# Modality and Redundancy Effects on Music Theory Learning Among Pupils of Different Anxiety Levels

Soon Fook Fong, Aldalalah, M. Osamah

*Abstract*—The purpose of this study was to investigate effects of modality and redundancy principles on music theory learning among pupils of different anxiety levels. The lesson of music theory was developed in three different modes, audio and image (AI), text with image (TI) and audio with image and text (AIT). The independent variables were the three modes of courseware. The moderator variable was the anxiety level, while the dependent variable was the post test score. The study sample consisted of 405 third-grade pupils. Descriptive and inferential statistics were conducted to analyze the collected data. Analyses of covariance (ANCOVA) and Post hoc were carried out to examine the main effects as well as the interaction effects of the independent variables on the dependent variable. The findings of this study showed that medium anxiety pupils performed significantly better than low and high anxiety pupils in all the three treatment modes. The AI mode was found to help pupils with high anxiety significantly more than the TI and AIT modes.

*Keywords*—Modality, Redundancy, Music theory, Cognitive theory of multimedia learning, Cognitive load theory, Anxiety.

## I. INTRODUCTION

THE optimal learning among a wide range of students requires a wide range of instructional modes or environments that suit the individual students' aptitude and learning styles [1]. Such a phenomenon is explained by the aptitude-treatment-interactions (ATI) strategy proposed by Cronbach & Snow [2]. Aptitude is defined as any individual characteristic that could increase or decrease the student's probability of success in a given treatment. The treatment is defined as variations in the mode or pace of instructions. Studies conducted by Cronbach [1], Swanson [3], Shute [4] and Fong [5] showed that the learning outcomes of students were indeed better when the modes of instruction were adapted to the student's aptitude and psychological profiles.

This research investigates the aptitude-treatment-interactions (ATI) proposed by Cronbach [1]. This research also investigates the aptitude-treatment-interactions (ATI) among students of differing anxiety levels with the three modes of

presentations (AI, TI and ATI) on the learning of and attitudes of the pupils toward music theory.

## II. MUSIC THEORY

Music theory is the field of study that deals with how music works. It basically addresses the language and notation of music in which music can be read and written. It helps to identify the different patterns and structures revealed in the techniques of composers, across or within genres, styles, or historical periods [6]. Music theory can be considered as a universal language as it has a universal context and notations [7]. Since music theory concentrates on how music notation is written (i.e. the elements of the notation) it provides a form of communication for musicians to express their musical concepts [8]. However, music theory also includes underlying concepts of music such as the structure, the organization and the history [9]. These underlying concepts contribute towards building the basic knowledge in music notation and understanding the evolving stages in music as well as the way the notation is used in different circumstances.

## III. ANXIETY

Anxiety is one of the most studied variables in the context of the learning and teaching process. Alshawa & Alhayek [10] conceptualized anxiety as an emotional state overwhelmed with unordinary feelings. There are different kinds of anxiety such as test anxiety, speech anxiety, mathematics anxiety and other forms of anxiety. All of these forms of anxiety describe an undesired emotional state like fear, despite the differences in the situations provoking such emotional state [11]. Students with high levels of anxiety have low performance levels in the average learning contexts. By contrast, students who report low levels of anxiety perform better even if the academic abilities of both groups of students were equivalent [12].

Anxiety is an emotion that results from the activation of fear, which is considered in turn an expressive thought of an evaluative situation of a certain threatening context. Hawwash & Elemat [13] argue that anxiety and fear symptoms are normal for the individual who is always thinking of sources of danger. Such negative thoughts express themselves through thinking about events and circumstances related with such negative thoughts. This will eventually lead to lack of ability in the anxious individual to reflect on these negative thoughts,

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or think about them with logic, thus generalizing the anxiety provoking stimuli to any perceived situation has been intimidating [14]. The attention of the anxious individual is always connected with the concepts or the stimuli related with provoking anxiety. As a result, the individual looses much of his ability to transmit his thoughts and experiences to other internal processes or other external provokers [15]. It is worthy to note that anxiety is a normal human phenomenon, and its severity varies from one individual to another. The greater the level of anxiety in the individual, the more the individual is characterized as distressed and exhausted. Anxiety has negative effects on an individual's attention and thinking, thus decreasing the academic achievement of the individual [12].

Students reporting high levels of anxiety have been characterized by poor achievement [16]. Low achievement among this group has been explained by stating that anxiety in the different situations hinders recall of previously learned material. This means that they divide their attention between the demands of the learning task and other learning task related to aspects consisting mainly of negative self engagement and demonstrating feelings of helplessness [17]. As for students demonstrating lower levels of anxiety, they dedicate much of their attention to the learning task, thus showing good performance [18].

