics and Science Education, Faculty of Education).

I would appreciate your help in this study. This would involve filling a short, anonymous questionnaire just once. The questionnaire will be filled at school at a time chosen by the school and will take about 15-20 minutes to complete. You are free not to take part and even if you do accept, you can stop participating at any point without giving a reason. You will not be asked to write your name or the name of the school on the questionnaire. Filling in the questionnaire will be taken as acceptance to be part of this study.

The questionnaires will be read by myself and the collective results gathered from all the questionnaires will be reported in my dissertation. The dissertation will be submitted to the Faculty of Education at the University of Malta.

In case of any difficulty or if you would like to ask me any questions, you can contact me on annette.coppini.97@um.edu.mt (mobile: 79461346) or Dr Josette Farrugia on josette.farrugia@um.edu.mt.

Thank you for your help.

Yours truly,

Annette Coppini

Għażiż/a student/a,

Jiena studenta tal-Università ta' Malta u qegħda nistudja għal 'Masters' fit-Tagħlim u t-Taħriġ. Bħala parti mil-kors, ser inkun qed nhejji studju dwar l-effett li għandu t-tagħlim tal-mużika fuq is-sugġetti akkademiċi, taħt is-supervizjoni ta' Dr Josette Farrugia (Dipartiment tal-Edukazzjoni tal-Matematika u x-Xjenza, Fakultà tal-Edukazzjoni).

Nixtieq l-għajjnuna tiegħek f'dan l-istudju, billi timla kwestjonarju qasir, darba biss. M'għandux jieħu iktar minn 15 sa 20 minuta biex jimtela, u dan isir l-iskola stess. Għandek dritt ma tiehux sehem u anki jekk tieħu sehem, għandek dritt tieqaf meta trid mingħajr ma tagħti l-ebda raġuni. Ladarba timla l-kwestjonarju, dan ikun ifisser li inti taċċetta li tkun parti minn dan l-istudju.

Jien ser ngħarbel ir-risposti li jingħataw fil-kwestjonarji, imbagħad ir-rizultati li joħorġu mill-kwestjonarji kollha ser jingabru u jidhlu fit-tezi tiegħi. Fl-aħħar nett, it-tezi tigi ppreżentata lill-Fakultà tal-Edukazzjoni tal-Università ta' Malta.

Jekk tixtieq tieħu sehem f'dan l-istudju, kull m'għandek tagħmel huwa li timla l-kwestjonarju.

F'każ ta' diffikultà, jew jekk tixtieq tistaqsini xi haġa, ikkuntatja lili fuq annette.coppini.97@um.ed.mt (ċellulari: 79461346) jew lil Dr Josette Farrugia fuq josette.farrugia@um.edu.mt.

Grazzi tal-għajjnuna tiegħek.

Dejjem tiegħek,

Annette Coppini

APPENDIX 15

Dear student,

I am a student at the University of Malta reading for a Masters in Teaching and Learning. I am carrying out research to study the significance and effect of music training in students under the supervision of Dr Josette Farrugia (Department of Mathematics and Science Education, Faculty of Education).

I would appreciate your help in this study. This would involve filling a short, anonymous questionnaire just once. You are free not to take part and even if you do accept, you can stop participating at any point without giving a reason. You will not be asked to write your name or the name of the school on the questionnaire. Filling-in the questionnaire will be taken as acceptance to be part of this study.

The questionnaires will be read by myself and the collective results gathered from all the questionnaires will be reported in my dissertation. The dissertation will be submitted to the Faculty of Education at the University of Malta.

In case of any difficulty or if you would like to ask me any questions, you can contact me on annette.coppini.97@um.edu.mt (mobile: 79461346) or Dr Josette Farrugia on josette.farrugia@um.edu.mt.

Thank you for your help.

Yours truly,

Annette Coppini

APPENDIX 16

Dear Sir/Madam,

I am a student at the University of Malta reading for a Masters in Teaching and Learning. I am carrying out research to study the significance and effect of music training in students vis-à-vis academic achievement - particularly in chemistry - under the supervision of Dr Josette Farrugia (Department of Mathematics and Science Education, Faculty of Education).

I would appreciate your help in this study. This would involve filling a short, anonymous questionnaire just once by clicking on the link below. The questionnaire will take about 15-20 minutes to complete. You are free not to take part and even if you do accept, you can opt out of the study at any point without giving a reason. You will not be asked to write your name or the name of the institution you attend on the questionnaire. Completion of the questionnaire will be taken as acceptance to participate in this study.

The questionnaires will be read by myself and the collective results gathered from all the questionnaires will be reported in my dissertation. The dissertation will be submitted to the Faculty of Education at the University of Malta.

By filling in the questionnaire you are agreeing to participate in the study.

In case of any difficulty or if you would like to ask me any questions, you can contact me on annette.coppini.97@um.edu.mt (mobile: 79461346) or Dr Josette Farrugia on josette.farrugia@um.edu.mt.

Thank you for your help.

Best regards,

Annette Coppini