Anxiety is described as a form of fears hindering students' achievement in the different educational stages. Several researchers concluded that the negative correlation between anxiety and academic achievement is attributed to the fact that anxiety provokes a comprehensive individual distress, and, thus, has negative effects on the different mental processes such as attention, thinking recall and reasonable judgments [19]. Such mental processes are said to be a prerequisite for success in the different learning tasks. Consequently, state of anxiety has negative impact on the learner's individual achievement. A student with high levels of anxiety appears incompetent and perceives himself as unable to pass a certain test. Due to the anxiety provoking response, the student has perceptions that the surrounding environment determines his abilities and competency [20]. Sawalhah & Assfa[12] pointed out that several factors affect the performance of students with high anxiety levels, including student's dependence on teacher, teacher's character and behaviors, and reinforcement provided to the student.

Several studies confirmed the presence of negative correlation between anxiety levels and academic achievement, and the students with high levels of anxiety will learn better if we worked on reducing levels of anxiety in the learning environment via using a program designated to reduce anxiety and train students to use effective study skills. In another study, Woodward [21] examined the effect of mathematics anxiety on students' achievement and found a negative correlation between mathematics anxiety and achievement. Brown [22] investigated the effect of test anxiety on students' results. The results revealed a correlation between anxiety and achievement. More specifically, the results found students with low levels of test anxiety had better scores in academic aptitude tests.

A study conducted by Fong [5] examined the effects of animations on students' procedural knowledge in biology. The results of this study confirmed previous results demonstrating the negative effects of anxiety on students' performance, but this effect varied across students. The results of the study demonstrated that students with moderate levels of anxiety outperformed both students with low and high levels of anxiety. This result is consistent with the finding by Toh [23] who reported a correlation between anxiety level and student achievement.

Research has indicated that anxiety for musical performance prevails with adverse effects on students' musical performance [24]. Kenny, Davis & Oates [25] noticed that opera performers showed attendance concern, which increased their vulnerability and stress regarding their job. Alfano, Beidel & Turner [26] and Lewinsohn, Gotlib, Lewinsohn, Steeley, & Allen [27] demonstrated that social concern is most widely seen in a community that perceivably has effects on musical performance.

Researchers who studied the factor of musical concern in musicians showed that musical concern appears as a result of three interacting factors: perception, automatic agitation, and explicit behavioral response [28]. Musical concern, in the first place, starts in the form of psychological events developed into anxiety in the nervous system that has an effect on musical performance. Some features of concern would be threatening for a performer in the case where concern may adversely affect the performance level [29]. As a matter of fact, musical concern is deemed relatively old, but the research interest in this field is modern as compared to other disciplines.

Some studies focused on the effect of anxiety on some variables, but the majority of these studies examined the effects of anxiety on academic achievement. Most studies confirmed the impact of anxiety on several variables, including achievement. Despite the fact that some studies have focused on the impact of anxiety on musical performance, as it is the case in the current study, a revision of the previous literature indicates that no study has examined the effect of anxiety on learning music in general, and learning different music theories specifically.

## IV. MODALITY PRINCIPLE

Moreno & Mayer [30] suggested that pictures should go together with a synchronized auditory explanatory recitation rather than a synchronized explanatory text, (see Fig. 1)
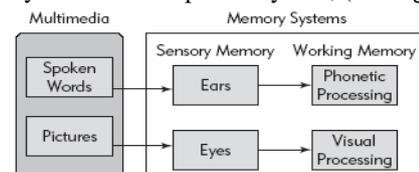


Fig. 1 Modality Principle, Mayer & Moreno [31]

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Mayer & Mereno [31] and Alherish, Alababneh & Aldalalah [32] found that the learner's understanding when watching animated images on a certain phenomenon accompanied with an auditory explanation is much better than the learner's understanding when watching animated images on the same phenomenon while verbally reading an onscreen-text explanation. At the same time, this principle is in tandem with the cognitive learning theory using multimedia techniques. The cognitive learning theory suggests that reading an onscreen-text along with animated pictures will add more load on the visual working memory because both are transported along the visual channel of the working memory. This will result in lower working memory capacity and lower capacity for information processing issuing in reduced learning [33]; [34]; [35]; [36]. Therefore, this result also fits the modality principle. The use of the visual channel for graphical material and the verbal channel for the narrated explanation helps increase the working memory capacity effectiveness and facilitate better learning [37].

## V. REDUNDANCY PRINCIPLE

There is now much evidence to suggest that redundant material imposes a significant extraneous cognitive load that has negative outcomes for learning and understanding [38]. Redundant material interferes with learning rather than proving to be advantageous or even neutral when acquiring new information. By eliminating redundant information the load on working memory is considerably reduced, thus facilitating better learning. The redundancy effect occurs when learners are required to attend to or engage in activities that are irrelevant to the task at hand [39]. The effect has been shown to interfere with the core material to be learned due to the extraneous load imposed on working memory [40]. Increasing working memory load by simultaneously processing redundant information with essential information that needs to be learned, results in the transfer of information into long-term memory becoming problematic. The redundancy effect is associated with materials or information that can be understood in isolation of each other [41]. Information presented in multiple forms, or information that is unnecessarily elaborated is representative of redundancy [42]. (Fig. 2)
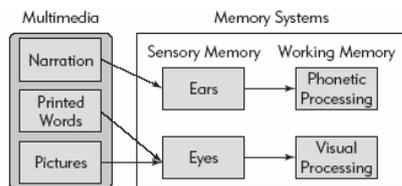


Fig. 2 Redundancy Principles [43]

Kalyuga, Chandler & Sweller [44] again demonstrated the redundancy effect in a task involving listening and reading identical text in a series of experiments involving training materials for technical apprentices. The redundancy effect has been described in the past as counter-intuitive [45] as it is often assumed that an abundance of information is advantageous to the learner. Cognitive load theory states otherwise asserting that an overload on working memory inhibits learning. Pictures are an additional and unnecessary load for the working memory to process when learning to read, and therefore redundant. Pictures are very likely to distract the child from the text thereby drawing on working memory resources that could be otherwise used for the processing and storing of core information associated with the decoding process [46].

## VI. RESEARCH QUESTIONS

1) Will pupils with medium anxiety (MA) attain significantly higher post-test scores (PTS) than low anxiety (LA) pupils?
2) Will pupils with low anxiety (LA) attain significantly higher post-test scores (PTS) than high anxiety (HA) pupils?
3) Will pupils with high anxiety (HA)using the Audio, Images (AI) mode attain significantly higher post-test scores (PTS) than high anxiety (HA) pupils using the Text, Images (TI) mode?
4) Will pupils with high anxiety (HA) using the Text, Images (TI) mode will not attain significantly higher post-test scores (PTS) than high anxiety (HA) pupils using the Audio, Images, Text (AIT) mode?
5) Are there interaction effects between treatment modes and anxiety on the post-test scores (PTS)?

## VII. METHODS

### A. Sample

The sample consisted of 405 third-grade pupils and were randomly selected from six different primary co-educational schools enrolled in the ALKORAH educational directorate in Irbid Governorate (Jordan) in the second semester for the 2008/2009 academic year. According to Gay & Airasian [47] ''all the individuals in the defined population have equal and independent chance of being selected''. The six schools were also randomly selected from the primary schools where music was taught in heterogeneous classes with no grouping or ability tracking.

### B. Experimental Condition

The pupils' distribution within the treatment groups was conducted randomly. Then the treatment groups were exposed to the treatment consecutively. The three treatment groups are as follows:

o First treatment: The educational material was shown as images and audio.
o Second treatment: It is similar to the first treatment except that a text is being displayed simultaneously with the images, but no audio is shown.
o Third treatment: The educational material was shown as a text (as written text on the screen) in addition to the images (as in first and second treatments), the educational materials were shown in a more redundant manner than the other treatments by adding the audio effects.

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### C. Instruments

1) The music achievement test that was administered on the participants of the three groups in this study is adapted from the music theory competency test developed by the researcher. the reliability of the test questions was calculated using the Cronbach Alpha procedure to calculate the internal consistency. The Cronbach Alpha of the test was 0.80, the internal consistency of the test was 0.93. and the difficulty values ranged from 0.31–0.66, and

2) Anxiety Scale: This test is used to measure the anxiety. The scale of trait anxiety consists of statements asking about feelings. Generally, the test consists of 20 items. Each item has a 4 point scale response. These are: 1- being almost never, 2- being sometimes, 3- being often and 4- being almost always. This instrument is adopted from Maznah, Ng and Yoong [48]. The reliability coefficient of this instrument (The Arabic version) was computed by the implementation of Cronbach Alpha whereby it was 0.88 for the whole scale. The internal consistency in this instrument (Arabic version) was 0.94.

3) Instruments Validity:Validity of the instruments are important aspects that should be taken into account when conducting a research. Validity consists of two different aspects that is face and content validity. According to Gay & Airasian [49] face validity relates to '' the degree to which a test appears to measure what it claims to measure''. Face validity was judged by a panel of experts in the field of education and music. Content validity refers to the ''degree to which a test measures an intended content area '' [49]. Content validity of the instruments in this research was justified by the panel. The feedback and comments received from the panel of experts were employed to establish the necessary clarifications, changes, and modifications before and after piloting the study.

### D. Study Design

This study followed the quasi experimental method to measure the impact of the 3 modes of treatments on the post test scores of the third grade pupils in the music classes according to the modality and redundancy principles of cognitive theory.

### D. Research Variables

The present research contains three types of variables (independent, dependent and moderating variables) that are presented as follows:
o Independent Variables:
The independent variables in this study were the three modes of presentation:
1. Multimedia computer-based learning courseware with music theory presented in audio and text (AI)
2. Multimedia computer-based learning courseware with music theory presented in text and image (TI)
3. Multimedia computer-based learning courseware with music theory presented in audio, image and text (AIT)
o Dependent Variable
1. Post Test Score (Music Theory Learning)
o Moderator Variable
1. Anxiety levels

## VIII. RESULTS

The analyses of the collected data were carried out through various statistical techniques such as the t-test, ANCOVA, ANOVA, The data were compiled and analyzed using the Statistical Package for the Social Science (SPSS 16) for Windows computer software.

### A. The Pre-Quasi Experimental Study Results

The purpose of the pre-quasi experimental study was to test the assumption that the participants across the three groups were equivalent in their prior knowledge of the unit on music theory for third grade primary pupils. To test that the participants across the three groups were equivalent, the pre-test was conducted four weeks before the beginning of the study. The pre-test papers were scored by the researcher. To determine if there were statistically significant differences between the groups' mean scores, the scores of the three groups were entered into the Statistical Package for Social Science (SPSS 16) for Windows computer software.

1) Measure of Relationship between Pre-test Scores and Post-test Scores

A correlation coefficient of R= 0.627** indicates a high positive relationship between the two variables.

2) Testing the three groups' equivalence

To examine the equality of treatment mode on the pre-scores, the ANOVA procedure was used. The results of the ANOVA test. The values $F_{(2,402)}= 2.349$, Mean Square = 13.519, and p = .097 showed that there is no significant difference in the pre-test scores among the three treatment groups. This means that the three groups have the same level of prior knowledge of the unit on music theory for third grade primary pupils.

3) Testing Homogeneity of Variances for the Variables in the Pre-tes and post-test

The results from Levene's Test for homogeneity of variance by comparing the dependent variables across the three groups for Treatments indicated homogeneity of variance was met by all the dependent variables. As p > 0.05 for all variables, the results show that the groups were homogenous.

4) Testing of Normality of Distributed Pre-test and post-test

A skewness range and kurtosis range presented values reveal that the variables are normally distributed and have met the criteria for further analysis.

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*B. Description of the Post-test Scores of Pupils with Different Levels of Anxiety (LA, MA & HA)*

A comparison was made between the three groups of pupils, that is, those with low levels of anxiety, medium level of anxiety and high level of anxiety (LA, MA & HA) based on the means of the post-test scores using the descriptive procedure (Table I).

TABLE I
POST-TEST SCORES OF PUPILS WITH DIFFERENT LEVELS OF ANXIETY (LA, MA & HA)

| Anxiety | Mean | Std. Deviation | N |
|---|---|---|---|
| Low | 17.4486 | 5.20383 | 107 |
| Medium | 21.4433 | 5.11555 | 203 |
| High | 17.2316 | 4.98818 | 95 |
| Total | 19.4000 | 5.49464 | 405 |

From Table 1 it can be seen that the post-test score mean (M = 21.44) for medium anxiety group is higher than the post-test score mean (M = 17.44) for the low anxiety group. The mean of post-test score (M = 17.44) for the low anxiety group is higher than the mean of the post-test score (M = 17.23) for the high anxiety group.

*C. ANCOVA of the Post-test Scores of Pupils with Different Levels of Anxiety (LA, MA & HA)*

In order to reduce the statistical error, the pre-test scores were used as the covariate, and a comparison was made among pupils with different levels of anxiety (LA, MA & HA) using the ANCOVA procedure (Table II).

TABLE II
ANCOVA OF THE POST-TEST SCORES OF PUPILS WITH DIFFERENT LEVELS OF ANXIETY (LA, MA & HA)

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 5300.142[a] | 3 | 1766.714 | 102.718 | .000 |
| Intercept | 699.756 | 1 | 699.756 | 40.684 | .000 |
| Pre-test | 3598.413 | 1 | 3598.413 | 209.214 | .000 |
| Anxiety | 509.137 | 2 | 254.569 | 14.801 | .000 |
| Error | 6897.058 | 401 | 17.200 | | |
| Total | 164623.000 | 405 | | | |
| Corrected Total | 12197.200 | 404 | | | |

The values F (2,401) = 14.801, Mean Square = 254.569, p = 0.000 showed a significant difference between the post-test scores of pupils with different levels of anxiety (LA, MA & HA). The ANCOVA results of comparing pupils' anxiety across the three groups (LA, MA & HA) on the dependent variable indicated that there were statistically significant differences between pupils' anxiety and the dependent variable. Therefore, the researchers further investigated the univariate statistics results (analysis of covariance ANCOVA) by performing a post hoc pairwise comparison using the LSD command for dependent variable in order to identify significantly where the differences in the means resided. Table 3 is a summary of the post hoc pairwise comparisons among pupils' learning across the three anxiety groups (LA, MA & HA).

TABLE III
SUMMARY OF POST HOC PAIRWISE COMPARISONS

| (I) Anxiety | (J) Anxiety | Mean Difference (I-J) | Std. Error | Sig.[a] |
|---|---|---|---|---|
| Low | Medium | -2.728[*] | .503 | .000 |
| | High | -1.392[*] | .595 | .020 |
| Medium | Low | 2.728[*] | .503 | .000 |
| | High | 1.335[*] | .553 | .016 |
| High | Low | 1.392[*] | .595 | .020 |
| | Medium | -1.335[*] | .553 | .016 |

Table II and Table III show that there are statistical differences among the pupils' learning in the three anxiety groups: there are statistical differences among pupils' learning in the low, medium and high anxiety groups in music theory learning. There are statistical differences between pupils' learning in low anxiety group and high anxiety group in music theory learning. The differences are presented below.

The medium anxiety group (Mean = 21.44, SD = 5.11) of pupils' learning significantly outperformed the low anxiety groupup (Mean = 17.44, SD = 5.20) and the high anxiety group (Mean = 17.23, SD = 4.98). There were significant differences between pupils' learning in the medium anxiety group and pupils' learning in the low anxiety group (p = 0.000). There were significant differences between pupils' learning in the medium anxiety group and pupils' learning in the high anxiety group (p = .016). Finally, there were significant differences between pupils' learning in the low and high anxiety groups (p = .020).

*D. Description of Post-test Scores of High Anxiety Pupils in Various Treatment Groups*

Table IV shows a difference between the means of post-test scores for groups with AI and groups with TI modes. The post-test scores mean of the group with AI (22.51) was higher than the post-test scores mean of group with TI (15.20). Moreover, it showed a difference between the means of post-test scores for the group with TI mode and the group with AIT mode. The mean of the post-test scores for the group with TI mode (15.20) was higher than the mean of the post-test scores for the group with AIT mode (14.06).

TABLE IV
POST-TEST SCORES OF HIGH ANXIETY PUPILS IN VARIOUS TREATMENT GROUPS

| Groups | Mean | Std. Deviation | N |
|---|---|---|---|
| AI | 22.5161 | 2.70642 | 31 |
| TI | 15.2059 | 4.02853 | 34 |
| AIT | 14.0667 | 3.09542 | 30 |
| Total | 17.2316 | 4.98818 | 95 |

*E. ANCOVA of Post-test scores of High Anxiety Pupils in Various Treatment Groups*

In order to reduce the statistical error, the pre-test score was used as the covariate and comparison was made between high anxiety pupils using AI mode and high anxiety pupils using TI mode, high anxiety pupils using TI mode and high

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anxiety pupils using AIT mode based on the mean of the post-test scores using the ANCOVA procedure (Table 5).

TABLE V
ANCOVA OF POST TEST SCORES OF HIGH ANXIETY PUPILS IN VARIOUS TREATMENT GROUPS

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 2048.394[a] | 3 | 682.798 | 213.880 | .000 |
| Intercept | 338.032 | 1 | 338.032 | 105.885 | .000 |
| Pre-test | 742.656 | 1 | 742.656 | 232.630 | .000 |
| Groups | 1248.733 | 2 | 624.366 | 195.577 | .000 |
| Error | 290.512 | 91 | 3.192 | | |
| Total | 30547.000 | 95 | | | |
| Corrected Total | 2338.905 | 94 | | | |

From Table V which shows the results of the ANCOVA test of statistical significance on the differences observed in the mean scores of the post-test for the various treatment modes with $F (2, 91) = 195.577$, Mean Square = 624.366 and $p = 0.000$. There is a significant difference in the post-test scores of high anxiety pupils among the three treatment modes.

The ANCOVA results of comparing high anxiety pupils across the three groups (AI, TI & AIT) on the dependent variables indicated that there were statistically significant differences of the post test scores between high anxiety pupils in the three groups. Therefore, the researchers further investigated the univariate statistics results (analysis of covariance ANCOVA) by performing a post hoc pairwise comparison using the LSD command for dependent variable in order to identify significantly where the differences in the means resided. Table VI is a summary of the post hoc pairwise comparisons between pupils' learning across the three groups.

TABLE VI
SUMMARY OF POST HOC PAIRWISE COMPARISONS

| (I) Groups | (J) Groups | Mean Difference (I-J) | Std. Error | Sig.[a] |
|---|---|---|---|---|
| AI | TI | 7.561[*] | .444 | .000 |
| | AIT | 7.918[*] | .459 | .000 |
| TI | AI | -7.561[*] | .444 | .000 |
| | AIT | .358 | .450 | .429 |
| AIT | AI | -7.918[*] | .459 | .000 |
| | TI | -.358- | .450 | .429 |

Table V and Table VI show that there are statistical differences among high anxiety pupils in the three groups in learning music theories. There are statistical differences between learning of high anxiety pupils in AI and TI group in music theory learning. There are statistical differences between learning of high anxiety pupils in AI and AIT group in music theory learning. Finally, there are no statistical differences between learning of high anxiety pupils in TI and AIT group in music theory learning. The differences are presented below.

The AI (Mean = 22.51, SD = 2.70) group of pupils' learning significantly outperformed the TI (Mean = 15.20, SD = 4.02) and the AIT (Mean = 14.06, SD = 3.09) groups. There were significant differences between learning of high anxiety pupils in AI group and learning of high anxiety pupils in TI group ($p = 0.000$). There were significant differences between pupils' learning in AI group and learning of high anxiety pupils in AIT group ($p = 0.000$). Finally, there were no significant differences between learning of high anxiety pupils in TI group and learning of high anxiety pupils in AIT group ($p =. 429$).

*F. Description of the Post-Test Scores by Anxiety in Various Treatment Groups*

Table VII presents the overall means and standard deviations of each post-test score by the interaction between the treatment modes and anxiety levels (low, medium and high). The mean scores of the AI group reported low anxiety (M = 23.13), medium anxiety (M = 27.72) and high anxiety (M = 22.51). The mean scores for the TI group reported low anxiety (M = 14.87), medium anxiety (M = 18.34) and high anxiety (M = 15.20). The mean scores for the AIT group reported low anxiety (M = 14.32), medium anxiety (M = 19.21) and high anxiety (M = 14.06).

TABLE VII
THE MEAN SCORE AND STANDARD DEVIATION OF THE POST-TEST SCORES BY ANXIETY IN VARIOUS TREATMENT GROUPS

| Groups | Anxiety | Mean | Std. Deviation | N |
|---|---|---|---|---|
| AI | Low | 23.1389 | 2.23163 | 36 |
| | Medium | 27.7213 | 2.13800 | 61 |
| | High | 22.5161 | 2.70642 | 31 |
| | Total | 25.1719 | 3.35817 | 128 |
| TI | Low | 14.8710 | 3.86214 | 31 |
| | Medium | 18.3421 | 2.88699 | 76 |
| | High | 15.2059 | 4.02853 | 34 |
| | Total | 16.8227 | 3.77072 | 141 |
| AIT | Low | 14.3250 | 3.53290 | 40 |
| | Medium | 19.2121 | 3.76835 | 66 |
| | High | 14.0667 | 3.09542 | 30 |
| | Total | 16.6397 | 4.33534 | 136 |
| Total | Low | 17.4486 | 5.20383 | 107 |
| | Medium | 21.4433 | 5.11555 | 203 |
| | High | 17.2316 | 4.98818 | 95 |
| | Total | 19.4000 | 5.49464 | 405 |

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*G. ANCOVA of Interaction Effect between Treatment Modes and Anxiety*

To examine if the effects of treatment mode on post-test scores depend on the anxiety level in AI mode, TI mode and AIT mode, analysis of covariance (ANCOVA) was conducted, while using the pre-test scores as the covariate.

TABLE VIII
ANCOVA FOR ANXIETY BY INTERACTION TREATMENT

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 10763.090[a] | 9 | 1195.899 | 329.389 | .000 |
| Intercept | 1249.034 | 1 | 1249.034 | 344.024 | .000 |
| pre-test | 2530.019 | 1 | 2530.019 | 696.848 | .000 |
| Anxiety | 725.456 | 2 | 362.728 | 99.907 | .000 |
| Groups | 4746.561 | 2 | 2373.280 | 653.678 | .000 |
| Groups * Anxiety | 43.471 | 4 | 10.868 | 2.993 | .019 |
| Error | 1434.110 | 395 | 3.631 | | |
| Total | 164623.000 | 405 | | | |
| Corrected Total | 12197.200 | 404 | | | |

Table VIII presents the results of the ANCOVA test, showing overall differences for the interaction between treatment modes and anxiety level effects on the post-test scores, while using the pre-test scores as the covariate. The ANCOVA results of the interaction effects on the post-test score was statistically significant F (4,395) = 2.993, and p = .019. This means that there were statistical interaction effects on the post-test scores across the three groups.

The ANCOVA results, as shown in Table VIII indicate that the main effects were found for either anxiety or treatment modes; however, both were almost significant, F (2, 395) = 99.907, p = 0.000 and F (2, 395) = 653.678, p = 0.000. This means that there are differences in the adjusted mean of the post-test score among the three treatment modes of pupils' anxiety. Although the effect of the treatment modes on the post-test scores depends on the anxiety level, there were differences in the post-test scores among the treatment modes for pupils of different anxiety levels. The AI mode had higher post-test scores than TI mode, and TI mode had higher post-test scores than the AIT mode.

The ANCOVA results of the interaction effects on post-test scores indicated that there were statistically significant interaction effects between the treatment modes and pupils' anxiety level.

## XI. DISCUSSION

This study found that there were differences in the post-test scores among pupils with different levels of anxiety in the three different treatment modes. Generally, pupils with moderate anxiety level outperformed pupils with high and low anxiety level regardless of the treatment modes. This result is consistent with many studies that show that student academic achievement is correlated to their level of anxiety [14]. Most of the studies show positive impact of moderate anxiety level on learning. This indicates that a certain degree of anxiety (not too high and not to low) helps students in their learning [5].

This study shows that students with a moderate anxiety level outperformed students with high and low anxiety level. This result is consistent with the finding by Toh [23] who reported a correlation between the anxiety level and student achievement. A study by Sawalhah & Assfa [12] also reported low anxiety students achieved higher gain scores compared to high anxiety students. There are several possible explanations to the findings of this study. Alshawa & Alhayek [10] indicated that minimal stimulus causes boredom among the low anxiety students whereas excessive stimulus will lower learning among the high anxiety students. This finding may explain the low achievement seen among the low and the high anxiety students. The low anxiety students may not pay sufficient attention to the instruction whereas high anxiety students may feel that the instruction may be too demanding. Warr & Downing [11] found that high anxiety students experience a high level of anxiety regardless of the test difficulty and this may contribute to their low unsatisfactory achievement. There are at least two possible theoretical explanations for this relationship. First, the pupils' lack of competency in music could be contributing to the increased mental effort. As described earlier, the results from this study showed a strong negative correlation between learning and anxiety. Pupils with high levels of anxiety performed poorly on the post-test scores. This implies that high anxiety pupils do indeed have lower levels of information processing. The second possible explanation to the detrimental effect of anxiety level on working memory capacity is discussed by Ashcraft & Kirk [50]. Intrusive thoughts and worry caused by reaction to anxiety can consume working memory resources, leaving fewer resources available for processing incoming information. As a result, high anxiety individuals are more likely to experience a cognitive overload, as they must attend to both the anxiety reaction and processing incoming information at the same time. Then the relationship between anxiety and mental effort can be explained by the extraneous cognitive load experienced by anxious students coping with the anxiety reaction

This study found that high anxiety pupils do not have the optimum condition for effective information processing. In this study high anxiety pupils using the AI mode performed significantly better than high anxiety pupils using the TI and AIT mode. According to Mayer [43] and cognitive load theory humans have a limited capacity in the amount of information that can be processed in each channel at any one time. From this account, it is not surprising that highly anxious pupils using AI mode reported low levels of mental effort than highly anxious pupils using TI mode. Since AI assisted in the reduction of intrinsic cognitive load, high anxiety pupils will experience lower levels of cognitive load when processing incoming information. In this way the information processed through the two channels are balanced, that is, neither one of the channel is overloaded.

Recent study has examined the possibility that anxiety may interfere with the working memory. In the TI mode when attempting to complete a music theory unit, highly anxious individuals devote a portion of their limited working memory resources to dealing with the worry and intrusive thoughts

brought on by the anxiety reaction. In the TI mode the image and the text are transported through the visual channel only; because of the limited capacity of the visual channel there is a condition of cognitive overload. As a result, in the TI mode fewer working memory resources remain available to deal with the task at hand. This puts anxious individuals at a severe disadvantage, as they are more likely to experience cognitive overload.

The results from several studies support this hypothesis, Low & Sweller [51] proposed that one way to reduce extraneous cognitive load is to minimize unnecessary demands on the working memory capacity so that cognitive resources can be freed to concentrate on essential activities. From this perspective, one way to reduce cognitive load is to diminish the pupils' anxiety so as to decrease the consumption of the limited, yet precious, working memory resources and devote them to the learning tasks.

In light of the findings of this study, it can be concluded that there is evidence supporting the existence of a relationship between anxiety and cognitive load. According to Chen & Chang [19] pupils with higher levels of anxiety tend to incur a higher cognitive load in the learning process. Anxiety causes worry, and worry always impairs performance on tasks requiring high attention or short-term memory. In other words, anxieties consume the working memory's processing resources, leaving less capacity for cognitive tasks and, hence, negatively affect learning. According to cognitive load theory [38] and Mayer's theory of multimedia learning [43], presenting information in two sensory modalities rather than one leads to a more efficient use of the working memory resources so that cognitive overload is prevented and learning is improved.

In the AI mode, the image is processed through visual channel in the working memory while the narrated text is processed through the auditory channel in the working memory. Apparently the AI mode is able to reduce anxiety level in the pupils and this will produce a more effective conducive condition for information processing; hence results in better learning.

The result in this study showed, no statistical difference between high anxiety pupils using the TI mode and high anxiety pupils using the AIT mode. In the TI mode, the text is being displayed simultaneously with the images, but no audio is given. Here, the music theory was shown as a text (as written text on the screen) in addition to the images but with no audio. And in the AIT mode music theory was shown as a text (as written text on the screen) in addition to images (as in first and second treatments), However, the music theory was shown in a more redundant manner than the other treatments (more ways for the same concept) by adding the audio effects. According to the cognitive theory of multimedia learning both TI and AIT modes use the visual channel to transport the printed text and image. According to Mayer [43] humans have limited capacity in the amount of information that can be processed in each channel and that at any one time there is the condition of cognitive overload.

The cognitive load theory and the split-attention effect indicate that the use of different information sources causes a higher cognitive load of working memory, and therefore,

impedes the learning process. This effect is due to the fact that pupils in the visual-only condition were required to process all incoming information through the visual channel. As a result, the auditory channel was left unused, and the visual channel was overloaded as it was required to process both the printed text and image.

Pupils using the TI and AIT mode experience greater cognitive load because they must alternate between looking at the diagrams and written text. In other words, when learning from both the written text and diagrams, participants must read some text, hold it in the working memory, switch to the diagram, find the appropriate section of the diagram related to the text, and mentally integrate the two pieces of information before reading the next line of text. This process of holding written text in the working memory while searching for the appropriate part of the diagram is thought to consume more working memory resources than looking at a diagram while simultaneously listening to the narration.

Results from the present study demonstrated interaction between anxiety and treatments; meaning that learning under the three treatments was affected by the pupils' anxiety level. AI mode has showed a positive effect on learning held by all pupils of various anxiety levels and primarily by the pupils with high anxiety levels. Since AI mode assists in the reduction of intrinsic cognitive load, the pupils with higher levels of anxiety will experience lower levels of cognitive load when processing incoming information. In this way the information processed through the two channels are balanced, that is, neither one of the channel is overloaded. Therefore, the AI mode reduced the working memory load among pupils with high anxiety levels, stimulated the best use and retrieval of cognitive abilities to process musical data which contributed to positive results of the students' overall achievements.

## X. CONCLUSIONS

This study found that the use of narrated text with animated images reduced the cognitive overload and increased the working memory capacity resulting in better music theory learning. The study also found that medium anxiety pupils significantly performed better than low and high anxiety pupils. However, the incorporation of the modality principle does help improve information processing in high anxiety pupils. Extraneous redundant information seems increase the cognitive overload and decreased the working memory capacity. Instructional designers should be cautious and economical in the incorporation of redundant multimedia information in educational learning materials.

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